BULLETIN 71

Mineral Resources of Taos County, New Mexico

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Description of mineral deposits, prospects, and mines as related to regional geology, with discussion of future possibilities and guides for exploration and development

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Contents

Page

Page

Illustrations

TABLES *Page*

FIGURES

PLATES

Abstract

Taos County has yielded a variety of metals and minerals, and has excellent future possibilities. Early prospecting was mainly for gold and copper, but production was small. Later, the county became an important producer of molybdenum, perlite, beryl, tantalum, and lithium. Smaller amounts of optical calcite, tungsten, scoria, silver, lead, zinc, bismuth, sand and gravel, and limestone also have been mined.

Precambrian pegmatites and copper- and tungsten-bearing quartz veins occur in the Picuris and Taos Ranges. Deposits of kyanite and sillimanite, graphite, and iron oxides are found in the Precambrian rocks in the mountains. Abundant limestone and a little impure "coal" are found in the Paleozoic sedimentary rocks of the "Tres Ritos hills." Miocene(?) hydrothermal veins and disseminated deposits, mainly in the Taos Range, contain molybdenum, copper, lead-zinc, gold, silver, and fluorite; disseminated deposits of molybdenum and copper may occur in the altered area along the Red River. Gold placers are found along the valleys in the Taos Range and along the Rio Grande and its tributaries in the Taos Plateau. Pleistocene(?) perlite and scoria deposits are found on the Taos Plateau. Sand and gravel are widespread and abundant.

Some of the mineral deposits that have not been mined show possibilities for future profitable exploitation. More detailed study is needed to evaluate such possibilities properly.

Introduction

PURPOSE AND SCOPE

This report provides information of value to persons interested in the mineral resources (excluding water, oil, and natural gas) of Taos County, New Mexico.

Sections covering the geographic features, geologic setting, and mining history and production are included to give background information. The geology and geographic distribution of the various types of mineral deposits in the county are given, and the prospects and mines that explore and develop each group are listed. The individual mines and prospects, grouped geographically, are described in varying detail. The future possibilities and guides for exploration and development are given for each substance (i.e., perlite, copper, pegmatite minerals, kyanite-sillimanite, placer gold, coal, etc.), but not for individual prospects; economic considerations are not covered in any detail.

It is hoped that this report will encourage the development of Taos County's mineral resources by providing a foundation for more detailed work. It is not designed to replace the more detailed studies of certain areas, but rather to complement them. Information contained in other reports has been summarized, and publications containing pertinent information not included are mentioned at appropriate places in the text. In addition, much previously unpublished information has been incorporated, which otherwise might be lost through the caving of workings, the destruction of records, and the death of "eye witnesses."

METHODS OF INVESTIGATION

Two types of work were done: (1) examination in the field, and (2) compilation of previous studies.

Although the location of many of the mines, prospects, and other mineral occurrences were known before they were visited, many others were located by a series of traverses by car and on foot. No attempt was made to cover the county so intensively that every prospect would be located—to do so would provide few additional data while increasing the time consumed manyfold.

The mineral deposits were examined in varying detail. Many were mapped; the surface features usually by planetable methods, and the underground workings by Brunton compass and tape. Specimens showing the mineralization, alteration, and country rock were collected for laboratory study and assaying. The field work was done during 1959.

A careful study of the literature was made for other information. In addition, much unpublished information was gathered from individuals, company records, and the files of the New Mexico Bureau of Mines and Mineral Resources.

PREVIOUS WORK

The numerous publications containing information about the mineral resources of Taos County are listed on pages 116-118. However, much of the work done (mine examinations, exploration, mining, etc.) has not been described in any publication, although many unpublished reports and maps have been made.

The writer first became interested in Taos County during the summer of 1950, while serving as an assistant to Philip McKinlay (1956, 1957), then of the New Mexico Bureau of Mines and Mineral Resources, who was mapping the geology of the Taos Range. Later, during 1951-55, a total of 14 months was spent examining the Questa molybdenum mine and surrounding area (Schilling, 1956).

ACKNOWLEDGMENTS

The writer is deeply indebted to Philip McKinlay, who has supplied so much useful information about the geology and ore deposits of Taos County. His field notes from the Taos Range mapping project added many details about the prospects, too numerous to acknowledge properly in the text.

Many residents of Taos County gave their wholehearted cooperation. Special thanks are offered to Walter and Winifred Hamilton, of Red River, for much information, especially about the Placer Creek area; Arthur Montgomery, of Dixon, for much information and numerous suggestions relating to the Picuris mining district; and 0. B. Siler, of Taos, for maps and information about the Black Copper mine. Robert J. Wright and Jack Sheridan, of American Metal Climax, Inc., J. B. Carman and A. L. Greslin, of the Molybdenum Corporation of America, M. B. Mickelsen, of the Johns-Manville Perlite Corp., and Fred Vernon, of the Denver & Rio Grande Western Railroad, also supplied important information.

Bureau and Institute personnel assisted in a number of ways. George B. Griswold, Edmund H. Kase, Jr., and Robert H. Weber read the report and made many helpful suggestions. Mrs. Nadine Richards typed the manuscript. William Arnold and Robert Price drafted most of the figures. Carl F. Austin helped with the mapping of underground workings. Robert H. Weber supplied information about the No Agua perlite deposit. Charles Treseder did the photographic work necessary in preparing the plates.

My wife, Constance, was my field assistant and has helped in so many other ways; her cheerful assistance and encouragement are deeply appreciated.

The help of the many other individuals who have not been mentioned by name is gratefully acknowledged.

Geographic Features

LOCATION AND ACCESSIBILITY

Taos County is in northernmost central New Mexico (fig. 1). It has an area of 2,256 square miles and a population of 17,305 (1950 census). Taos is the county seat and largest town (other towns are shown on fig. 2). Tourists, mining, lumbering, cattle and sheep raising, and irrigated farming are the main sources of revenue.

A number of State and Federal highways cross the county; there are also many secondary roads, some of which are unmaintained and primitive or impassable (fig. 2). Much of the relatively flat western half of the county is readily accessible by using a jeep or pickup truck to travel cross country between roads. In contrast, many areas in the mountainous eastern and southern parts of the county can only be reached on foot or by horse. There are good, but commonly unpaved, roads along the major canyons, from which jeep roads extend into the "high country." (A section below, Base Maps, describes maps showing roads.)

Taos is handicapped by its lack of railroads; distances to railroad shipping points are great except for the northwestern corner of the county (fig. 1). The closest railroad shipping point to most of the county is on the Denver & Rio Grande Western Railroad, at Antonito, Colorado, 5 miles north of the Colorado-New Mexico Stateline. Various stations on the Atchison, Topeka & Santa Fe Railway lines to the south and east of the county are the closest shipping points to the extreme eastern and southern parts of the county. Of course, the choice of a shipping point depends not only on the location of the ore deposit, but also on the ultimate destination.

BASE MAPS AND AERIAL PHOTOGRAPHS

A number of base maps and aerial photographs are available which are of value to those interested in the mineral resources of Taos County.

PLANIMETRIC MAPS

A county map issued as ozalid prints by the New Mexico State Highway Department, Santa Fe, New Mexico, shows roads, towns, drainage, and land boundaries, including townships and sections, at a scale of 1 inch to 2 miles. This map may be ordered from the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico.

Planimetric maps of 15-minute quadrangles issued as ozalid prints by the U. S. Forest Service (scale: 2 inches to 1 mile) and the U. S. Soil Conservation Service (scale: 1 inch to 1 mile or 2 inches to 1 mile) show drainage, roads and other works of man, land boundaries, and principal topographic features indicated by hachures; Forest Service maps also show trails. Over 85 percent of the county is covered by these maps.

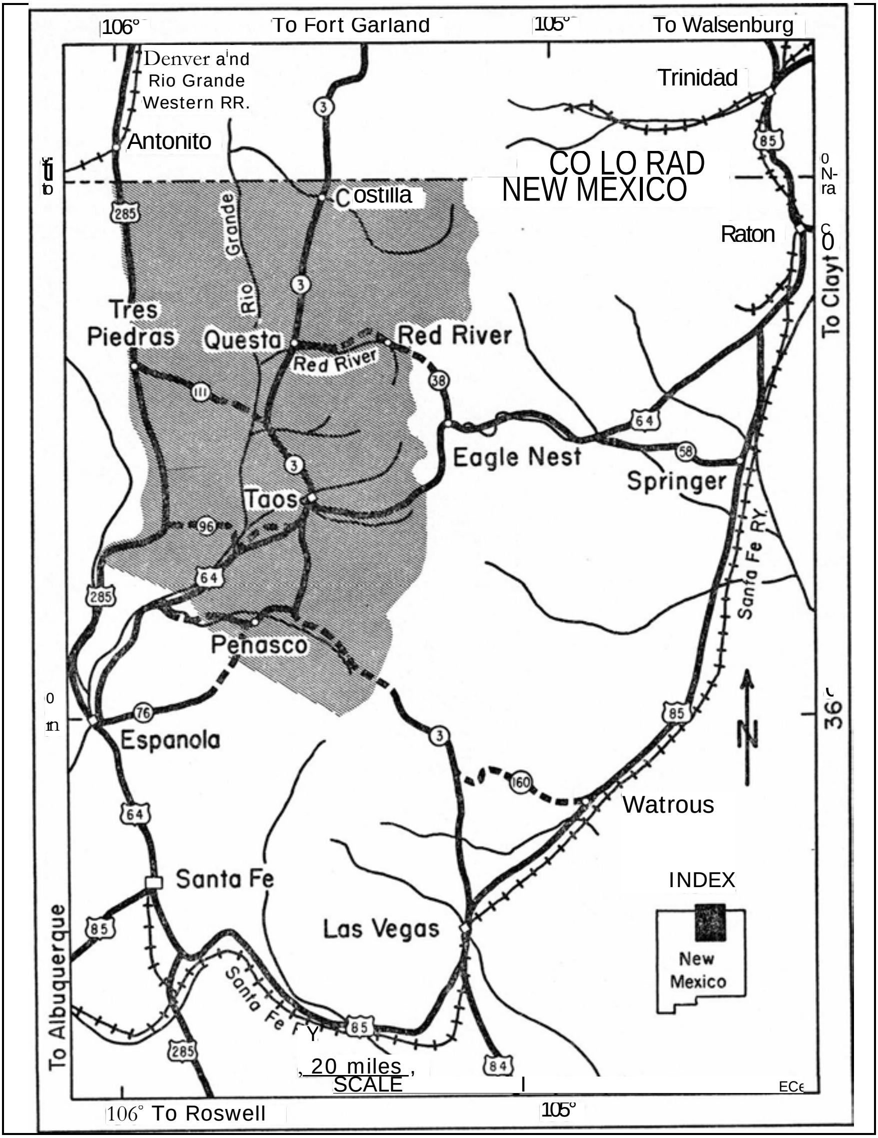


Figure 1

INDEX MAP OF TAOS COUNTY

The county is shown by the lined pattern.

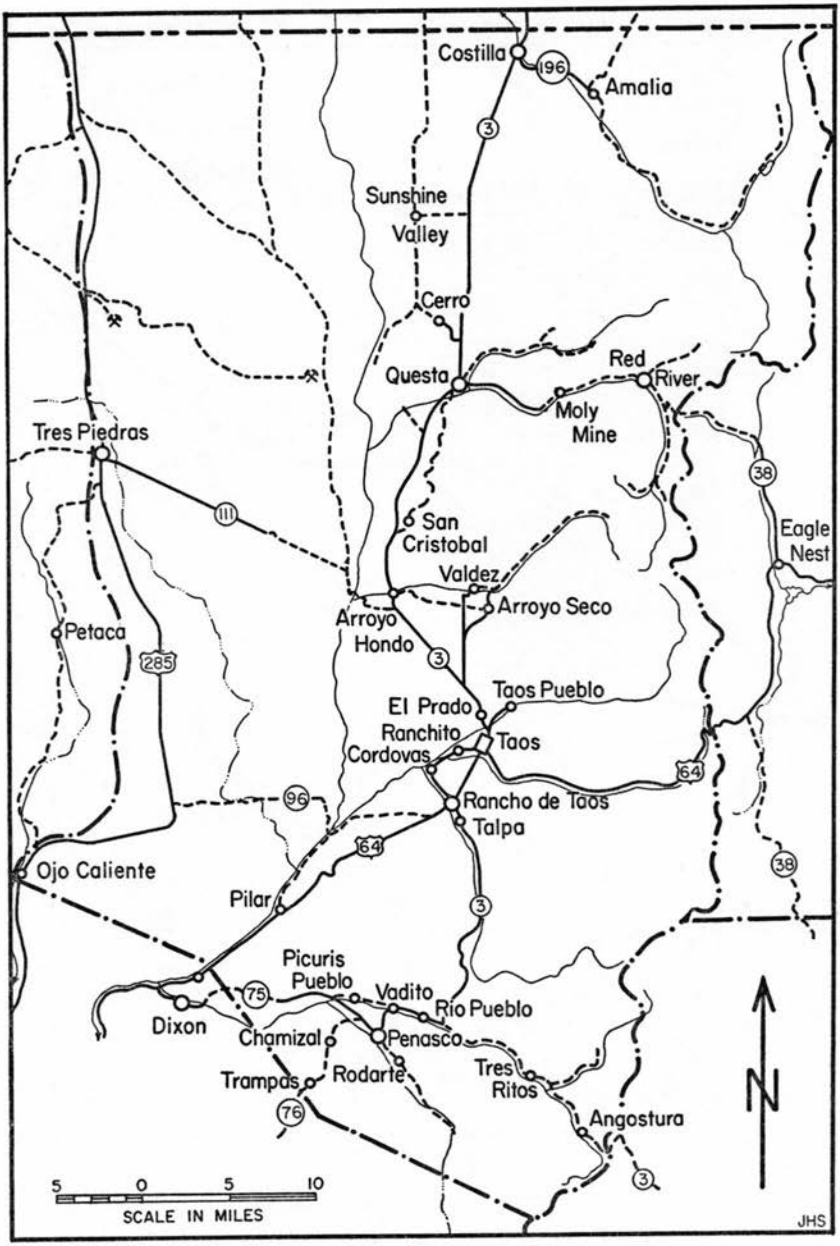


Figure 2
MAP OF TAOS COUNTY
Showing roads (unpaved, dashed) and towns.

Indices to available maps are on file at the Cartographic Unit, U. S. Soil Conservation Service, Fort Worth, Texas, and the Mapping and Cartography Division, U. S. Forest Service, Albuquerque, New Mexico.

TOPOGRAPHIC MAPS

Topographic maps, in addition to showing drainage, land boundaries, and works of man, indicate by means of contours the shape and elevation of the land surface.

The Army Map Service 6-color topographic map (NJ 13-11; scale: 1 inch to 4 miles) of Raton quadrangle covers all of Taos County except the extreme southwestern corner. In addition to the usual features, the wooded areas are shown in green. An excellent plastic relief edition of this map is available, which shows the topography in three dimensions. These maps may be ordered from the Geological Survey, Federal Center, Denver, Colorado.

The U. S. Geological Survey, Washington, D. C., has issued topographic maps covering several areas of Taos County. These maps show contours, drainage, land boundaries, and works of man, usually in four colors. They may be ordered from the U. S. Geological Survey, Federal Center, Denver, Colorado, or from the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico.

AERIAL PHOTOGRAPHS AND MOSAICS

Aerial photographs covering the county have been prepared for various Federal agencies. Most of these photographs are 10- x 10-inch contact prints at scales ranging from 1:15,840 to 1:60,000. The Soil Conservation Service also issues controlled 71/2-minute and 15-minute mosaics covering the entire county at scales of 2 inches to 1 mile and 1 inch to 1 mile. Indices to available photographs and mosaics are on file at the Cartographic Unit, U. S. Soil Conservation Service, Fort Worth, Texas, and the Mapping and Cartography Division, U. S. Forest Service, Albuquerque, New Mexico.

FURTHER INFORMATION

Further information concerning maps and aerial photographs and mosaics, especially about new maps published since this report was written, may be obtained from the Map Information Office, U. S. Geological Survey, Washington 25, D. C., and the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico.

PHYSICAL FEATURES

The western half of Taos County is a level plateau, whereas the eastern and southern areas are mountainous. The physiographic subdivisions are shown in Figure 3 and described below. The highest point is Wheeler Peak (13,160 ft), the highest point in New Mexico; the lowest

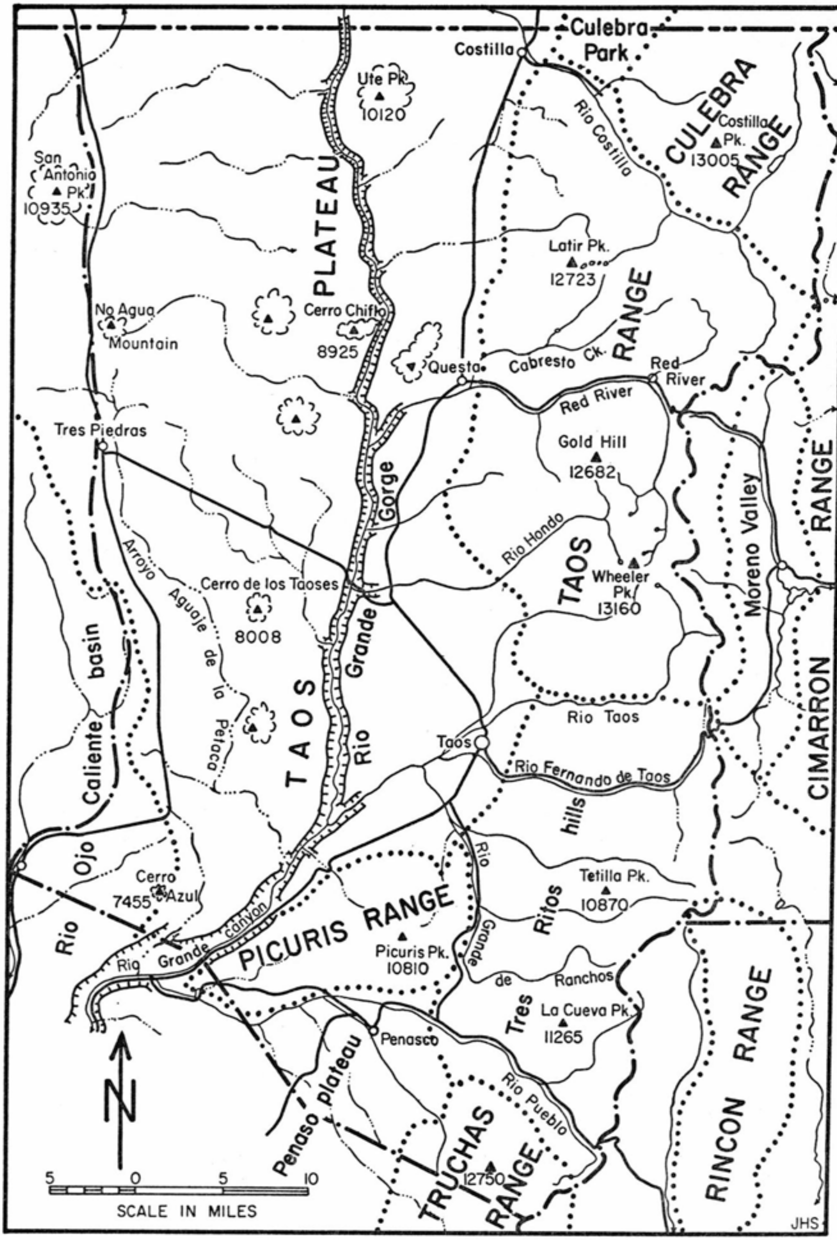


Figure 3
PHYSICAL FEATURES OF TAOS COUNTY

point in the county is on the Rio Grande (5,870 ft) at the southwest edge of the county. The Rio Grande and its tributaries drain the entire county.

RIO GRANDE DEPRESSION

Taos Plateau. The Taos Plateau, also called the Taos Plain, covers the western half of the county. It is part of the Rio Grande Depression and a southern extension of the San Luis Valley of Colorado. The Plateau slopes gently up to the mountains to the east and west, and ranges in altitude from 6,900 to 8,100 feet. Hills—the larger could just as easily be called mountains—dot the plateau.

Rio Grande Gorge. The narrow, steep-walled Rio Grande Gorge cuts southward across the Taos Plateau, deepening toward the south from 300 feet, at the Colorado line, to over 1,000 feet, at Pilar. East of the gorge, shallow, dry arroyos and deep valleys with flowing streams cut westward and southwestward from the mountains to the Rio Grande. West of the gorge, there are no flowing streams, and the arroyos trend southeast.

Culebra Park. Culebra Park, a plateau located mainly in Colorado but extending a short distance into New Mexico, stands 400 feet above the San Luis Valley to the west, from which it is separated by a north-trending escarpment.

Penasco plateau. South of the Picuris Range is a highly dissected plateau which rises gently eastward toward the Sangre de Cristo Mountains. In this report, this geographic subdivision is referred to as the "Penasco plateau."

SANGRE DE CRISTO MOUNTAINS

Culebra Range. The Culebra Range of the Sangre de Cristo Mountains is located mainly in Colorado but extends southward into Taos County. The Rio Costilla canyon separates this range from the Taos Range to the south.

Taos Range. The rugged Taos Range of the Sangre de Cristo Mountains occupies much of the eastern half of the county. Prominent features of the range are: its steep south-trending western front, which rises abruptly over 2,000 feet from the 8,000-foot altitude of the Taos Plain; the high peaks (fig. 3) grouped into several massifs that reach up above the timberline (11,800 ft); and the deep canyons cut by the major perennial streams (fig. 3). Over 90 percent of the range is drained by streams that flow westward into the Rio Grande.

Picuris Range. The Picuris Range, also called the Picuris Prong, is an isolated spur projecting southwestward from the main south-trending Sangre de Cristo Mountains. It is a maze of ridges and deep canyons, its main crest rising gradually northeastward from 6,000 feet to the 10,810-foot altitude of Picuris Peak, where there is an abrupt drop of several thousand feet eastward. One slope of the range drains north-westward into the Rio Grande, the other draining southward into the perennial Rio Pueblo; all streams are intermittent.

Tres Ritos hills. South of the Taos Range and east of the Picuris Range is a lower lying segment of the Sangre de Cristo Mountains. It is a region of deep canyons cutting into a rolling upland; only a few small areas are higher than 11,000 feet. In this report, this geographic subdivision is referred to as the "Tres Ritos hills."

Truchas Range. The Truchas Range of the Sangre de Cristo Mountains extends only a short distance into the southern part of the county.

CLIMATE

Except in the higher elevations, the climate of Taos County is semiarid. (See table 1 for climatological data.) Days are characteristically much warmer than the nights, and extremes of hot and cold are uncommon except for the subzero winter temperatures of the high peaks. The average temperatures decrease with increasing altitude, the mountains having a much cooler climate than the plateau. Sunny weather predominates throughout the county, with cloudy days more frequent in the mountains than on the plateau. Spring is windy, and at this season dust storms are common on the plateau.

The rainy season is during July and August, when afternoon thunderstorms are common; spring showers occur in May. The runoff accompanying these storms frequently blocks and damages the roads. In the summer, the moisture falls as rain and hail except on the higher peaks, where snowstorms also are frequent occurrences. In the winter, although the heaviest snowfall is limited to the higher parts of the

TABLE 1. CLIMATOLOGICAL DATA FOR TAOS COUNTY

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

STATION	ALTITUDE (feet)	TEMPERATURE (degrees Fahrenheit) JANUARY AVERAGE	JULY AVERAGE	MAXIMUM	MINIMUM
Taos	6,960	26.3	68.5	101	—27
Cerro	7,550	20.7	64.4	100	—34
Tres Piedras	8,100	20.4	62.9	93	—35
Red River	8,680	18.8	59.4	94	—34

STATION	ALTITUDE (feet)	PRECIPITATION (inches) WETTEST MONTH (average)	DRIEST MONTH (average)	ANNUAL AVERAGE
Taos	6,960	1.85 (July)	0.49 (Dec.)	12.71
Questa	7,450	2.73 (July)	0.58 (Nov.)	15.71
Cerro	7,550	2.52 (Aug.)	0.34 (Nov.)	13.87
Tres Piedras	8,100	2.96 (July)	0.70 (Nov.)	15.84
Red River	8,680	3.69 (July)	0.94 (Nov.)	22.04

mountains, snow makes field work useless in most other areas in the mountains. Although snow remains on the high peaks until August, the plateau is often bare of snow during the winter. More rain and snow fall in the mountains than on the plateau, the amount of precipitation increasing with increasing altitude. Because of their proximity to high areas, the canyons and areas along the mountain front (e.g., Red River and Questa in table 1) have more precipitation than other areas at the same altitude.

VEGETATION

The Taos Plateau is covered with sagebrush. The Picuris Range and Penasco plateau, as well as hills and margins of the Taos Plateau, are wooded with pirion, juniper, scrub oak, and mountain mahogany. Valleys with flowing streams are lined with cottonwood trees and willows. In the Picuris Range, high areas and sheltered canyons have stands of Ponderosa pine.

Over much of their area, the Sangre de Cristo Mountains are forested. Ponderosa pines give way with increasing altitude to Douglas fir, aspen groves, and grassy meadows. Spruce and fir are common throughout the mountains but are more abundant at the higher altitudes. Above timber-line, the only vegetation consists of alpine grasses, sedges, and herbs. Lower, south-facing slopes are covered by pillion, juniper, scrub oak, and mountain mahogany. The lower reaches of the canyons have cottonwood trees, willows, and Ponderosa pines.

History of Mining

The earliest mining in Taos County was done by the Indians. Their efforts were on a very small scale and restricted to the surface mining of nonmetallic substances, such as clay for pottery, ocher for pigments, and various rock types for arrowheads.

According to legend, Catholic priests, prior to 1680, mined gold, silver, and copper in Taos County, using slave labor. The mines reportedly were extremely rich, "$10,000,000 [being] collected by the priests as tithes from a single mine in the Taos mountains." The Spaniards probably did recover some gold from placer deposits, and may have done some prospecting for other minerals, but it is doubtful that they did any underground mining or had the technical knowledge needed to convert ore to metal on any but the smallest scale.

Tales of fabulously rich "lost" mines are commonplace in the Southwest, and are often accepted without reservation as the truth. Most such tales have no basis in fact. They owe their origin to the tendency to expand a story with each retelling; the need for an alibi to account for the possession of "high-graded" gold; the mistranslation of the Spanish word *mina* in old documents as *mine,* when it also means, in older Spanish, simply *locality where minerals are found;* or to the attempts of dishonest promoters to sell stock in worthless prospects.

Prospecting first began on an important scale after 1866, when rich gold placers were discovered at Elizabethtown just east of Taos County. The Copper King copper mine, initially worked in 1867, was the first known mine to be developed. Most of the early prospecting, however, was for placer gold. Numerous placer deposits were located in the Taos Range; most of these soon were worked out or proved of too low grade to mine.

In the 1880's, the main effort had switched from the placers to a search for gold and copper lode deposits. Prospectors swarmed over the Taos Range, and most of the areas showing any promise were staked and worked extensively.

In 1893, the camps of Amizette and Twining along the Rio Hondo boomed as gold lodes were discovered in the surrounding area. The short-lived activity at the Frazer copper mine revived interest in the area, but by 1906 both towns had almost disappeared.

Gold lodes also were discovered at the headwaters of Bitter Creek, and over the divide to the east on tributaries of Comanche Creek. The towns of LaBelle, Anchor, and Midnight sprang up but soon died when the "mines" proved unworthy of the name.

In 1895, a number of gold prospects were located along the Red River (then known as the Rio Colorado or Colorado Creek). The town of Red River grew up in the middle of these prospects. By 1897, Red River had 14 saloons and about 2,000 people (Reed, 1922, p. 3; this

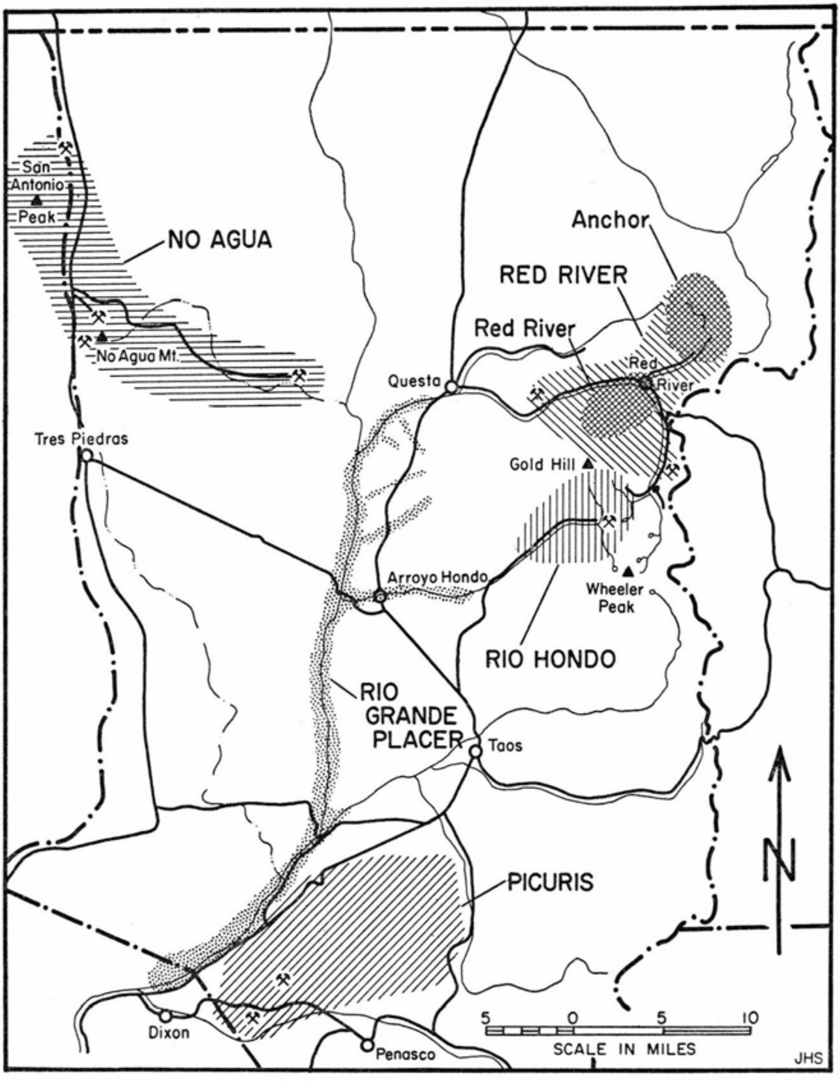


Figure 4

MINING DISTRICTS OF TAOS COUNTY

Much confusion exists as to the names and extent of the districts. The Red River and Anchor subdistricts commonly are included in a much larger Red River district, which in its broadest application extends west to the Questa Molybdenum (Moly) mine and southeast to the Black Copper mine. No Agua is a new district established in this report and defined as including the perlite and scoria deposits of northwestern Taos County.

population figure probably includes the people living at the various mines and prospects in the vicinity).

Although a few high-grade gold pockets were mined, no large deposits were found. A combination of low-grade ore, excessive water in the workings, poor mining and milling methods, and ownership disputes caused a rapid decline in activity after 1900. A last "boomlet" occurred in 1904, when a rich pocket of gold was found in the Independence mine on Bitter Creek. Intermittent attempts have been made up to the present time to operate various gold properties, but with little success. Too often, elaborate mills were built first, then frantic and unsuccessful attempts were made to find ore. Shafts were popular and were used where adits would have been better and cheaper. Reed (1922, p. 21) states: "Many of these prospects [Red River mining district] have been developed by men who thought that if there was ore the whole area should be ore. They evidently located their mines near town for convenience." However, although poor management caused difficulties, in nearly all cases so little gold, copper, or lead-zinc ore was found that profitable mining would have been impossible.

Anderson (1957, p. 145) estimates that the total gold, silver, copper, and lead produced in Taos County prior to 1923 had a value of less than $100,000, and there has been very little production of these metals since then. The small dumps and tailing piles of the mines indicate that production could not have been large.

The first important mine in Taos County was the Questa Molybdenum (Moly) mine. Production was continuous from 1922 to 1958 (fig. 13). For many years this mine was one of the largest producers of molybdenum in the world.

Beginning with World War II, the Harding pegmatite mine, operated by Arthur Montgomery and Flaudio Griego, has been an important producer of strategic minerals. The mine is one (the larger) of only two producers of microlite (a tantalum mineral) in the world. Tantalite-columbite (tantalum-columbium), beryl (beryllium), and spodumene (lithium) also were produced during World War II. Since 1950, the mine has been one of the leading producers (in some years, the largest) of beryl in the United States.

In 1948, a huge perlite deposit was discovered at No Agua Mountain. Three separate mines now are operating in the deposit, and a fourth mine has begun production from a separate deposit 10 miles to the east, making Taos County one of the important perlite-producing centers in the world (fig. 43).

Taos County has become an important mineral producer, and the area has excellent possibilities for the future. Unfortunately, the development of the county's resources has been hindered by the promotion of worthless or even nonexistent mineral deposits, and by the misuse of money obtained to explore and develop promising deposits.

Geologic Setting

INTRODUCTION

Taos County is divided into four areas of contrasting geology and topography.

The flat downfaulted Rio Grande Depression of the western half of the county is filled with Tertiary and Quaternary bolson gravels and interbedded basalt flows, on which are scattered the eroded remnants of volcanoes and extrusive domes. High-angle faults separate this area from the Sangre de Cristo Mountains to the east.

The uplifted Sangre de Cristo Mountains expose Precambrian granite and metamorphic rocks over extensive areas. Foliation is well developed in the Precambrian rocks, striking predominantly east to north, with steep to vertical dips. Tertiary andesite, quartz latite, and rhyolite flows and pyroclastic rocks, as well as clastic sediments, overlie the Precambrian rocks in the northern half of the Taos Range; Tertiary dikes and granitic bodies have intruded the other rocks. High-angle faults trending north to east are common throughout the mountains; thrust faults occur along the east edge of the Taos Range.

In contrast to the rest of the Sangre de Cristo Mountains, the Tres Ritos hills area and the southeastern corner of the Taos Range expose Mississippian, Pennsylvanian, and Permian arkosic sandstone and conglomerate, shale, and limestone. These beds have been folded gently along north-south axes.

A prominent downfaulted zone extends east-west across the Taos Range at Red River. Rocks in this zone are highly brecciated and altered, and weathering and erosion have produced distinctive, bare, yellow "badlands" found nowhere else in the county.

THE ROCKS

PRECAMBRIAN

Metamorphic Complex

All the Precambrian rocks of Taos County, except the granite, pegmatites, and diabase, are grouped together in this report into a metamorphic complex. The rocks of this complex crop out mainly in the Taos and Picuris Ranges, as well as in small areas on the Taos Plateau and in the Tres Ritos hills.

In the Taos Range, this complex includes metaquartzite, amphibolite, quartz-mica schist, graphite gneiss, and sillimanite schist. The quartzite along lower Cabresto Canyon was named Cabresto metaquartzite by McKinlay (1956, p. 8), who tentatively assigned the thicker metaquartzites throughout the Taos Range to this formation; the metaquartzites of the southern part of the Taos Range earlier had been called Pueblo quartzite by Gruner (1920). The other rock types of the complex were called "undifferentiated metamorphics" by McKinlay (1956, p. 7-8; 1957, p. 4-5).

In the Picuris Range, metaquartzite, phyllite, amphibolite, quartz-mica schist, and sillimanite-kyanite gneiss and schist are common. Montgomery (1953, p. 6-32) has described the metamorphic complex of the Picuris Range in detail as the Vadito and Ortega formations.

Precambrian metaquartzites also crop out at Cerro Azul on the southern edge of the Taos Plateau and along the Rio Pueblo in the Tres Ritos hills.

The individual units of the metamorphic complex have been delineated only within the Picuris Range (Montgomery, 1953). The thickest metaquartzite sequence apparently lies near the base of the complex; thus, the lower quartzite member of the Ortega formation in the Picuris Range and the Cabresto metaquartzite of the Taos Range may be equivalent. Precambrian granite, pegmatite, and diabase have intruded the Precambrian complex.

Granite

Gray to pinkish granite crops out over large areas of the Culebra, Taos, and Picuris Ranges, as well as on the Taos Plateau at Tres Piedras.

The granite varies from a fine-grained aplite to pegmatitic material, including both equigranular and porphyritic varieties. Foliation may be well developed or entirely absent. In general, the granite is composed of microcline, quartz, albite-oligoclase, and biotite or muscovite.

Montgomery (1953, p. 37) gave the name Embudo granite to the Precambrian granite of the Picuris Range; Just (1937, p. 24) had used the name Dixon granite. The Precambrian granite intruded the metamorphic complex as dikes and stocks and is unconformably overlain by Mississippian and younger rocks.

Pegmatites

Pegmatite dikes occur in the other Precambrian rocks, especially in and near Precambrian granite. They range from thin stringers to large lenses 50 or more feet wide and over 2,000 feet long. Most have simple compositions—quartz, orthoclase, albite, and muscovite; a few contain valuable minerals.

Diabase

Diabase dikes and irregular bodies occur in the Precambrian rocks, but are not found in any of the younger rocks.

MISSISSIPPIAN

Only small erosional remnants of Mississippian rocks are found in Taos County. Some 140 feet of Mississippian limestone, sandstone, and conglomerate crops out along the northeast corner of the Picuris Range, and has been assigned to the Arroyo Penasco formation by Armstrong

(1955, p. 20). A thin sequence of limestone, dolomitic limestone, and a few thin sandstone beds overlying Precambrian rocks in the high country around Wheeler Peak also may be Mississippian in age.

PENNSYLVANIAN-PERMIAN

Pennsylvanian and Permian sediments crop out over nearly the entire area of the Tres Ritos hills, along the eastern edge of the Picuris Range, and along the eastern and southern edges of the Taos Range, as well as in scattered outcrops within the latter range.

Sandia Formation

The Sandia formation consists of thick beds of conglomeratic sandstone, siltstone, carbonaceous shale, and some thin limestones. It is Pennsylvanian in age.

Madera Limestone

The Madera limestone lies conformably on the Sandia formation. There are two distinct units: (1) a lower, gray limestone member with interbedded shale, siltstone, and thin sandstones; and (2) an upper, arkosic limestone member of coarse-grained conglomeratic arkosic sandstone, fossiliferous gray limestone, gray and olive shales, and thinner purple and red shales. These members have a gradational contact. The Madera limestone is Pennsylvanian in age.

Sangre de Cristo Formation

The Sangre de Cristo formation is conformable and intertongues with the underlying Madera limestone. This formation consists of conglomerate, conglomeratic arkosic sandstone, red, green, and gray shale and siltstone, and rare thin limestones. It is late Pennsylvanian and early Permian in age.

TERTIARY

Tertiary volcanic, intrusive, and clastic sedimentary rocks are widespread in Taos County. The relationships of the various units to one another are complex and poorly understood. Locally the Tertiary rocks have been divided into mappable units, which, because of the complex relationships and limited extent of most of the units, can at best be correlated and dated only approximately.

Volcanic Complex

A thick, complex sequence of volcanic flows and pyroclastic rocks crops out over much of the Taos Range north of the Red River, as well as on the north side of the Gold Hill massif south of the town of Red River.

The volcanic complex can be divided in a general way into three units: (1) a lower sequence composed predominantly of andesite; (2)

a middle sequence composed predominantly of quartz lathe; and (3) an upper sequence of rhyolite. The contact between these units is gradational vertically and laterally, and each unit contains rock types typical of the other units. The maximum thickness of this complex is over 3,000 feet.

The andesites and quartz latites are gray and purplish gray; the rhyolites are white to light gray. The flows of all three rock types include porphyries and aphanites, and less commonly glasses and phanerites; the pyroclastic rocks range from breccias, with rock fragments over 3 feet in diameter, to fine-grained tuffs.

McKinlay (1956, p. 12-15; 1957, p. 8-10) divided the volcanic complex into the three units described above, and called the middle unit the Latir Peak latite. Schilling (1956, p. 23-25) divided the complex along the lower Red River into two units: a lower, "andesitic series," and an upper, "rhyolitic series."

The volcanic complex has been dated tentatively as Miocene (McKinlay, 1956). Northward it intertongues with the Amalia formation (see Sedimentary Rocks).

Intrusive Rocks

Andesite, quartz latite, and rhyolite dikes, sills, and plugs occur throughout the Taos Range, and probably are the intrusive equivalents of the volcanic complex. All these intrusive rocks cut the Precambrian and Paleozoic rocks. The andesite and latite dikes cut varying thicknesses of the lower andesite and middle latite volcanic sequences, but not the upper rhyolite sequence; on the other hand, the rhyolite dikes cut varying thicknesses of the rhyolite sequence.

Granite and quartz monzonite dikes and stocks are present throughout the Taos Range. Quantitatively, these granitic intrusives are much more common than the other Tertiary intrusive rocks. They are pink to gray, porphyritic to equigranular, and consist of quartz, orthoclase, plagioclase, and biotite or hornblende. These granitic rocks were intruded at various times during the volcanic activity (Miocene?) that produced the volcanic complex and other intrusive rocks. The soda granite (Schilling, 1956, p. 26-30) along the lower part of Red River Canyon represents a late phase of this activity. Quartz monzonite dikes throughout the Taos Range were intruded during the last phase of the same activity; these dikes cut all other Miocene(?) igneous rocks.

Sedimentary Rocks

The Miocene(?) and Pliocene(?) sedimentary rocks of Taos County can probably all be included in the Santa Fe group.

The Amalia formation (McKinlay, 1956, p. 16) crops out in the northern part of the Taos Range, and includes interbedded tuffaceous siltstones, sandstones, and conglomerates, tuff, welded tuff, and basalt flows. Southward it intertongues with the volcanic complex.

Downfaulted and tilted Miocene(?) sediments crop out around the border of the Picuris Range, on the Penasco plateau, and along valleys in the northern and western parts of the Tres Ritos hills. These sediments include boulder and gravel beds with clayey or tuffaceous matrix, pink sands and silts, variegated clay, white water-laid tuffs, and thin basalt flows. The coarser facies commonly are referred to as Carson conglomerate, whereas finer tuffaceous beds are called Picuris tuff. In the Picuris Range, Montgomery (1953, p. 52) mapped both the conglomerates and tuffs as Picuris tuff.

The volcanic complex, Amalia formation, Picuris tuff, and Carson conglomerate probably are equivalent in age to the Miocene basal unit of the Santa Fe group (Baldwin, 1956).

Pale pink sands, silts, and clays cropping out along the western side of the Picuris Range and throughout the Penasco plateau probably are equivalent to the middle unit (late Miocene-Pliocene) of the Santa Fe group (Baldwin, 1956). In the Picuris Range area, these predominantly sandy beds conformably overlie and interfinger with the predominantly volcanic material of the Picuris tuff; Montgomery (1953, p. 53) mapped this unit as the Santa Fe formation.

TERTIARY-QUATERNARY

The Taos Plateau is underlain by nearly horizontal bolson gravels with prominent interbedded basalt flows. The gravels contain layers of micaceous sand and locally abundant limonite. This unit is dated as late Pliocene to Pleistocene. It unconformably overlies both Picuris tuff and Santa Fe formation beds along the northern margins of the Picuris Range. In the Tres Piedras area, Butler (1946, p. 133) named this unit the Servilleta formation; Montgomery (1953, p. 53) also used this name in the Picuris Range and along the Rio Grande Canyon.

Eroded remnants of volcanoes, cinder cones, and extrusive domes dot the Taos Plateau. Although basalt flows are the predominant rock type, perlite, scoria, and rhyolite, andesite, and latite flows and pyroclastic rocks also are associated with these volcanic centers.

STRUCTURES

FOLDS

In the Picuris Range, the Precambrian rocks have been folded into a series of east-west anticlines and synclines. In the Tres Ritos hills, the Paleozoic rocks are folded gently along north-south axes into a central syncline and a narrower western anticline. Elsewhere in the county, folding is a relatively unimportant structural feature.

FAULTS

High-angle faults separate the downfaulted Rio Grande Depression from the uplifted Sangre de Cristo Mountains. These frontal faults trend south along the Taos Range, then turn southwest along the Picuris Range. Vertical displacements of over 6,000 feet have been reported (Philip McKinlay, personal communication).

Other high-angle faults are widespread in the Sangre de Cristo Mountains. Many have south trends. A second group trend east to northeast. Most show predominantly dip-slip movements, although others are tear faults with strike-slip movements. A belt of east- to northeast-trending faults forms a prominent downfaulted area extending east-northeast across the Taos Range at Red River. High-angle faulting may have begun during Cretaceous time, and probably is still active.

South-trending thrust faults along the east edge of the Taos Range have thrust the Precambrian rocks eastward over Paleozoic and younger sediments. McKinlay (1956, p. 21) dated this thrusting as late Cretaceous to early Tertiary.

BRECCIATION

Brecciation is widespread in the downfaulted zone along the Red River in the Taos Range. The intensity of brecciation within this zone varies greatly from place to place.

Brecciation and shearing also occurred along various other faults and along the margins of the larger Tertiary intrusive bodies. Although quantitatively insignificant, these brecciated areas locally are important factors in ore control.

FOLIATION

Foliation is well developed in the Precambrian rocks. In the Taos Range, by far the most common orientation is a northeast strike and nearly vertical dip, whereas in the Picuris Range, the foliation strikes east with vertical to steep dips, usually to the south.

ALTERATION

Hydrothermal solutions, moving through the more highly brecciated areas in the downfaulted zone along the Red River, altered (silicified, sericitized, kaolinized, pyritized) the brecciated rock. These altered zones were called hydrothermal pipes by Schilling (1956). Later weathering and erosion of these zones formed distinctive, bare yellow-stained areas. Both the Miocene(?) volcanic complex and Precambrian rocks have been altered in the brecciated areas of the downfaulted zone, whereas large areas of the same volcanic rocks just to the north are completely unaffected.

Elsewhere various types of alteration are locally important, especially along intrusive contacts and veins.

Mineral Deposits

This section briefly describes the geology of the various types of mineral deposits found in Taos County. A description of each mine and prospect mentioned below is given in a separate section (Mines and Prospects). A discussion of possibilities and guides for future exploration are given in the section Future Possibilities and Guides for Exploration and Development.

PRECAMBRIAN DEPOSITS

PEGMATITES

Pegmatites are present throughout much of the Sangre de Cristo Mountains and are particularly abundant in the Picuris Range, Culebra Range, and northern part of the Taos Range. The pegmatites occur only in Precambrian rocks, commonly parallel to the foliation. They are most abundant in or near Precambrian granite, and are abundant to a lesser degree in other Precambrian rocks where foliation is well developed. The pegmatites range in size from veinlets to dikes over 50 feet thick and over 2,000 feet long. However, thicknesses of more than 10 feet are unusual.

The common minerals are quartz, one or more types of feldspar, and some muscovite mica. Quartz and microcline occur together as coarse aggregates. Quartz also occurs alone as cores in the thicker dikes. Commonly albite partially replaces the microcline. Books of muscovite mica occur along the borders and near the centers of many dikes. Tiny crystals of spessartite garnet, crude octahedra of magnetite, and coarse prisms of black tourmaline occur in many of the pegmatites and in the adjacent country rock.

Most of the pegmatites are simple in mineral composition, lacking significant amounts of rare-element minerals. In contrast, the Harding pegmatite, the only pegmatite deposit that has been mined successfully in Taos County, contains immense concentrations of lithium, tantalum, and beryllium minerals. A number of pegmatites contain some beryl and/or columbite-tantalite; the Cedro pegmatite in the northern part of the Taos Range is representative of these. A small pegmatite in Fletcher Canyon, about a mile south of Pilar, contains fairly abundant lepidolite.

Field relationships and mineralogical similarities strongly suggest that the pegmatites are related genetically to the Precambrian granite.

ORE-BEARING QUARTZ VEINS

Precambrian quartz veins occur in the Precambrian rocks of the Picuris Range, commonly along postpegmatite, north-south joints. Such veins are most common in or near Precambrian granite masses. They range from veinlets to 20 feet thick, but rarely exceed 100 feet in length.

The veins are mostly quartz. Some contain copper, tungsten, gold, silver, and other ore minerals. Many of the ore-bearing and barren veins contain crystals of black to brown tourmaline. At the Champion mine and Wilson prospect, pyrite and copper minerals (chalcocite, malachite, chrysocolla, and cuprite) are found in the quartz veins. At the Tungsten mine, wolframite occurs in the veins with copper minerals.

Field relationships and mineralogical similarities strongly suggest that the quartz veins are related genetically to the Precambrian granite and pegmatites. The pegmatites apparently were emplaced earlier than the veins, as they do not occur along the north-south joints in which the veins commonly are found.

In the Taos Range, quartz-copper veins in Precambrian rocks at the Frazer mine, Highline prospect, and Comstock prospect in the Rio Hondo mining district, and at prospects along Cabresto Canyon, probably are Precambrian in age. Although no tourmaline was seen in these ore-bearing veins, it occurs in other quartz veins near these deposits.

KYANITE-SILLIMANITE

In the Picuris Range, kyanite and sillimanite are abundant in a few thin layers in the lower quartzite member of the Precambrian Ortega formation, which crops out in two east-west belts. In the southern belt, a layer of muscovite schist several feet thick, containing as much as 25 percent of coarse, bladed kyanite and some grains of ilmenite, can be traced for several miles along its strike south of Copper Mountain. In the northern belt, two quartz-muscovite schist or gneiss layers contain radiating clusters of pink sillimanite needles, blue blades of kyanite, and some ilmenite, magnetite, and hematite. The two layers are 3 to 25 feet thick (average thickness, 10 feet), crop out about 1,000 feet apart, and can be traced for over a mile. The northern layer is especially rich, containing as much as 50 percent of the two minerals; the Hondo Canyon sillimanite-kyanite prospect is in this bed.

In many areas of the Picuris Range, sillimanite and kyanite are scattered sparsely through the quartzite of the lower member of the Ortega formation, and occur as large crystals and aggregates in small Precambrian quartz veins. In the Taos Range, sillimanite occurs in moderate amounts in 1- to 50-foot granitic gneiss layers in massive Precambrian Cabresto quartzite along Cabresto Creek. The extent of these beds is not known. In both the Taos and Picuris Ranges, sillimanite needles occur sparingly in other Precambrian rocks adjacent to Precambrian granite masses.

In all the occurrences noted above, the sillimanite and kyanite were formed by hydrothermal metamorphism that took place during the emplacement of the Precambrian granite, pegmatites, and quartz veins.

GRAPHITE GNEISS AND SCHIST

Graphite gneiss and schist occur as layers in the Precambrian metamorphic complex and Cabresto metaquartzite of the Taos Range. Exposures of this rock are common from lower Cabresto Creek northwest to the mountain front; elsewhere graphite is rare. Thicknesses of over 200 feet are found, but the distribution, stratigraphic position, and thickness are not known in detail.

Alined crystalline flakes and fine-grained streaks of graphite occur in banded to schistose aggregates of quartz, muscovite, and albite (or orthoclase). The amount of graphite varies greatly; some of the rock contains over 10 percent. The Cabresto Lake graphite prospect and a number of small prospects along the Rio Primero and Canada Pinabeta explore rich concentrations.

The graphite gneiss and schist probably were formed during Precambrian time by the metamorphism of carbonaceous shales.

IRON OXIDE-BEARING METAMORPHIC ROCKS

Iron oxides are abundant in some units of the Precambrian metaquartzite, gneiss, and schist in the Sangre de Cristo Mountains. Richer concentrations contain up to 25 percent iron; several different iron oxide minerals are present, and in varying ratios.

Grains of magnetite, ilmenite, and/or hematite are arranged in thin bands in the massive metaquartzite, forming iron-rich units ranging up to 50 feet thick. Prospects in the Taos Range south of Cabresto Creek opposite the Hornet mine are in such an iron-rich unit. Specular hematite flakes are scattered through schists and gneisses of the metamorphic complex. Thin biotite-garnet-magnetite bands commonly separate the massive metaquartzite beds. The Iron King prospect along Cabresto Creek in the Taos Range explores several such bands.

Magnetite and ilmenite grains are locally abundant in other Precambrian rocks adjacent to Precambrian granite masses. They probably were formed by contact metamorphism during the intrusion of the granite.

PALEOZOIC DEPOSITS

COAL

In the Tres Ritos hills, small, impure lenses of Pennsylvanian coal occur in the Sandia formation and in the lower part of the Sangre de Cristo formation. The coal is interbedded with sandstones, siltstones, and shales. Prospects along the Rio Fernando de Taos explore such coal lenses in the Sandia formation.

TERTIARY DEPOSITS

ORE-BEARING VEINS AND DISSEMINATED DEPOSITS

Distribution. Miocene(?) mineral deposits are common in the Taos Range. A few veins in the Picuris Range may belong to this group, but good evidence for dating is lacking. These deposits are most abundant in or near the intrusive rocks (soda granite bodies, quartz monzonite and quartz latite dikes, and rhyolite porphyry dikes) that were intruded during the last stages of the Miocene(?) igneous activity.

Classification. The veins and their disseminated equivalents can be classified into five types (fig. 5) on the basis of variations in mineral composition. These five types also are distinct ore categories, and each has different relationships with the source rocks.

Molybdenite deposits. Molybdenum-bearing veins and disseminations are present in or near soda granite bodies, usually within several hundred feet of the contact. The veins are up to 7 feet thick, although thicknesses of over a foot are unusual. They are largely quartz, molybdenite, and pyrite, with locally abundant biotite, fluorite, chalcopyrite, calcite, and rhodochrosite. The wall rock commonly is silicified and contains small disseminated grains of pyrite; feldspar is altered to clay and sericite. Thin films and specks of molybdenite commonly occur in fractures along veins and in brecciated areas.

The Log Cabin Canyon, Bear Canyon, main southern BJB, and Hercules prospects in the lower Red River area, and the Jacks and Sixes prospect in the Red River mining subdistrict, expose molybdenite veins. The Questa Molybdenum (Moly) mine has both veins and disseminations.

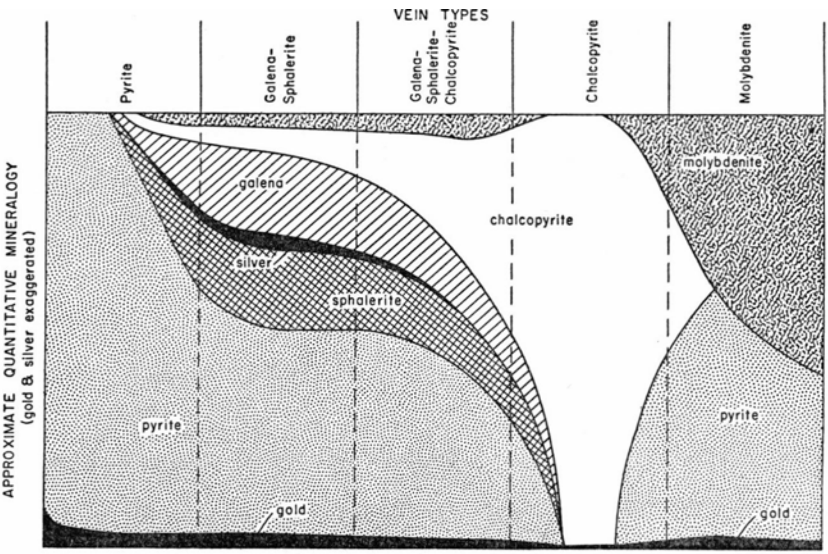


Figure 5
CLASSIFICATION OF THE TERTIARY VEINS
Based on quantitative vein mineralogy.

Chalcopyrite deposits. Chalcopyrite-rich Miocene(?) veins occur sparingly throughout the Taos Range. No obvious spatial relation to any one rock type was noted; however, small veins of this type are most common in the altered and brecciated rocks along the Red River. The veins occur as distinct, continuous sheets up to 6 inches thick along through-going fractures, and as small, irregular veinlets in shear zones up to 50 feet wide. They are largely quartz and chalcopyrite, with locally abundant pyrite and fluorite, rare molybdenite, sphalerite, and galena, and traces of gold and silver. Secondary minerals (malachite, azurite, chalcocite, and limonite, and rare cuprite and native copper) commonly occur in a surface zone of oxidation.

The middle and northern BJB prospects along Goat Hill Gulch in the lower Red River area expose small chalcopyrite veins; the Copper King mine and Granite prospect in the Red River mining subdistrict explore a wide shear zone.

Galena-sphalerite-chalcopyrite deposits. Lead-zinc-copper deposits are found near the same type of Miocene(?) granites that are associated with concentrations of molybdenite. Some deposits are in the granite, many others, however, occur up to a half mile from the granite. Such deposits also occur even farther away from the granite but near quartz monzonite, quartz latite, and rhyolite porphyry dikes. Quartz, pyrite, sphalerite, and silver-bearing galena, locally abundant fluorite, and some rhodochrosite, molybdenite, and gold are found in veins up to 6 feet wide and as disseminations (veinlets and grains) in shear zones and fractures along veins.

The southern Bernhardt prospect in lower Red River Canyon and the Jack Pot prospect in Rio Hondo Canyon belong to this type. Deposits containing galena and sphalerite but only rare chalcopyrite are common enough to be classed as a separate type; the veins and disseminations at the Hornet prospect in Cabresto Canyon and at the Nickel Plate and Silver Bell prospects along the lower Red River are of this type. The Victor No. 2 and Esther prospects have chalcopyrite and galena but no sphalerite; the Silver Star prospect exposes galena and secondary copper minerals.

Pyrite-gold deposits. Gold-bearing pyrite deposits are common in or near Miocene(?) quartz monzonite, quartz latite, and rhyolite porphyry dikes. Small grains and cubes of pyrite occur in thin veins of drusy quartz, in quartz stringers and quartz breccia fillings in shear zones, and disseminated through the wall rock along veins and in shear zones. Silicification is common along veins and in shear zones; gouge is abundant in the latter. Some deposits contain small amounts of calcite, chalcopyrite, galena, sphalerite, and fluorite, and rarer molybdenite. The presence of petzite, argentite, and other gold and silver minerals has been reported, but could not be verified. The deposits are oxidized to a depth of from less than 10 to not more than 200 feet; much of the pyrite in the oxidized zone is decomposed to limonite containing free gold.

In the Red River mining district, the quartz-pyrite-gold mineralization and the Miocene(?) quartz monzonite and latite dikes occur along wide, through-going, steep-dipping, east-west shear zones; along narrower and shorter, steep-dipping, north-south, crosscutting shears and fractures; and along small, discontinuous shears and fractures paralleling the main east-west shears. Small, rich gold pockets occur irregularly along, and at the brecciated intersections of, these structures. Later faulting has offset some of the veins and shear zones. In the Rio Hondo mining district, this mineralization and the Miocene(?) rhyolite porphyry dikes follow north-northeast fractures, shear zones, and faults. However, these patterns vary greatly in detail.

The following mines and prospects all explore Tertiary pyrite-gold deposits: the Hanosh prospect along lower Red River Canyon; most of the "mines" and prospects of the Anchor and Red River subdistricts of the Red River mining district; the Black Copper mine; and the South Fork mine, Commodore prospect, and prospects around Amizette and on Fairview Mountain in the Rio Hondo mining district.

Genesis and controls. The granitic rocks, intruded during the late stages of the Miocene(?) igneous activity, are believed to be the common source of the hydrothermal solutions that formed the Miocene(?) mineral deposits. This view is strongly supported by similarities in vein mineralogy (similar textures, paragenetic relationships, etc.), wall-rock alteration, and age relations, as well as by the zonal arrangement of the minerals (and vein types) outward from the larger bodies of the source rocks. The source rocks (soda granite and similar granites, quartz monzonite and quartz latite dikes, and rhyolite porphyry dikes) probably came from the same parent magma and were intruded at about the same time. These source rocks are all quite similar in mineral composition, but vary texturally; most, however, are porphyritic or inequigranular.

Other Miocene(?) granites do not have concentrations of mineral deposits associated with them; field relationships indicate that these "dry" granites were intruded somewhat earlier than the "wet," late-stage granitic intrusive rocks.

The type of deposit (mineralogical composition) formed at a given spot varied with the nearness and size of the granitic source-rock bodies. Apparently, after depositing the higher temperature minerals closer to to their source, the hydrothermal solutions deposited the lower temperature minerals at the lower temperatures and pressures existing away from the larger sized sources. No evidence was found to indicate that the mineral composition of the Miocene(?) deposits varies with the type of host rock.

The size and location, but not the composition, of the deposits, depend on the degree of fracturing. This varies with rock type and intensity of the fracture-producing stresses. In general, the Tertiary volcanic rocks break easily but irregularly; faulting produces wide shear zones. The larger Tertiary granite bodies commonly break with more difficulty; fewer fractures, though more regular, continuous, and open, are produced. Precambrian rocks show no clear-cut pattern; however, the schistose rocks most commonly break along a few, short, relatively tight fractures.

TERTIARY-QUATERNARY

GOLD PLACERS

In the Red River mining district, placer gold is found in the stream gravels along Placer Creek, Bitter Creek, the Red River, and the tributaries of Comanche Creek near LaBelle. At the Denmark prospect, low terrace gravels are cemented by limonite. High-level terrace gravels that occur on Red River Pass and the north flanks of Gold Hill (pl. 1), some 1,500 feet above the Red River, may contain placer gold; the Hilltop prospect unsuccessfully explores these gravels. The gold in all these placer deposits probably has been derived mainly from the erosion of the Miocene(?) pyrite-gold deposits.

The placer gold deposits of the Rio Grande Placer mining district are described under Mines and Prospects.

PERLITE

Perlite bodies occur in the Pliocene-Pleistocene volcanic centers on the Taos Plateau, spatially associated with basalt flows and scoria, and rhyolite, latite, and lesser andesite flows, tuffs, and breccias. The two known deposits, in No Agua Mountain and southeast of Cerro de la 011a, are huge. The geology of the No Agua deposit is described under Mines and Prospects, No Agua Mining District. Field relations suggest that both deposits were extruded as volcanic domes during the late stages of the Pliocene-Pleistocene volcanic activity that occurred throughout much of the Southwest.

SCORIA

Cinder cones and blankets occur around the Pliocene-Pleistocene volcanic centers on the Taos Plateau. The red and black basaltic scoria making up these deposits was ejected, accompanied by the extrusion of basalt flows, during various stages of the Pliocene-Pleistocene volcanic activity.

Mines and Prospects

The individual mines and prospects of Taos County, grouped geographically, are described in this section in varying detail. The coverage is not exhaustive: many prospects undoubtedly have been missed; others are described from second-hand information; still others, which exposed nothing of interest, are described solely as a negative record or are not mentioned at all. It should be remembered that much of the background information about the various prospects and mines, especially names, locations, and histories, necessarily is uncertain or incomplete.

CULEBRA RANGE

There are very few prospects in the Culebra Range of Taos County. It has been reported that some prospecting was done on the west side of the Costilla massif, where galena occurs in Precambrian amphibolite. A few small prospect pits follow gougy, limonite-stained shears and fractures in Precambrian granite gneiss.

NORTHERN TAOS RANGE

This area includes the entire Taos Range north of the Cabresto Creek and Comanche Creek drainages; namely, the area drained by the Rio Costilla (Costilla Creek) and all its tributaries except Comanche Creek, as well as the short intermittent streams draining the west front of the range. The Comanche Creek area is described under the Anchor subdistrict.

There are no mines and only a few prospects in this area. Much of the area is in the privately held Sangre de Cristo grant.

Cedros Prospect

The Cedros pegmatite prospect is located on the ridge west of the head of the south fork of the Rito de los Cedros, 5 airline miles south-southeast of the Costilla post office.

A primitive road goes to within a quarter of a mile of the prospect. This road leaves State Highway 3 three miles south of that highway's junction with State Highway 196 at Costilla. Leaving the highway, the access road leads east along the Rito de los Cedros for 2.8 miles through a box canyon and past a sawmill, then turns south along the main south fork of the Rito de los Cedros for 1.4 miles.

A pit and trench explore the pegmatite.

The pegmatite body is a dike in the Precambrian quartz-mica schist and metaquartzite, striking N. 5° E. with a 40° W. dip. It has a thickness of 5 feet throughout much of its traceable length of over 1,000 feet. In general, the pegmatite has three distinct zones: (1) a border zone up to 1 foot thick of intergrown graphic granite and muscovite mica; (2) a

2-foot zone of intergrown white albite feldspar, quartz, muscovite mica, and minor red garnet; and (3) a discontinuous core of white quartz lenses.

The mica, which is abundant, occurs in the border zone as books up to 3 inches across; nearly all the mica, however, is of scrap grade. McKinlay (1956, p. 11) found a beryl crystal 6 inches long and 2 inches in diameter, and several small yellow chrysoberyl crystals, in the albite-quartz-muscovite zone.

Prospects Along the Rio Primero and Canada Pinabete

In the Rio (Rito) Primero and Caflada Pinabete drainages along the mountain front north of Cabresto Canyon, a number of small prospect pits have been made where there are greater than normal concentrations of graphite in the Precambrian schists and gneiss. These occurrences are similar to that of the Cabresto Lake prospect.

CABRESTO CREEK

This area (fig. 6) includes all of the Cabresto Creek drainage basin in the Taos Range. Cabresto Creek is the next main stream north of the Red River.

Prospect Along Lower Cabresto Canyon

There is a small open cut located 0.8 mile east of the National Forest boundary along the western front of the mountains, and lying south of Cabresto Creek on a ridge point some 100 feet above the canyon floor (fig. 6). A road has recently been bulldozed to the prospect. An east-west shear zone cuts Tertiary andesite and latite. The volcanic rocks are highly altered and limonite stained. Azurite and malachite stains also are common.

Cabresto Lake Prospect

The Cabresto Lake graphite prospect is located on the north side of, and some 100 feet above, Cabresto Lake (on the Lake Fork of Cabresto Creek; fig. 6). A graded road extends as far as the south side of the lake; from the end of this road, a trail follows the northwestern shore of the lake and passes the prospect.

An open cut exposes Precambrian quartz-mica schist and gneiss striking N. 10° E. and dipping 60° W. To the north and west, the schist and gneiss are covered by Tertiary andesite; to the south and east, the metamorphic rocks are in contact with Tertiary soda granite.

A 200-foot sequence of the metamorphic rocks is exposed in the prospect and outcrops to the west. Schist predominates, the gneiss being interlayered with the schist. Several thin layers of pegmatitic material follow the foliation; some layers contain numerous half-inch flakes of muscovite mica.

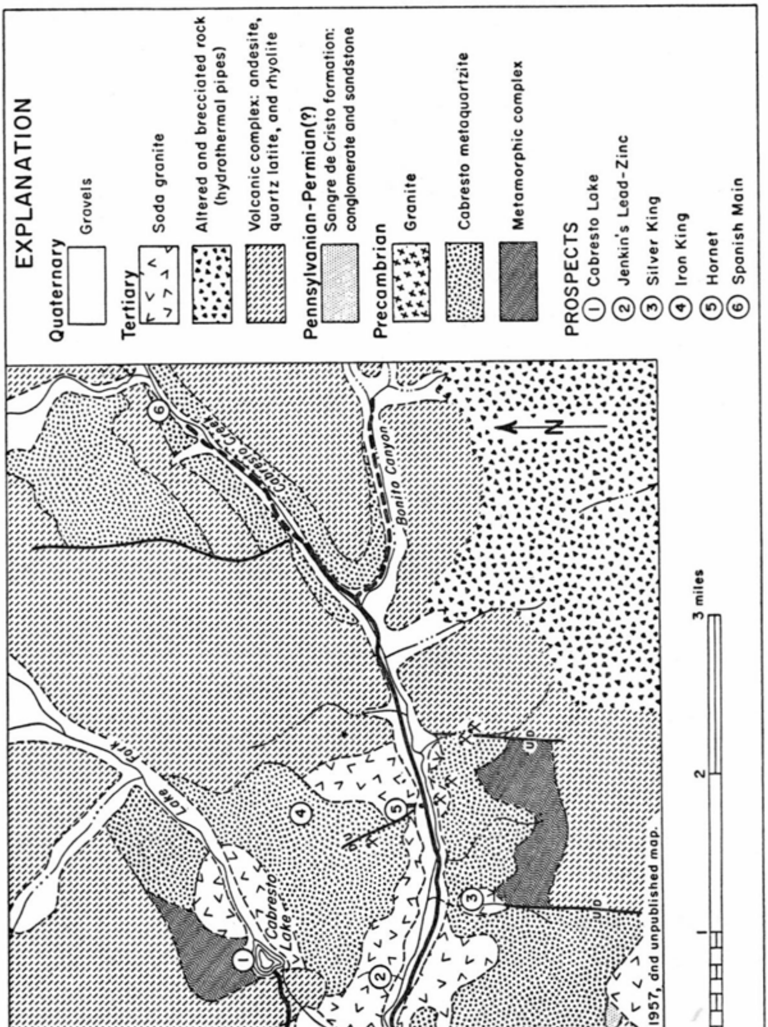


Figure 6

Geology and Prospects of Cabresto Creek

Graphite occurs as specks and fine-grained aggregates in some of the schist and gneiss layers. Commonly, it is intergrown with the quartz, mica, and feldspar that make up the schists and gneisses. The amount of graphite varies from layer to layer, in a few cases exceeding 10 percent. The average grade was not determined.

Jenkin's Lead-Zinc Prospect

Jenkin's Lead-Zinc prospect is located 0.2 mile north of Cabresto Creek, in a side canyon 0.7 mile east of the junction of the Lake Fork with the main branch of Cabresto Creek (fig. 6). A now impassable jeep track from the main road in Cabresto Canyon extends north to the prospect, which is some 1,000 feet above Cabresto Creek.

An inclined adit, now caved, extends into the west slope of the side canyon. A 3- to 4-foot-wide shear zone striking west and dipping 50° N. extends across •the canyon; the adit follows this structure. The shear zone cuts Tertiary soda granite. No lead or zinc minerals were found on the dump.

Silver King Prospect

The Silver King prospect is located approximately 0.2 mile south of Cabresto Creek in a prominent side canyon, which extends south from Cabresto Canyon 1.2 miles east of the junction of the Lake Fork with the main Cabresto Canyon (fig. 6).

The only adit (fig. 7) extends east from near the canyon bottom. It is open and exposes fractured and highly altered Tertiary soda granite. Numerous slips containing gouge cut the granite. Pyrite is disseminated through the wall rock and in the fractures and slips. No other mineralization was observed.

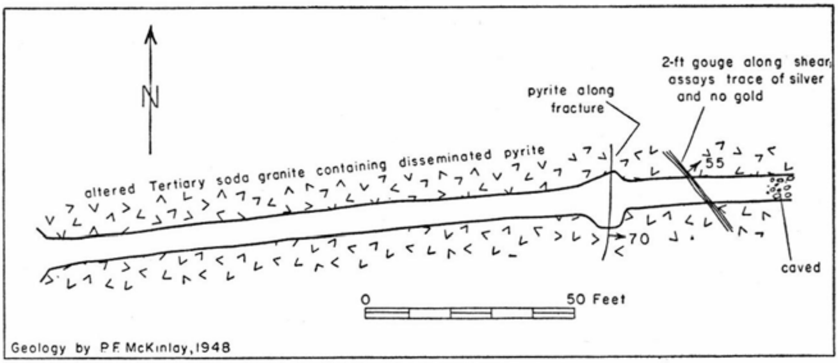


Figure 7

Geologic Map of the Silver King Prospect

Iron King Prospect

The Iron King iron prospect is located on the ridge north of the Hornet prospect, 1 mile north of Cabresto Creek (fig. 6). The nearest road is at the Hornet prospect some 0.8 mile to the south, and over 1,000 feet lower.

This small prospect exposes several magnetite-garnet-rich bands in Precambrian metaquartzite. The magnetite and ilmenite(?) occur as alined grains forming layers in the quartzite.

Prospects Between Jenkin's Iron Prospect and the Hornet Prospect

Several small open cuts and a caved shaft along the ridge between the Jenkin's Iron prospect and the Hornet prospect explore the same fault zone found at the Hornet prospect (fig. 6). Here the fault cuts Precambrian metaquartzite and strikes N. 15° W. with a 60? E. dip. Abundant limonite is the only evident mineralization.

Hornet [Weary Willie(?)] Prospect

The Hornet lead-zinc prospect is located in a side canyon 0.3 mile north of Cabresto Creek, 2 miles east of the junction of the Lake Fork with the main branch of Cabresto Creek (fig. 6). A jeep road from the main road in Cabresto Canyon extends half a mile north to the workings.

A small camp is located along the main Cabresto Canyon road west of the side road to the mine. There are four adits at the prospect (fig. 8). The portal of the lower main adit, now caved, is between two crude buildings (fig. 9). A small adit to the northeast also is caved. The other two adits, both open, are high on the slope to the northwest (fig. 10). A chute extends down the hill slope from the upper adits to the road at the lower main adit.

This prospect probably is the same as the Weary Willie prospect that was being worked actively in 1926 (see Weary Willie Prospect below). In 1948, the Mineral Resources Corporation, of Albuquerque, bulldozed the road to the prospect, built the camp, opened and extended(?) the lower main adit, and did some diamond drilling. Since then there has been no activity. One "carload" of ore reportedly has been shipped; production obviously has been very small.

Tertiary soda granite crops out on both sides of the gulch in which the prospect is located. Precambrian metaquartzite overlies the granite and crops out at and above the middle adit. The contact between the two rock types is poorly exposed except in the middle adit, where it is an irregular, rolling, subhorizontal surface with dikelike protuberances up into the quartzite. A northwest-trending, nearly vertical, 10-foot-wide fault zone containing abundant gouge cuts both rock types.

Pyrite, purple and green fluorite, black to resinous-brown sphalerite, calcite, and chlorite, as well as lesser amounts of galena and rhodochro-

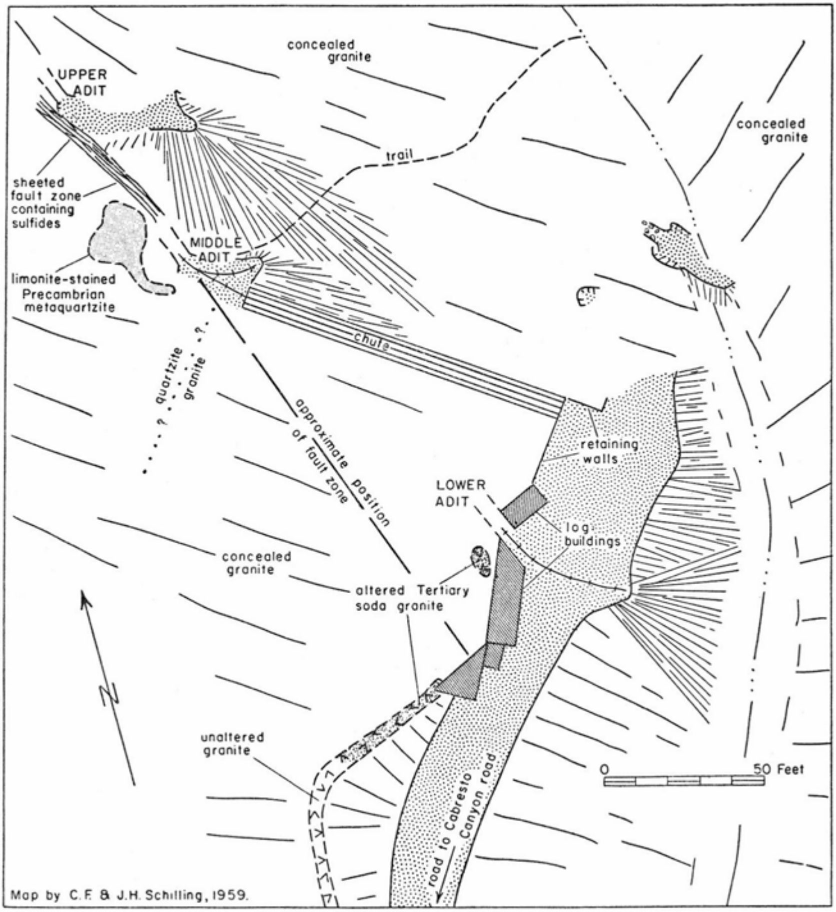


Figure 8
SURFACE MAP OF THE HORNET PROSPECT

site, occur together and separately disseminated along the subhorizontal contact; such occurrences are mainly in the metaquartzite and to a lesser degree in the granite. Along the contact, the granite is highly brecciated, with much gouge and brown to yellow limonite stains; the metaquartzite is brecciated and stained yellow brown and black. Massive glassy red garnet occurs in the metaquartzite along the contact, probably as a result of contact metamorphism.

The same minerals occur as disseminations and streaks, commonly as bands in glassy to milky quartz, in the slips and fractures making up the fault zone; they also occur as disseminations in the wall rock bordering the fault. Below the middle adit, where both walls of the fault zone

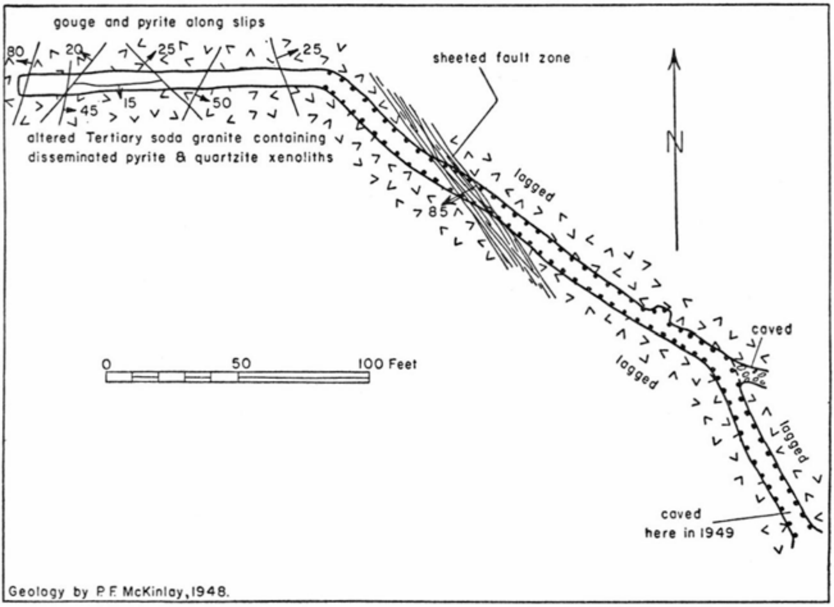


Figure 9
GEOLOGIC MAP OF THE LOWER MAIN ADIT, HORNET PROSPECT

are granite, pyrite veinlets and disseminated grains are abundant in and near the fault zone, and the granite is altered and limonite stained; here the other minerals are absent.

Weary Willie [Hornet(?)] Prospect

This prospect probably is the same as the Hornet prospect described above. It is mentioned by Ellis (1930, p. 125):

> Canyon Cabresto joins Red River at Questa. About 2 miles above the junction of these canyons, on the north side of Cabresto Canyon, is located the Weary Willie group of claims. . . . The ore occurs in a brecciated zone between quartzite and porphyry; the hanging wall is quartzite and the footwall porphyry. . . . The principal ores are lead and zinc. . . . There are four tunnels, with about 650 feet of work, altogether....

This prospect could not be at the location given by Ellis, which is west of the mountain front in Quaternary gravels. Furthermore, the Red River and Cabresto Canyons do not join; the two streams join after leaving their respective canyons. Probably "the junction of these canyons" refers to the junction of the main Cabresto Canyon and the Lake Fork. If so, the location would coincide with the Hornet prospect; the description of the geology and workings accurately fits the Hornet.

Prospects South of Cabresto Creek, Opposite the Hornet Prospect

A small caved adit just south of Cabresto Creek opposite the Hornet prospect (fig. 6) has manganese-stained metaquartzite and red "limonite" material on its dump. The adit apparently follows a shear zone trending N. 40° E. and dipping 65° SE.

A short distance to the southeast, in a small gulch, are several small caved adits in Precambrian metaquartzite, which strikes N. 30° E. and dips 35° E. Philip McKinlay (personal communication) believes that these prospects explored iron-rich layers in the metaquartzite.

Prospects South of Cabresto Creek, Between the Hornet Prospect and Bonito Canyon

There are a number of small prospects in a side gulch heading south from the main Cabresto Canyon, 0.8 mile west of Bonito Canyon. The nearest road is along Cabresto Canyon (fig. 6).

About 0.3 mile south of Cabresto Creek, three prospect pits on the east side of the gulch expose altered Tertiary quartz latite along a north-south fault; a fourth pit, on the west side of the gulch, follows an east-west fracture in Precambrian metaquartzite and quartz-mica schist.

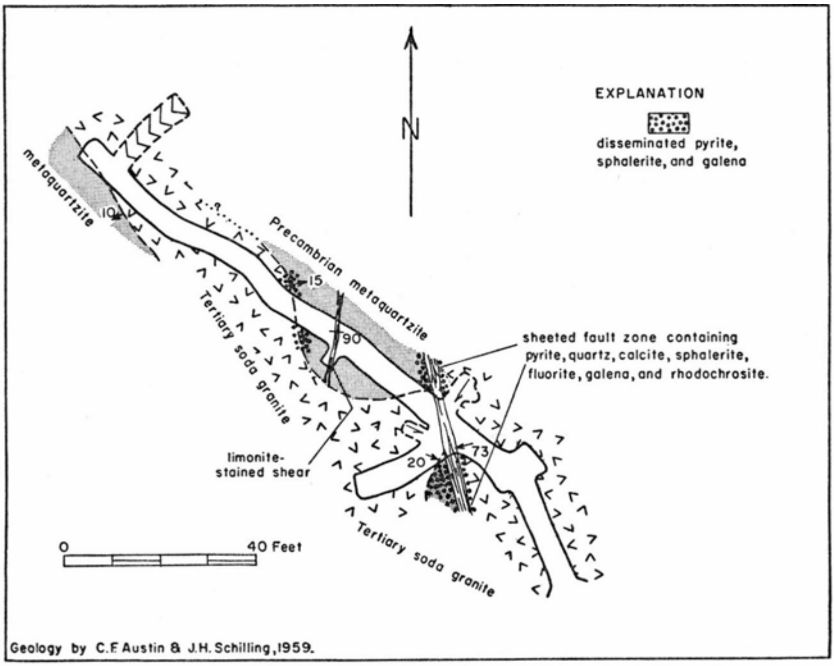


Figure 10

GEOLOGIC MAP OF THE MIDDLE ADIT, HORNET PROSPECT

A small amount of disseminated pyrite is the only mineralization present. A short distance south of these four prospect pits, a small prospect on the east side of the gulch explored the same north-south fault, exposing altered limonite-stained quartz latite containing disseminated pyrite and quartz veins.

About 0.3 mile farther south, a small prospect pit on the south side of the east fork of the gulch exposes highly altered Tertiary quartz latite along a vertical shear zone, one-half foot wide, striking N. 30° E. Chlorite and pyrite are scattered through the rock.

Spanish Main Prospect ["Govenor's Mine"(?)]

The Spanish Main prospect is located on the north side of Cabresto Creek approximately 2 miles above the junction with Bonito Canyon (fig. 6).

Reed (1922, p. 40) reports:

> A Spanish legend states that a mine in Cabresto Canon was owned and operated by the Spaniards some time during the seventeenth century. The ore .. . is said to have been extremely rich. An uprising of the Taos Indians forced the Spaniards to leave . . . [they] back filled the entire mine. . . . The original owners never reopened the mine and ... no one else was ever able to locate the workings.
>
> . . . Recently a company has been organized to clean out an old tunnel which was discovered . . . in 1896. The part of the tunnel reopened checks with the description of the "Govenors [sic!] Mine," one of the old Spanish mines.
>
> ... The first part of the tunnel has a steep grade sloping down from the surface. A short distance from the mouth . . . [there is] a large room from which the main tunnel and a drift continue. The walls of the room and tunnels are covered with carbon evidently from fires inside the workings. There are no marks of picks or other steel instruments anywhere in the mine.

The prospect is now caved. It cuts Precambrian metaquartzite. Reportedly there is no mineralization in the workings; there is none on the dump.

Although the workings are old, it is doubtful that any "extremely rich" ore was mined. The quartzite contains graphite-rich schist layers; possibly the graphite was mistaken for silver ore (as it has been elsewhere). Legends die hard!

LOWER RED RIVER

This area is in the Taos Range and includes all the Red River drainage basin from Questa to 2 miles east of the Moly mine camp (fig. 11). The eastern part of the area commonly is considered as part of the Red River district. Many small prospects are scattered over the area; the Moly (Questa Molybdenum) mine is the only mine.

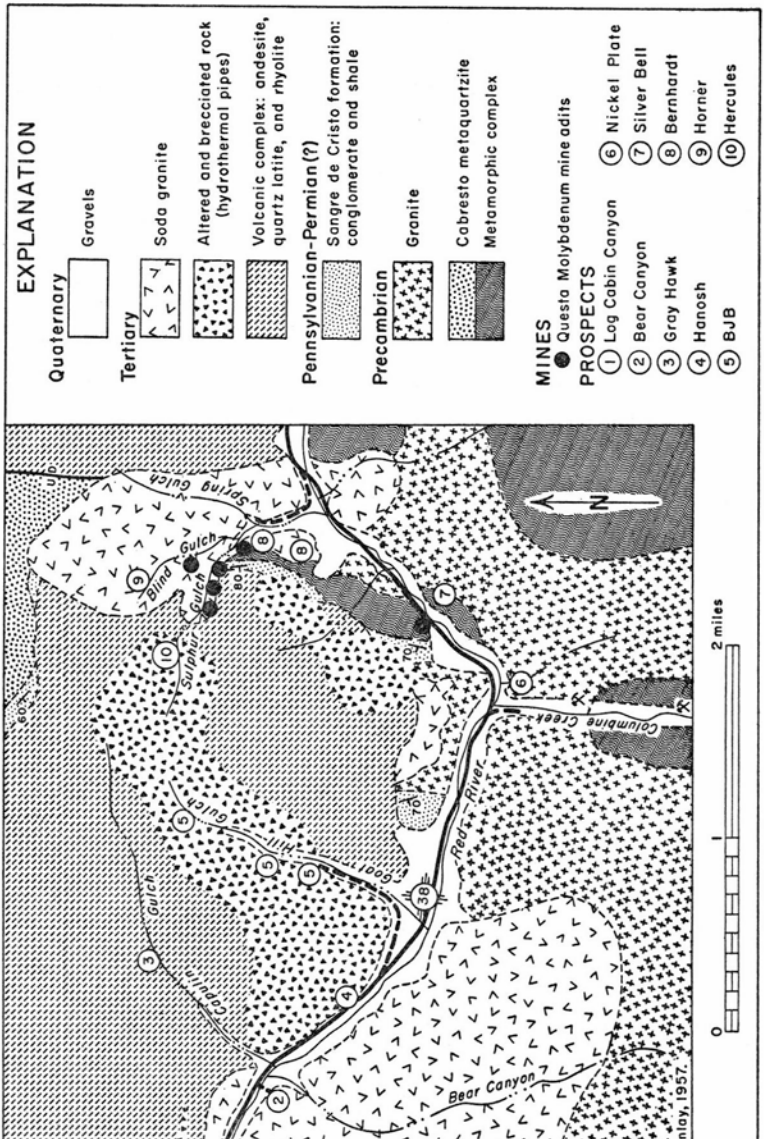


Figure 11

Geology, Prospects, and Mines of Lower Red River

Questa Molybdenum [Moly, R and S] Mine

Location and access. The mill, camp, main haulage adit, and dump are located along the Red River, 5 to 6 miles east of Questa; the adits to the older workings are along Sulphur Gulch (Bradenburg Gulch), an intermittent tributary of the Red River (fig. 11). State Highway 38, a graded gravel road, passes the mine and camp.

History. This mine has been a large producer of molybdenum. The true nature of the veins was first recognized in 1916, when Jimmy Fahy had a sample assayed for copper, gold, and silver; the assayer mentioned the presence of molybdenite and its value. Fahy located some claims, and the Western Molybdenum Co. was organized; little was done, however, to develop the deposit. In November 1918, the R and S (Rapp and Savery) Molybdenum Co. was formed, which acquired seven claims of the Western Molybdenum Co. Additional claims were located, and development work was done during the winter of 1918-1919. Production began in the spring; the ore was treated at the June Bug, a converted gold mill on the Red River, about 4 miles above the mine.

In 1920, the present owners, the Molybdenum Corp. of America, acquired the property. Mining was discontinued during the depression of 1921; however, development work was continued. Operations were on a small scale until 1923, when a mill was built on the present mill site. In 1929, this mill was rebuilt.

In 1942, the present haulage adit (Moly tunnel) was driven north from the Red River for 1 mile, connecting with the lowest level in the mine and greatly improving haulage, ventilation, and drainage. The mill was rebuilt again at about the same time. By 1955, the workings had reached a point 240 feet below the Moly tunnel, which remains the lowest point in the mine.

In recent years, much of the old tailing dumps has been remilled, supplementing the decreasing production of the mine. Total production has been about 20 million pounds of molybdenite (fig. 13).

In 1957, the Defense Minerals Exploration Administration awarded the Molybdenum Corp. of America an exploration contract for $255,250, the corporation being required to spend an equal amount of its own money. In connection with this contract, the corporation is conducting an intensive exploration program at the mine. A geochemical survey has been made, the lowest level in the mine has been extended to the west, and extensive core drilling is being done both from the surface and underground. Results have been encouraging; an immense tonnage of low-grade molybdenite mineralization has been found (J. B. Carman, personal communication).

Surface plant and mine. The present camp consists of an office building, which also contains the warehouse and commissary, the mill, assay laboratory, cookhouse, bunkhouse, school, and houses for employees. At the haulage-adit (Moly tunnel) portal, 1 mile west of the camp, there

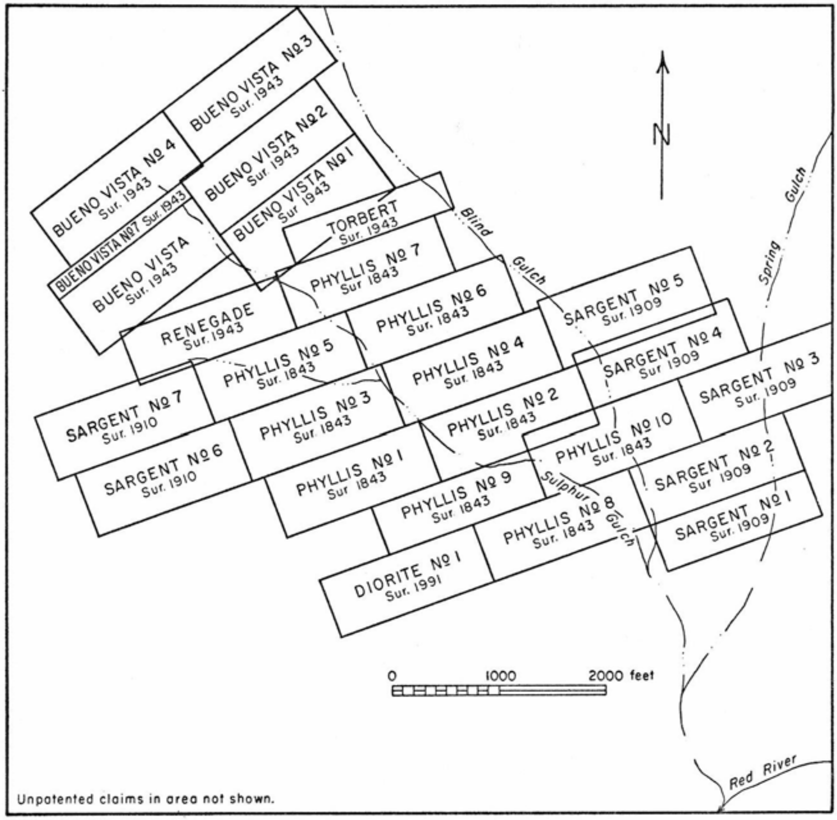


Figure 12

CLAIM MAP OF THE SULPHUR GULCH AREA, LOWER RED RIVER

is a building containing a lamp room, change room, blacksmith shop, and the air compressors and electric generating equipment. Timber-framing facilities are housed in a small building also located near the adit portal. Surface track from the adit continues a quarter of a mile down the canyon to the ore bins and dump. The mine has over 36 miles of workings, with a vertical extent of 1,200 feet (for details, see Schilling, 1956, pl. 1 and 2).

Mining methods. The high-grade ore shoots were located by following the veins encountered until they opened up. Most ore shoots occurred in the granite near its contact with altered volcanic rocks; this zone was explored thoroughly. Electrical prospecting (Sunberg and Nordstrom) was tried in 1917 with some success.

Mining was by overhand, horizontal slicing in stull-supported or, less commonly, open stopes. The irregularity of the molybdenite pockets in the veins required selective mining, the methods used varying from round to round.

The mining methods are described in more detail by Carman (1931) and Schilling (1956, p. 8-10).

Milling methods. The mill has a capacity of 50 tons of ore per day, the flotation process producing molybdenite concentrates averaging 85 percent MoS_2. The mill is described in more detail by Carman (1932) and Schilling (1956, p. 10).

Geology. Larsen and Ross (1920) and Vanderwilt (1938) have described the geology. A more detailed description is given by Schilling (1956), from which the following is abstracted.

The ore occurs in the Tertiary Sulphur Gulch soda granite stock along a locally east-west-striking, south-dipping contact with propylitized volcanic rocks. Most of the veins are on the contact, or in the granite within 50 feet of the contact where they roughly parallel the contact. The ore zone is over 1,500 feet long at the surface but decreases in length with depth.

In detail, the veins are complex. Dips range from vertical to horizontal but average 45 degrees. Commonly they pinch and split. At places they cross the granite contact and pass out into the softer volcanic rocks, where they die out; elsewhere they follow granite dikes, which extend outward from the granite stock. The veins commonly cut across any irregularities of the granite contact. Individual veins are not continuous downdip or laterally, but their general position along the contact is taken by other veins. Numerous faults offset the veins for short distances.

The veins range from film-thin layers, locally called "paint," to over 7 feet in thickness. Steeply dipping veins are commonly thicker than gently dipping ones, and therefore contain most of the ore shoots. These ore shoots are lenticular. A few cylindrical ore shoots commonly occur at vein intersections. Numerous thin, irregular veinlets occur in brecciated areas along the contact; these bodies are of low grade but hold great future promise.

The veins are largely quartz and molybdenite, with locally abundant biotite, fluorite, pyrite, chalcopyrite, calcite, and rhodochrosite, and minor amounts of chlorite, galena, sphalerite, huebnerite, ferrimolybdite, limonite, and malachite. The apparent order of deposition was: (1) quartz; (2) quartz, molybdenite, and biotite; (3) pyrite and chalcopyrite; (4) fluorite; and (5) calcite and rhodochrosite. This sequence is often repeated completely or in part.

Wall-rock alteration is not intense, usually extending only a few inches from the veins. Silicification is common, feldspar is locally altered to clay and sericite, and disseminated pyrite is scattered through the wall rock.

The veins were deposited as fissure fillings, probably during late

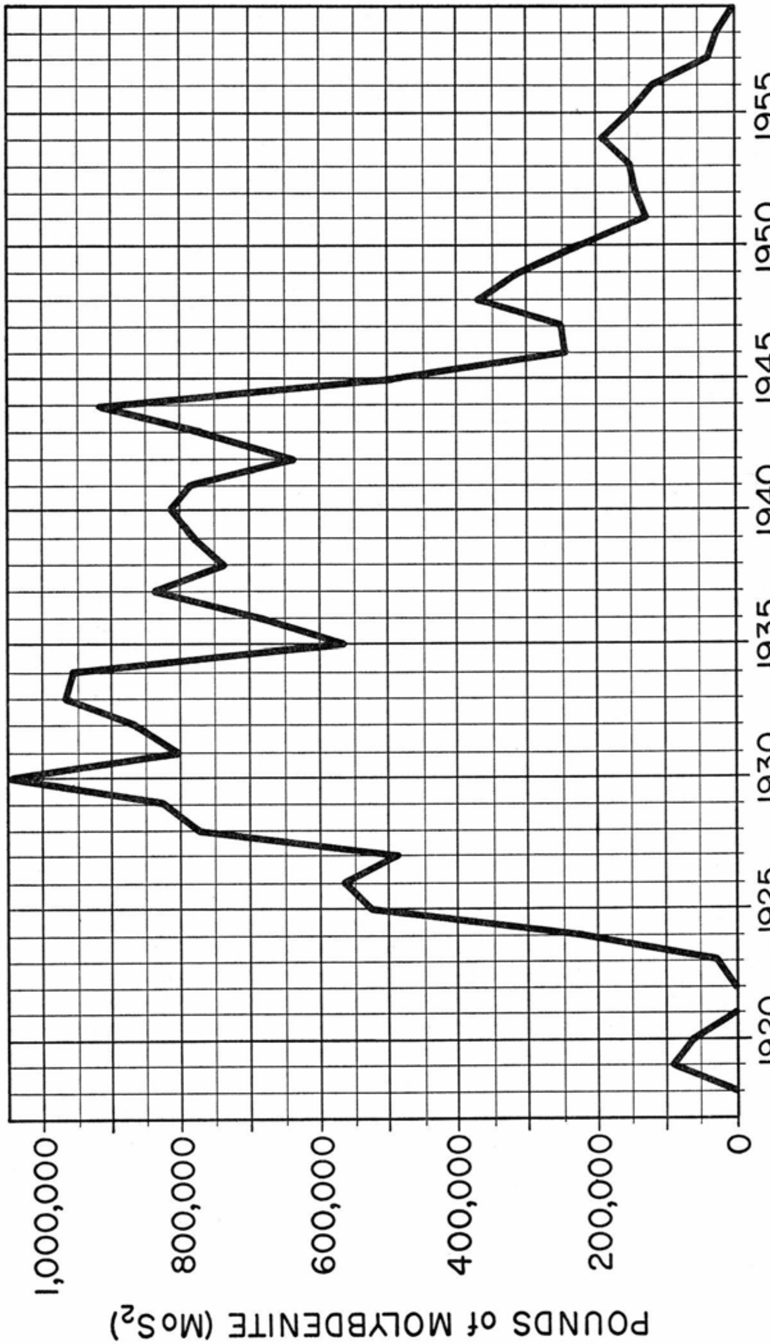


Figure 13

MOLYBDENITE PRODUCTION OF THE QUESTA MOLYBDENUM MINE

From Vanderwilt (1938), Molybdenum Corp. of America records, and annual reports of the State Inspector of Mines.

Tertiary time, and on the basis of their mineralogy are classified as mesothermal.

Log Cabin Canyon [Fibbs-Nogle, Steve's(?)] Prospect

The Log Cabin Canyon molybdenum prospect is located in the bottom of Nogal (Log Cabin) Canyon on the northwest flank of Flag Mountain, 2 miles southeast of Questa (fig. 11). The prospect is accessible by a jeep road along the bottom of the canyon.

Nothing is known of the early history of this prospect. In the 1930's, the Molybdenum Corp. of America drove a long adit southeast along the canyon. This adit crosscuts a number of small molybdenite veins; drifts from the crosscut follow two of the veins (fig. 14). Several short adits on both side of the canyon, several hundred feet "upstream" from the main adit, were driven earlier. In 1959, the Molybdenum Corp. of America drilled two vertical diamond-drill holes on the slope a few hundred feet to the south of the main adit, and located a number of claims (the Log Cabin group) in the surrounding area.

A number of thin, northeast-trending quartz-molybdenite-pyrite veins crop out along the northeast side of the canyon; these same veins are also exposed in the main adit, as well as in the small older adits. At the surface, the veins have been oxidized to ferrimolybdite and limonite and have a yellow color. These veins are in the Flag Mountain soda granite stock near its contact with Precambrian granite and other metamorphic rocks and Tertiary volcanic rocks. Although the contact roughly follows the bottom of the southeast-trending canyon, in detail it is quite complex. Tongues of the Tertiary soda granite extend south into the other rocks; large xenoliths of these rocks are present in the stock completely surrounded by granite. Intense brecciation and bleaching, accompanied by deposition and later oxidation of disseminated pyrite, occur along the contact, making identification of the various rock types difficult at best.

The main adit is open. It begins in highly brecciated and altered soda granite, passes through propylitized Precambrian metamorphic rocks (or Tertiary andesite?), and then reenters the Tertiary soda granite (fig. 14). A number of 1- to 3-inch quartz-molybdenite-pyrite veins cut both rock types; most strike northeast with vertical to 45-degree dips. Some veins contain fault gouge, commonly streaked with molybdenite. Biotite was noted in one vein.

The soda granite at the prospect is silicified. The silicification forms a band of bold cliffy outcrops extending to the northeast across the Flag Mountain stock toward the Bear Canyon prospect, and may represent a continuous zone of mineralization.

Bear Canyon [Horseshoe, Cisneros, Mexican, Mammoth] Prospects

The Bear Canyon molybdenum prospects are located along the south side of Red River Canyon, at its junction with Bear Canyon, 3 miles

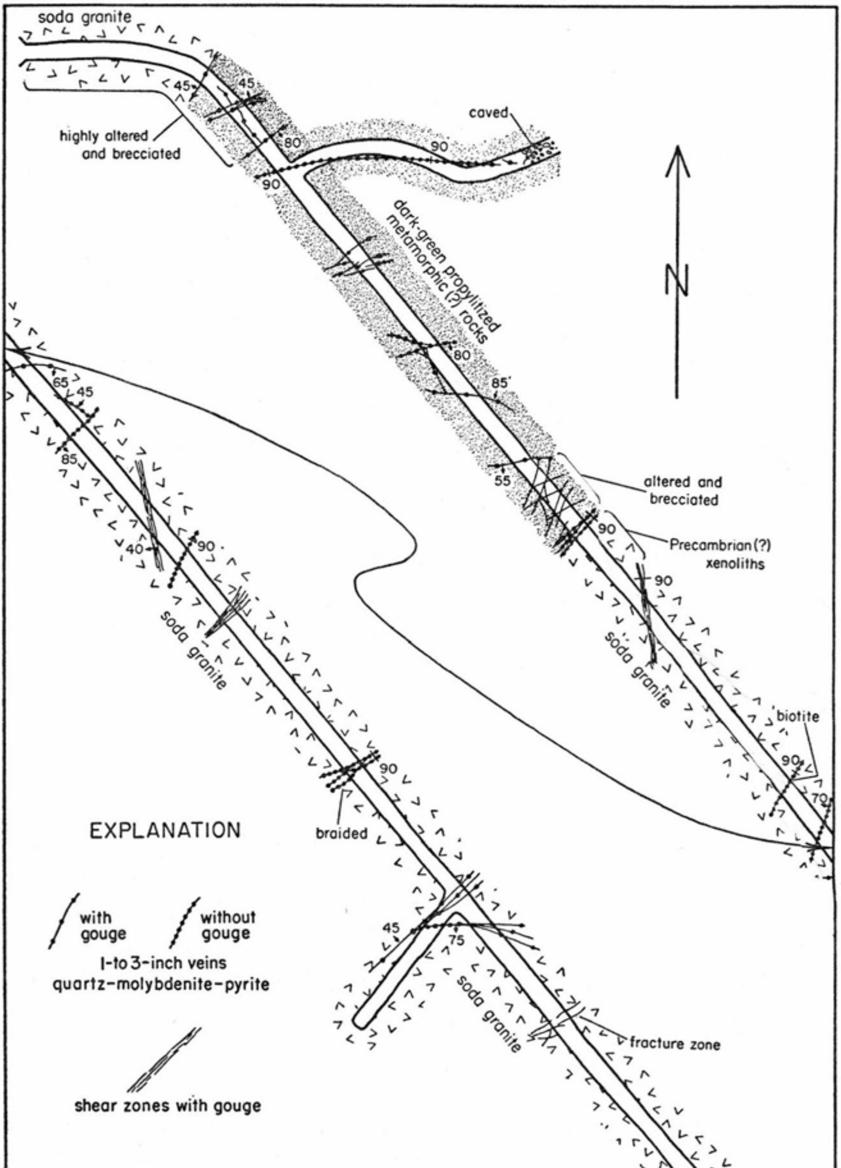


Figure 14

Geologic Map of the Log Cabin Canyon Prospect east of Questa (fig. 11). An adit on the Red River, just west of Bear Canyon, and less than 100 feet south of State Highway 38, is the entrance to the only extensive workings (fig. 15); these workings are open throughout their entire length. Several small prospect holes are located in the cliffs along the west side of Bear Canyon, and there is a caved adit some distance west of the main workings.

Little is known of the early history. The Mammoth Molybdenum Corp. is reported to have done some prospecting here prior to 1930. Dan Cisneros and Juan Aragon, of Questa, worked these prospects for many years, and much of the workings is a result of their efforts. No ore has been milled, although there is on the dump a pile containing a few tons of low-grade molybdenite ore.

The veins encountered in the workings and on the surface cut the Tertiary Flag Mountain soda granite stock. The nearest contact of the stock is over 800 feet to the north of the nearest exposed vein, and the granite is fractured much less than at the Moly mine deposit. Along this contact, the soda granite is in contact with the Tertiary volcanic complex, but outcrops show little mineralization or favorable fracturing. The veins follow slips and fractures in the granite, most commonly striking east-west, with steep dips to the north and south; others show random orientation. No brecciation accompanied by stockwork veinlets of molybdenite has been encountered.

The veins range from "paint" to 3 feet thick; there is no apparent relation between the angle of dip and the thickness of the vein. "Splits" and "pinches" are common, as in the Moly mine. Only a few small pockets of molybdenite ore were found, usually at the intersection of a vein with another vein, fracture, or fault.

The veins consist largely of quartz, with some molybdenite, pyrite, chalcopyrite, and minor biotite and fluorite. Huebnerite occurs rarely as small masses in the quartz. Mineral associations and textures, paragenesis, and wall-rock alteration are similar to those in the Moly mine deposit. However, there are important differences: the veins thus far explored are not near the soda granite contact; fractures and veins are less common, tighter, and form no definite pattern.

Gray Hawk [McDonald] Prospect

The Gray Hawk prospect is located on the northwest side of Capulin (Choke Cherry) Gulch about 0.8 mile northeast of the Red River (fig. 11). A caved adit extends N. 40° E. along a narrow, irregular fluorite-pyrite vein dipping 40° E. The vein is in a limonite-stained breccia zone cutting Tertiary rhyolite.

Hanosh Prospect

The only working of the Hanosh prospect is an adit located just north of State Highway 38, about 0.5 mile east of the mouth of Capulin (Choke Cherry) Gulch, and so close to the highway that the portal was

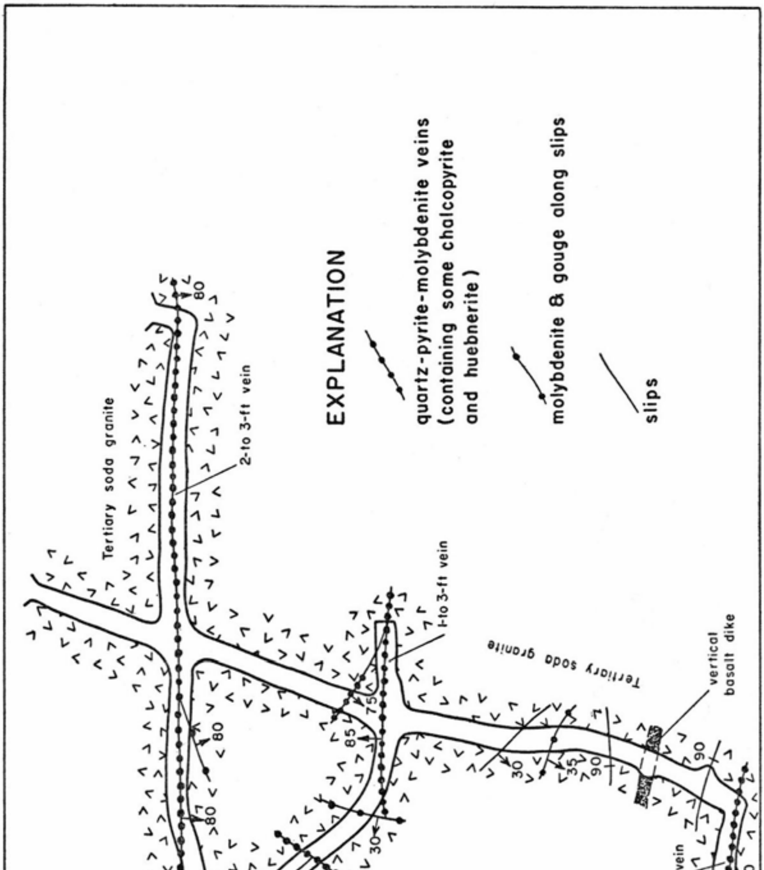


Figure 15
Geologic Map of the Bear Canyon Prospect

cut away and partially filled when the highway was straightened and paved (fig. 11). This prospect is presently held by the Molybdenum Corp. of America.

The adit extended N. 30° E. for 70 feet along a fault in highly altered and brecciated Tertiary volcanic rocks (fig. 16). Discontinuous lenses, up to 1 foot wide, of quartz, pyrite, and gouge occur along the fault; a few specks of malachite also can be noted. The wall rock is brecciated, silicified, bleached, and limonite stained, making identification difficult.

A channel sample across the widest pyrite-rich lens contained a trace of gold and 0.4 ounce of silver per ton.

BJB [Wilde, Goat Hill Gulch] Prospects

The BJB prospects are located along the west side of Goat Hill Gulch (Alum Gulch), which extends north from the Red River 4 miles east of Questa (fig. 11). At one time, a primitive road extended almost to the northernmost adit; the road is now passable only as far as the southernmost adits, having been completely destroyed beyond this point by flash floods. These prospects were worked by Bill Wilde until the late 1940's. There is no record of any production.

All the adits are in altered rocks of the Tertiary volcanic complex. The southernmost (uncaved) adit is on the west edge of the gulch bottom and extends N. 45° W. for 475 feet in alternating porphyritic and fine-grained andesite. Several irregular pyrite-chalcopyrite-fluorite-

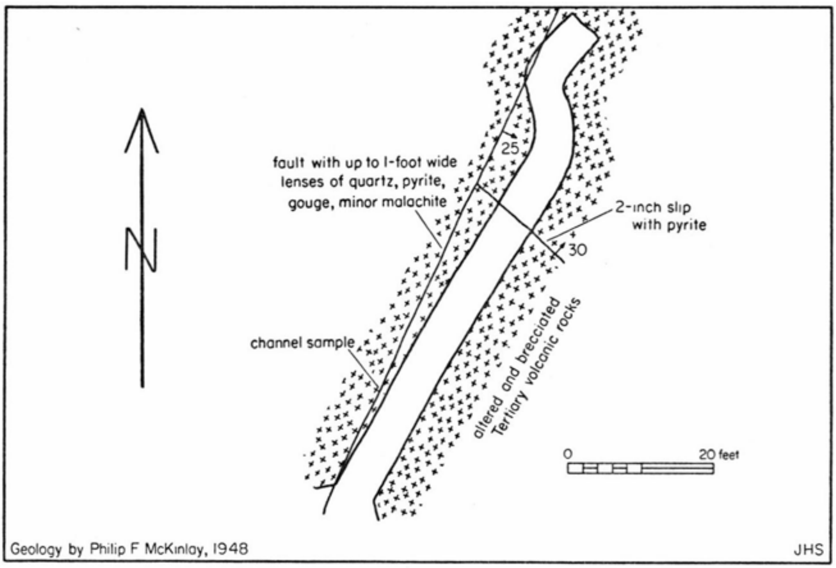


Figure 16
GEOLOGIC MAP OF THE HANOSH PROSPECT

molybdenite veins are present, and molybdenite "paint" is found on the dump. Secondary minerals coat the adit walls. A winze, now filled, along this adit hit a small but rich pocket of molybdenite.

A short distance southwest of the aforementioned adit is an adit which is caved shut. Nothing is known about this adit; its dump shows only limonite-stained volcanic rocks.

The middle adit, 0.2 mile upstream from the two southernmost adits, is now badly caved. It reportedly extends north from the northwest edge of the gulch bottom for about 400 feet. The adit is in fine-grained rhyolite and andesite. Secondary gypsum fills many open fractures. Small, irregular pyrite-chalcopyrite-fluorite veins are common, and a drift (250 feet from the portal) was driven west along one of these. Molybdenite does not occur with the other minerals, but is common as "paint." A short side drift about 150 feet in from the portal extends 20 feet to the west along a slip striking N. 80° W. and dipping 75° S. "Mud" (gouge impregnated with molybdenite) and pyrite occur along this slip, and small masses of molybdenite are found in fractures adjacent to the slip. A few small masses of galena were found on the dump.

The northernmost adit is known as the Hawk tunnel (Highland Chief, Bueno; fig. 17). It is in the cliff along the west side of the gulch some 20 feet above the gulch bottom. The portal is in rhyolite tuff, whereas the rest of the adit is in andesite breccia. The wall rock is not brecciated, being a resistant mass in a highly brecciated hydrothermal pipe. An irregular vein of quartz, chalcopyrite, pyrite, green fluorite, and rare galena, trending N. 45° E. and dipping 45° SE., was exposed. The chalcopyrite occurs in massive chunks rather than in aggregates of fine grains, which is more commonly the case in the altered areas. Secondary selenite is common along fractures. The hill in which the vein occurs is stained red, whereas the surrounding outcrops show the more typical yellows of the hydrothermal pipes.

Prospects in Columbine Canyon

There are several prospects along Columbine Creek. Nothing is known about their history. The larger two are caved adits that extend into the east wall of the canyon; they are accessible only by foot. One is located 0.4 mile south of the Red River, in Precambrian gneissic granite; the other is 11/2 miles south of the Red River, in Precambrian amphibolite schist and gneiss. Thin stringers of quartz and pyrite are found on both dumps.

Nickel Plate Prospect

The Nickel Plate prospect is located less than 0.2 mile south of the Red River in a small canyon several hundred feet east of Columbine Creek (fig. 11). An adit, caved shut, extends west from the canyon bottom. Nothing is known of its history.

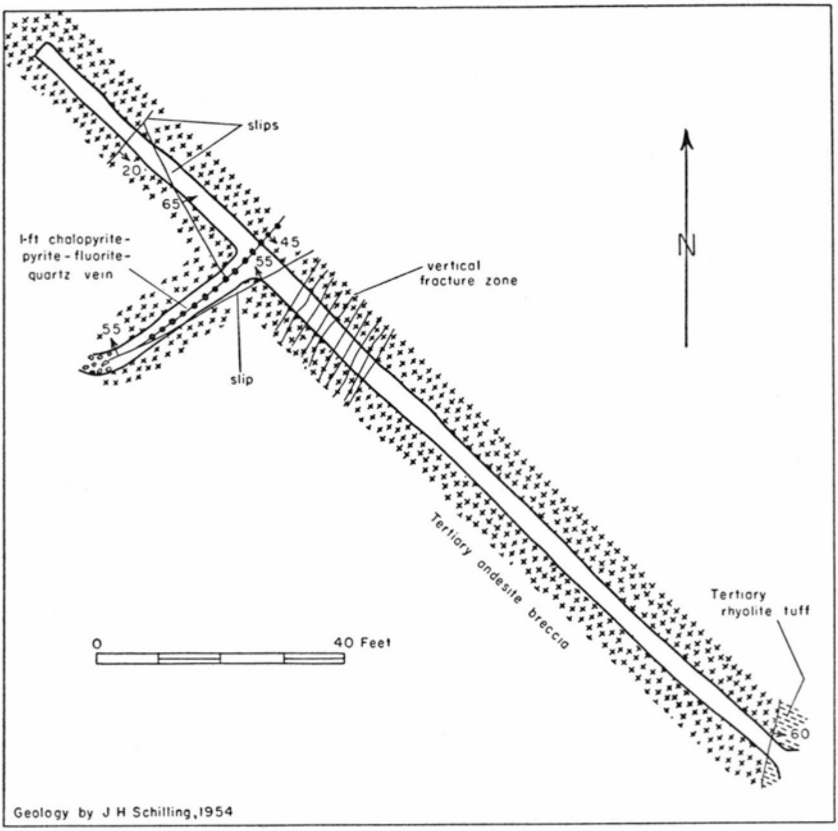


Figure 17
GEOLOGIC MAP OF THE HAWK TUNNEL, NORTHERNMOST BJB PROSPECT

The adit is in Precambrian gneissic granite. The dump shows massive pyrite and quartz, as well as veined and disseminated pyrite and lesser galena, black sphalerite, green fluorite, and epidote. Manganese stains are common.

Silver Bell [Mossman] Prospect

The Silver Bell prospect is located in a small canyon south of Red River, several hundred feet southeast and across the river from the Moly tunnel (main haulage adit) of the Moly mine (fig. 11). There are several cabins in a clearing west of the prospect. In recent years, Henry Mossman held the prospect. There has been no production.

Four short adits, all open, extend east into the side of the small canyon. The northernmost adit is in highly altered and brecciated Precambrian diabase(?) containing minor amounts of disseminated pyrite. The next adit to the south has black diabase in the lower part of its walls, with Precambrian granite above; no mineralization is exposed.

The two southern adits are in Precambrian granite and expose small, irregular veins and disseminations of specular hematite, pyrite, and quartz, with some galena and black sphalerite, and minor amounts of chalcopyrite. The mineralization is silver bearing and manganese stained. Sphalerite(?) boxworks commonly occur where the specular hematite is most abundant.

Bernhardt Prospects

The Bernhardt prospects are located just north of the Red River and west of Sulphur Gulch (fig. 11), and are bounded on the north and west by workings of the Moly mine.

The late Leroy Bernhardt located a number of claims in this area; the many prospect pits and several adits scattered over the claims are the results of his efforts. Two cabins are the only buildings. No ore was mined.

All the prospects are in the Tertiary Sulphur Gulch soda granite stock. (Schilling, 1956, pl. 2, shows the various prospects and surface geology.) The main southern adit (fig. 18) is in the slope north of the cabins some 300 feet above the Red River. This open adit cuts several veins. An oxidized vein exposed at the surface contained specularite, quartz, pyrite, chalcopyrite, sphalerite, and galena, striking N. 45° E. and dipping 40°-60° NW.; it assayed 50 ounces of silver per ton. This vein was about a foot wide at the surface, but as it was explored downward, it pinched out less than 6 feet below the surface. A similar vein, striking N. 60° E. and dipping 20° S., was encountered. It was less than 6 inches thick and extended downward until it intersected the first vein. This second vein contained chalcopyrite, with only small amounts of sphalerite and galena, and low silver assays. The adit was extended northwest 120 feet, but cut no additional chalcopyrite-sphalerite-galena veins. Several thin veins containing molybdenite, quartz, and pyrite were exposed, but no ore pockets were found. The granite in the adit is not highly fractured; its contact is over 200 feet to the east.

The northern adit is in the west side of Sulphur Gulch several hundred feet northwest of the mouth of Spring Gulch. It was driven approximately 100 feet west along a mineralized shear zone, which also extends over 1,000 feet to the east, trending N. 80° E. and dipping vertically. The soda granite has been badly brecciated and altered along this zone. The alteration is similar to that found along the veins in the Moly mine; small quartz veins are accompanied by silicification of the soda granite, pyrite is disseminated through the rock, and feldspar phenocrysts are altered to clay. Molybdenite "paint" coats many of the

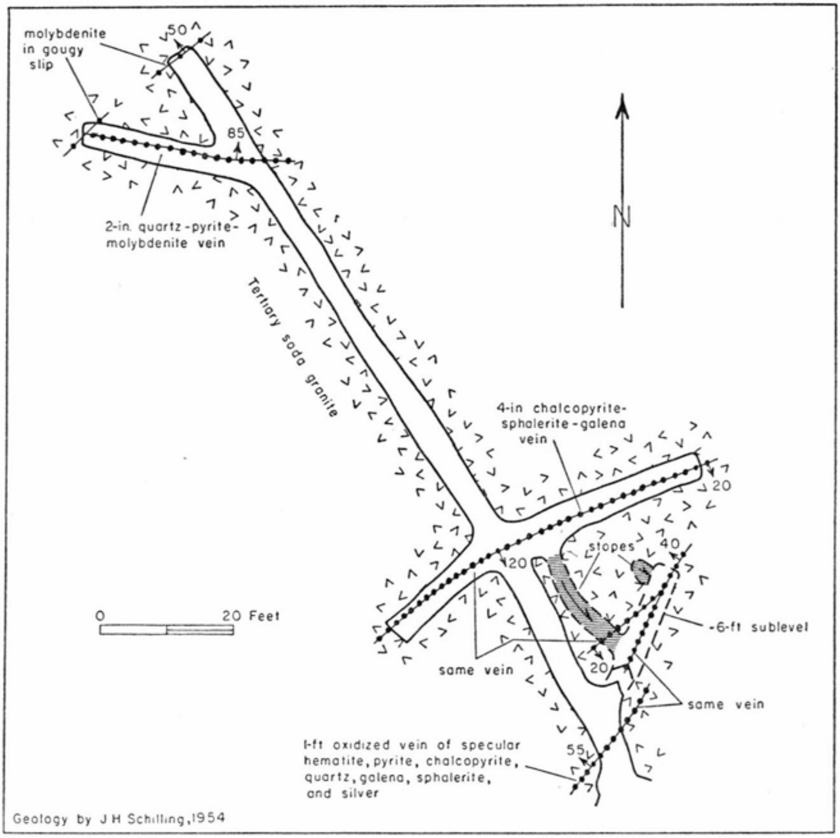


Figure 18

GEOLOGIC MAP OF THE SOUTHERN BERNHARDT PROSPECT

fractures. A small prospect pit in the slope above and west of this adit is in the same shear zone.

Prospects Along Spring Gulch

The N. 80° E.-trending, vertically dipping shear zone followed by the northern Bernhardt adit, described above, extends over 1,000 feet to the east in the soda granite, crossing Sulphur Gulch about 100 feet north of the junction of Sulphur and Spring Gulches, and then crossing Spring Gulch before being concealed under soil cover. Several caved adits and prospect holes have explored the shear zone; nothing is known of their history. Pyrite and chalcopyrite grains are scattered through the rock; partial oxidation has occurred, and limonite, malachite, and azurite stains are common. Small masses of purple fluorite and quartz veinlets also are common. Two caved adits along the southeast side of Spring Gulch at its junction with Sulphur Gulch did not explore the shear zone; no mineralization was found on their dumps.

Homer Prospect

The Homer prospect is located along the northeast side of Blind Gulch one-half mile above its junction with Sulphur Gulch (fig. 11). A private jeep road of the Molybdenum Corp. of America extends north from the Red River and passes this prospect.

In 1940(?), Sam Homer located several claims, and later drove the three adits. He lived in the cabin at the prospect. This area is now held by the Molybdenum Corp. of America.

All three adits are in Tertiary soda granite. The one adit which is not caved extends northeast for 85 feet along a shear zone having a N. 65° E. trend and an 85° S. dip. Mineralization is very weak. Pyrite, chalcopyrite, quartz, limonite, and malachite are present in small amounts as veinlets and disseminations in the crushed rock of the shear zone. No molybdenite was noted.

Hercules [Bueno Vista] Prospect

The Hercules molybdenum prospect is located at the head of Sulphur Gulch (fig. 11). The three adits, now caved, are some 50 feet above the bottom of the gulch. The small camp (three buildings), now gone, was high on the slope to the north of the adits.

A trail from the Red River extended up Sulphur Gulch and Blind Gulch, then cut across Highline Ridge to the camp. The adits were difficult to reach from the camp because of the steep, loose slopes; access up Sulphur Gulch is extremely difficult because of a 20-foot "falls" flanked by cliffs. Recently the Molybdenum Corp. of America has widened the trail to the camp into a jeep road and extended the road down into the head of Sulphur Gulch near the adits.

In 1924, Fred Colburn located the Bueno Vista claims (fig. 12) and organized the Hercules Molybdenum Corp. The adits were driven, but apparently no ore was found; the company abandoned the camp the following year. Recently the Molybdenum Corp. of America acquired the claims. There has been no production.

The three adits follow mineralized, east-west shear zones in highly altered and brecciated rocks of the Tertiary volcanic complex. The surrounding surface shows small fluorite-pyrite-chalcopyrite veins, quartz veins accompanied by silicification, and some molybdenite films along fractures. A Tertiary soda granite dike, striking N. 20° E., cuts the volcanic complex and the lower two adits.

SAN CRISTOBAL CREEK

This area includes the entire San Cristobal Creek drainage basin in the Taos Range. San Cristobal Creek is a relatively short stream located along the western front of the mountains between the Red River and the Rio Hondo. A good trail follows the creek.

Portorico(?) Prospect

This prospect is located approximately 0.2 mile north of San Cristobal Creek, 1.3 miles east of the western mountain front. An adit, inclined 20 degrees from the horizontal, extends' N. 5° W. for 65 feet along a 2- to 4-foot-wide shear zone, striking N. 55° E. and dipping 30° N., in Precambrian metaquartzite. Pyrite, chalcopyrite, and calcite occur in the shear; limonite stains are common. A short crosscut 50 feet from the portal extends west from the adit.

Lower San Cristobal Canyon

An adit and several prospect pits located about 0.2 mile north of San Cristobal Creek, 0.7 mile east of the western mountain front, explore a 15-foot-wide shear zone, trending N. 85° W. and dipping 80° N., in Precambrian metaquartzite. Abundant limonite and rare pyrite and chalcopyrite occur in the shear zone.

ANCHOR MINING SUBDISTRICT

The Anchor (Keystone, LaBelle, Midnight) mining subdistrict is part of the much larger Red River mining district (fig. 4). It is located in the Taos Range north of the Red River and east of the headwaters of Cabresto Creek, and includes the headwaters and middle reaches of the Bitter Creek drainage basin and the area around the ghost town of LaBelle, in the Comanche Creek drainage basin to the northeast (fig. 19).

LABELLE AREA

Aztec [What Is It, Larsen] Prospect

The Aztec gold prospect is located one-half mile northwest of the ghost town of LaBelle, along the north side of a south fork of Gold Creek (fig. 19). The Aztec Mining and Milling Co. began operations in the 1890's, sinking a 100-foot shaft and driving a 180-foot adit on the What Is It claim. Although this was considered one of the best properties in the LaBelle area, the ore proved to be of very low grade, and operations were soon stopped. Production, if any, was small.

The shaft is caved. The 180-foot adit (fig. 20) east of the shaft is open. Apparently the adit was driven to unwater the shaft but was stopped short of its goal. The workings are in altered and brecciated

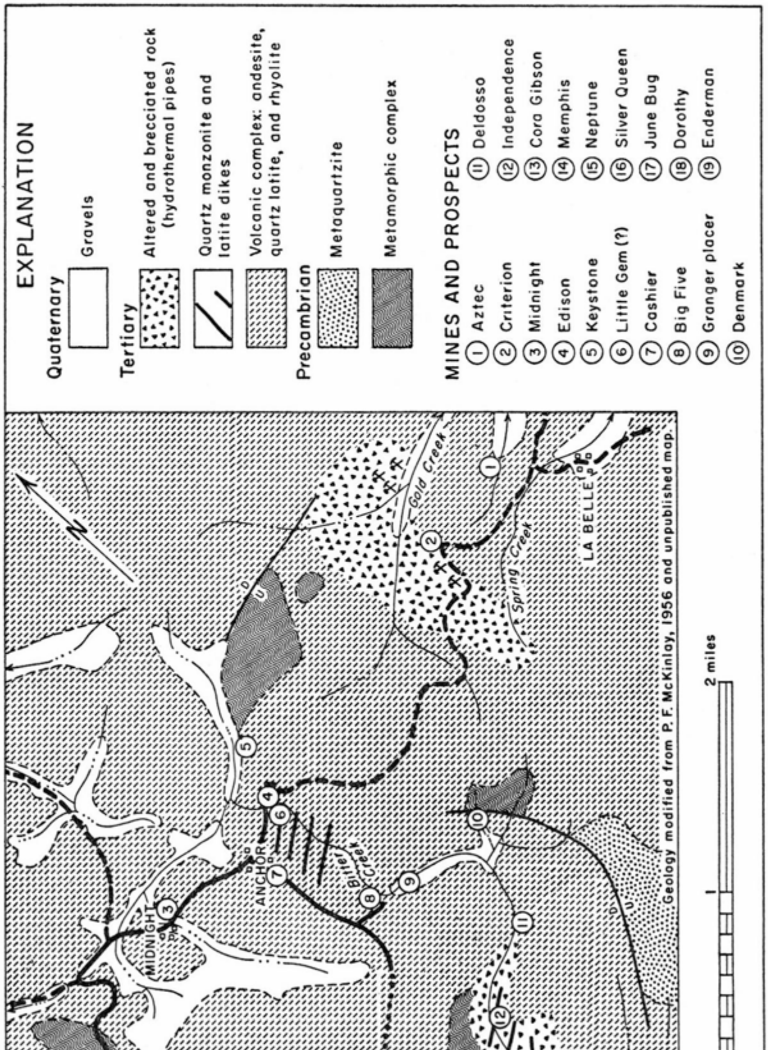


Figure 19

GEOLOGY, MINES, AND PROSPECTS OF THE ANCHOR MINING SUBDISTRICT

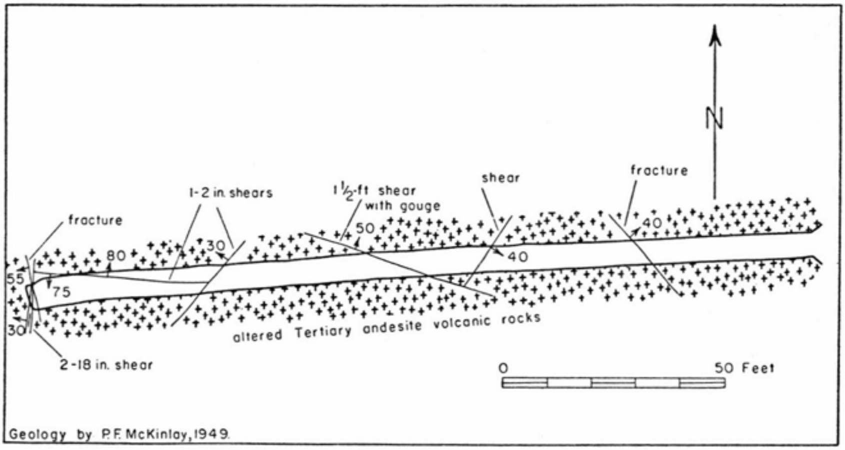


Figure 20
GEOLOGIC MAP OF THE AZTEC TUNNEL

Tertiary andesite breccias, tuffs, and flows. The adit cuts a number of shears, but no mineralization is exposed except limonite stains.

Prospects on Gold Creek

There are a number of old, caved adits in the north side of Gold Gulch a mile northwest of LaBelle (fig. 19). The two adits nearest Gold Creek have large dumps, indicating that each probably has over 600 feet of workings. It is likely that one of these is the Snyder tunnel, about which Lindgren and Graton (1910, p. 89) said:

> In 1905 the Snyder tunnel . . . was being continued. It is a crosscut tunnel 800 feet long, being driven to cut the supposed vein which furnished the rich float found on the hill above. A few quartz-bearing seams have been cut.

All these prospects were driven in search of gold. There has been no known production.

This group of prospects is in highly altered Tertiary andesitic volcanic rocks. All explore shear zones containing quartz stringers and disseminated pyrite. Much of the pyrite is decomposed and altered to limonite, which contains some gold.

Criterion Claim

The Criterion gold claim is located along the old LaBelle-Anchor stage road, a mile west of LaBelle (fig. 19). Work was first done in the 1890's; some development was done as late as 1904. There has been no production.

Several shallow shafts and pits expose small quartz veins in moderately altered and brecciated Tertiary andesitic volcanic rocks. Limonite is common.

Other Prospects in the Criterion Area

There are a number of shallow shafts, adits, and pits in the area just to the west and southwest of the Criterion claim. These gold prospects explore quartz stringers, commonly along shear zones, in highly altered and brecciated Tertiary andesitic and quartz latitic volcanic rocks. The shears and veins most commonly are oriented north-south with steep dips, although other orientations and gentle dips also are common. Rare pyrite, almost completely decomposed to limonite, occurs in the quartz veins and shear zones. Limonite stains are widespread.

There is no record of production from these prospects.

Gold Placers

Placer gold was discovered about 1870 in stream gravels near LaBelle. Small placer mining operations were carried on for a few years at scattered spots along Gold Creek and Spring Creek. In most cases, the gravels proved to be of low grade; the total production from these placers was small.

ANCHOR-MIDNIGHT AREA

Midnight Mine

The Midnight gold "mine" is located at the head of Bitter Creek, 5 miles northeast of the town of Red River (fig. 19). The mine is accessible by a good jeep road from Red River, which follows Mallette Canyon, climbs over a divide, and drops into the Bitter Creek drainage.

This mine was operated for 3 years during the late 1890's. A shaft inclined 55° W. was sunk to a depth of 185 feet, and a number of drifts and crosscuts were driven from the shaft at several levels. A small steam hoist was used at the shaft. Ore was hand trammed, by a switchback track, directly to the mill, which was located several hundred feet west of the shaft. The mill had a capacity of about 10 tons per day and was equipped with a Dodge jaw crusher, Huntington mill, amalgamation plates, and concentrating tables.

The shaft is now caved, and the headframe, buildings, and machinery are gone. Total production could not have been great, in view of the small amount of tailings at the mill. In later years, during the Prohibition period, the mine served a more useful purpose as a front for bootlegging operations.

Altered and limonite-stained Tertiary andesitic and quartz latitic volcanic rocks, and vein quartz, are present on the dump. Reportedly (Reed, 1922, p. 36), the deposit consists of a number of stringers of fine-grained, gray quartz containing abundant small cubes of limonite, probably along a shear zone. This is the only mine in this area whose workings extend below the zone of oxidation; primary ore (pyrite cubes in quartz) was found below the 150-foot level. Native gold occurs in the pyrite, and its oxidation product limonite.

Edison Mine

The Edison gold "mine" is located 0.7 mile east of the Midnight mine, on the east side of Bitter Creek, just south of the old LaBelle-Anchor stage road (fig. 19). The same jeep road from Red River that passes the Midnight mine extends to the Edison mine. A U. S. Geological Survey topographic map ("Taos and Vicinity") shows this mine but calls it the Anchor; as a result, this error has become entrenched in many reports and on other maps.

The mine was worked in the late 1890's and early 1900's by the Edison Mining and Milling Co. A 150-foot shaft is located just east of the bed of Bitter Creek. It is filled with water to stream level, which is some 30 feet below the collar. Water was a problem from the beginning and soon forced abandonment of the shaft. An adit, now caved shut, at the shaft collar apparently extended northeast along the lode. A second adit, now caved 75 feet in from the portal, some 100 feet northwest of the shaft, crosscuts S. 78° E. to the shear zone. Nothing could be learned about the lengths of the adits, or about any workings extending out from the shaft.

A 10-stamp mill with amalgamation plates was located at the shaft. A steam engine furnished power. The mill was operated 18 days until

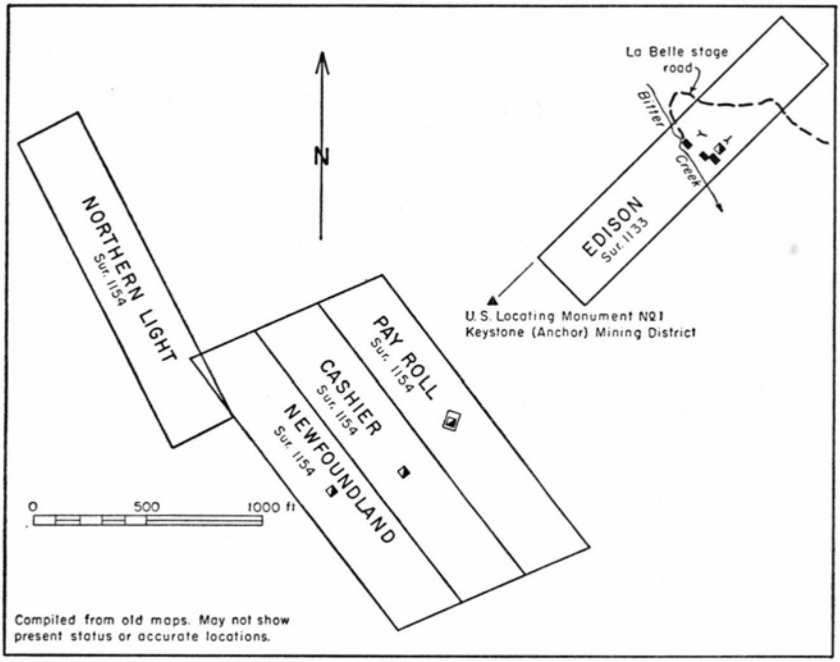


Figure 21

CLAIM MAP OF THE EDISON AND CASHIER MINES water in the shaft stopped operations. Pumping equipment was never installed. Unsuccessful efforts have since been made to work this property. The machinery has been removed; only the shells of the buildings remain.

The workings explore a vertical, N. 50° E. shear zone in slightly altered Tertiary andesite and quartz latite porphyry. A swarm of Tertiary quartz latite porphyry and quartz monzonite porphyry dikes cut the volcanic rocks parallel to the shear zone. This zone, consisting of a number of irregular and discontinuous shears, varies greatly in width, reaching a maximum of 20 feet. Small quartz stringers follow the shears; the wall rock commonly is silicified. Particles of limonite containing native gold are enclosed in the quartz. The limonite probably was formed by the oxidation of pyrite. The richest streak reported in the mine was less than a foot wide, averaging, it is said, $14 per ton in gold.

Anchor Mine

Much confusion exists about the Anchor "mine." Its location has been variously reported as 1 mile west of the Midnight mine, 1 mile south of the Midnight mine, east of the Cashier cabin shaft, or at the spot where the Edison mine is located! The only other clue is that it was "developed by shafts." Lindgren and Graton (1910) do not mention the mine at all.

Although nothing can be said with certainty, it seems likely that the Anchor mine probably was one of the first prospects in the area, inasmuch as its name was applied to the "town" that grew up nearby. It is probable, moreover, that the Anchor mine either included the westernmost shafts of what later became the Cashier "mine" or some of the prospect pits just to the southwest.

Keystone Tunnel [Lillian] Prospect

The Keystone tunnel is located on the southeast side of the east fork of Bitter Creek, a quarter of a mile north of the Edison mine (fig. 19). There are three cabins and a large dump at the portal of the caved adit. The dump is made up of altered Tertiary quartz monzonite and latite porphyry; no vein material was seen.

Reed (1922, p. 36) says:

> Near the Edison a long crosscut tunnel was driven to cut the [gold] ore. . . . This tunnel, the Keystone, cut several veins, but so steep a grade was maintained that the tunnel was barely under the surface and in one place caved shortly after completion.

This probably was one of the first workings in the Anchor area, as nearly all early documents call this area the Keystone mining district. The tunnel was reportedly 1,900 feet long (Lindgren and Graton, 1910, p. 89).

Little Gem(?) Prospect

About 300 feet south of the Edison shaft, on the west side of Bitter Creek, there are a shaft, adit, and the remains of a small mill and water wheel (fig. 19). The shaft is caved; its dump indicates less than 100 feet of workings. A short caved adit at stream level extends southwest toward the shaft, which is on the hillside some 50 feet above the stream.

This probably is the Little Gem prospect, about which Lindgren and Graton (1910, p. 89) say:

> The Little Gem claim is near the Rosita and has a short tunnel and a 40-foot shaft on a small vein parallel to the Edison vein. A 3-inch streak of quartz carrying oxidized pyrite is said to assay from $120 to more than $300 a ton. A little of this ore is being put through an arrastre.

Reed (1922, p. 33-34) states:

> The Little Gem mine is located in the gulch of Bitter Creek . . . a small mill on the property . . . resembles a small testing plant. . . . Mill machinery consists of a small crusher; one-stamp mill; an amalgamating table; a concentrating table . . . ; a centrifugal pump; and an oil engine. . . . A flow of water in the shaft was evidently the cause of closing the mine.

Rosita Prospect

According to Lindgren and Graton (1910, p. 89), "the Rosita claim is on the continuation of the Edison vein. It is developed by a 65-foot shaft . . ." This prospect could not be located.

Cashier Mine

The Cashier gold "mine" is located west of Bitter Creek, 1,600 feet southwest of the Edison mine, along a road extending south from the Midnight-Edison road (fig. 19). The property (fig. 21) was worked in the late 1890's and early 1900's by the Cashier Gold Mining Co. No work has been done since then. Three shafts, now caved, explored the deposit. The northeasternmost shaft reportedly was 85 feet deep; the collar of this shaft was inside a log cabin. The other shafts were 300 and 600 feet to the southwest. The dumps at the shafts indicate that the workings were not extensive. An arrastra was used for milling. Operations were suspended because of water in the shafts. Production, if any, was small.

The shafts explored the same N. 50° E., vertical shear zone as the Edison mine and Rosita prospect. The shear zone at the Cashier mine was reportedly 27 feet wide and carried free gold, the ore ranging from $4 to $20 per ton. The deposit is similar to the other gold lodes in the area. Vein quartz containing pyrite oxidized to limonite is common on the dumps and as float along the outcrop of the shear zone. The shear and a parallel swarm of Tertiary quartz latite and monzonite prophyry dikes cut altered Tertiary rhyolitic and andesi tic volcanic rocks.

Big Five [Oro Fino, Orofino] Prospect

The Big Five gold prospect is in the bottom of Bitter Creek Gulch on the west side of the stream, about 0.7 mile south of the Edison mine (fig. 19). A side road, branching from the road which extends south past the Cashier "mine," winds part of the way down into Bitter Creek Gulch; a trail from the end of this road continues north to the prospect.

This property has been worked since the early 1900's by C. C. Lowe, of Taos, who has done a considerable amount of exploration work during the last few years. An adit about 10 feet above the stream extends west into the hillside; this adit is in good condition and shows signs (new timbers and track) of recent work. There are several old, caved adits and a shaft in the slope northwest of the open adit.

There was a small mill just north of the lower adit; only the foundation, a water wheel, and a few other pieces of machinery remain. Production is not known. There is a cabin on the east side of the stream.

Tertiary rhyolite tuff containing green and purple fragments of andesite(?) is exposed along both sides of the gulch. Locally the tuff is welded and streaked. The lower adit begins in the rhyolite tuff but extends into greenish-brown propylitized andesite. No mineralization was seen. Apparently the old workings explored quartz stringers containing gold-bearing pyrite, along a shear zone.

Granger Placer

The Granger gold placer is located in the bottom of Bitter Creek several hundred feet southeast of the Big Five prospect (fig. 19). A donkey steam engine—the boiler and tall stack still remain—on the southwest wall of the gulch was used to power a boom and cable system to remove the gravels. The grade and production are not known.

MIDDLE REACHES OF BITTER CREEK

Denmark Prospect

The Denmark gold prospect is located in a side canyon extending northeast from Bitter Creek Gulch, 6 miles northeast of the town of Red River and less than a half mile downstream from the Granger gold placer (fig. 19).

There are 4 caved adits, reportedly ranging from 50 to 100 feet in length, an open cut, and a shallow, caved shaft along this side canyon. Here Quaternary cemented gravels overlie Tertiary latite(?) tuff. The gravels contain Precambrian metamorphic and Tertiary igneous rocks, and are well cemented by limonite. These gravels differ from the stream gravels along Bitter Creek only in the abundance of limonite cement. The source of the limonite was not determined.

The workings (fig. 22) reportedly were driven in the late 1800's and early 1900's by Alexander Sneddon in search of placer gold at the base of the cemented gravels. Although some additional work was done in the early 1930's, very little gold was found.

Deldosso Prospect

The Deldosso gold prospect is located along the east side of Bitter Creek, 51/2 miles from the town of Red River and about half a mile upstream from the Independence mine (fig. 19). This prospect was worked for many years by Pete Deldosso, of Red River. Several cabins still stand on the property.

An open adit (fig. 23) with several short crosscuts extends southeast into the side of the gulch. The crosscuts follow small northeast-trending shears and fractures in brecciated, sericitized, and silicified Tertiary quartz latite(?). A few small quartz stringers follow the shears. There is no pyrite. Only traces of gold occur. There has been no production.

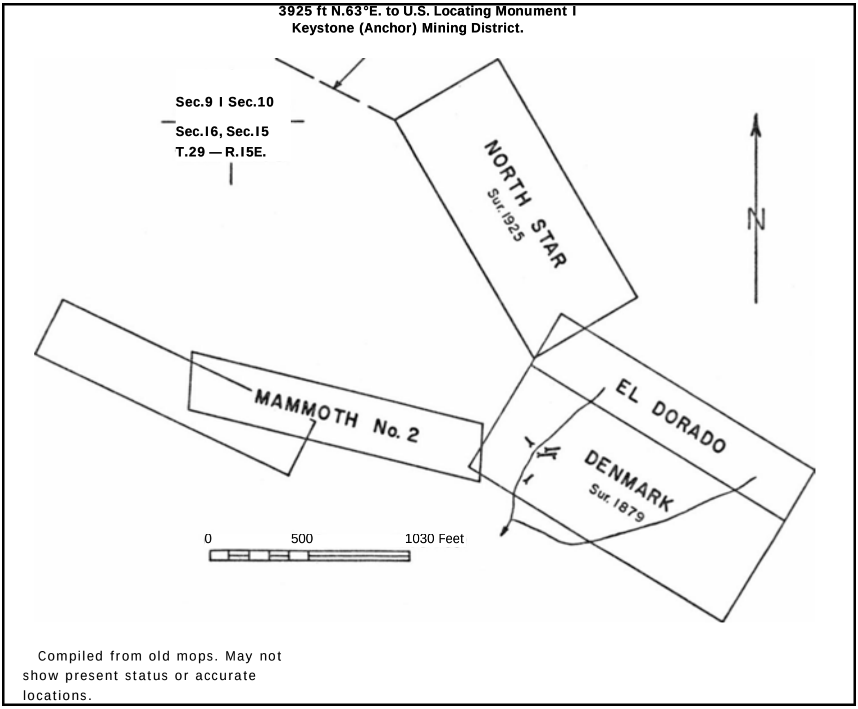


Figure 22

CLAIM MAP OF THE DENMARK AREA, ANCHOR MINING SUBDISTRICT

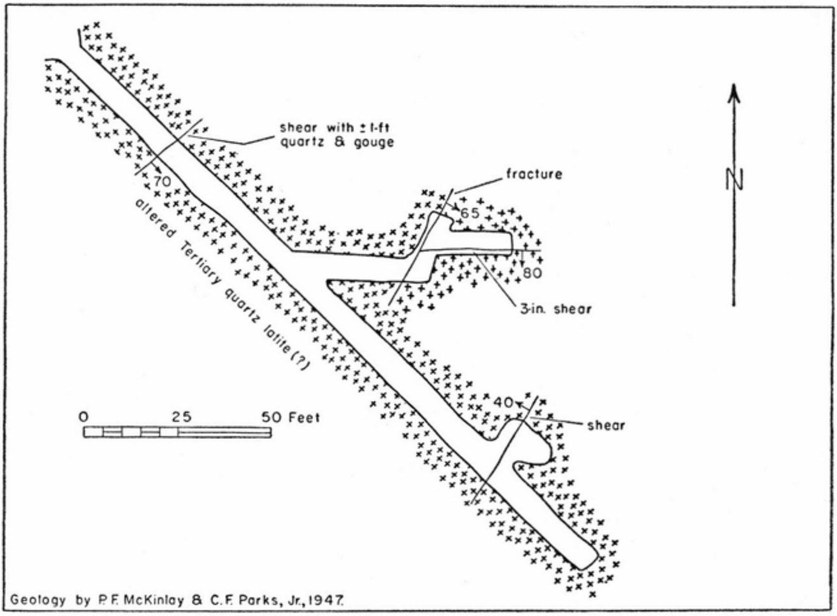


Figure 23
GEOLOGIC MAP OF THE DELDOSSO PROSPECT

Independence Mine

The Independence gold mine is located along the east side of Bitter Creek, 5 miles from Red River and over half a mile north of the Memphis mine (fig. 19).

A rich strike was made on the property in June 1904 by John Lacaniche and Louie Marchino, causing a rush to this area. Much prospecting was done in the sourrounding area, but "most of the prospects were located in order to be as close to the Independence as possible without regard to the presence or absence of mineral" (Reed, 1922, p. 30).

During the summer of 1905, a shaft house containing a hoist and compressor, a mill, an office building, an assay office, and bunkhouses were built. The rich pocket of gold ore found in 1904 was mined and shipped; 25 tons of ore, reportedly assaying over $400 per ton in gold, was produced. Ore and supplies were hauled over a wagon road, now badly washed and impassable, to Moreno Valley.

Although much exploration work was done during the next few years, no other rich ore was discovered. A few shipments of low-grade gold ore were made, but most failed to cover freight and smelter charges. Since then, sporadic attempts have been made to locate more ore, but without success. Only the main adit is partially open. A winze in this adit is filled with water; reportedly there are several drifts from this winze.

Several shear zones cut altered Tertiary quartz monzonite. Lindgren and Graton (1910, p. 88) state:

> A narrow stringer [fissure], containing quartz in some places and in others only kaolin . . . strik[es] S. 12° E. and approximately vertical. This was followed by an adit for 350 feet without obtaining an encouraging assay and then hard lumps of quartz containing pyritic ore were struck. The ore proved to be a mixture of pyrite and a telluride and to carry high values in gold. From this point the vein has been exposed for 80 feet farther and at the breast was 2 feet 8 inches wide. This width comprised the rich streak [mined in 1904] and included not only a narrow quartz-filled fissure, showing beautiful comb structure and numerous druses, but the surrounding blue, silicified wall rock, which is impregnated with pyrite and the telluride, and which carries better values than the quartz itself. Outside of this zone the altered porphyry, less silicified than the "blue ore," also carries low values. In the druses of the vein perfect little sphenoids of chalcopyrite are found. The telluride is present in very small lustrous grains of dark-gray color. . . . A qualitative test proves the presence of tellurium, and the mineral may be petzite, as it has *been* called.

The main adit (fig. 24) follows a second shear zone striking N. 80° E. and dipping 85° S. Quartz stringers from 1 inch to 1 foot wide follow the shear. Specks of pyrite are disseminated through the wall rock and in the quartz. Assays show some gold (fig. 24). Light-gray gouge is abundant in the shear zone; it is composed mainly of finely ground quartz (Park and McKinlay, 1948, p. 26). The quartz-monzonite wall rock is silicified along the shear.

Cora Gibson Prospect

The Cora Gibson gold prospect is located along the east side of Bitter Creek some 500 feet north of the Memphis mine (fig. 19). The prospect is in the Cora Gibson claim, which is part of the Memphis group of claims (fig. 25), but is described separately because the workings explore a different vein. This property was worked by the Memphis Red River Mining Co., which also owned the Memphis mine and other claims in this area.

An adit, now badly caved, crosscuts approximately 300 feet N. 60° E. to the Cora Gibson vein. Drifts extend approximately 70 feet northwest and 160 feet southeast along the vein, which strikes N. 60° W. and dips steeply to the southwest. The vein actually is a series of disconnected quartz stringers along a 4-foot-wide shear zone in altered and brecciated Tertiary rhyolite(?). Pyrite is disseminated through the quartz and wall rock; silicification is common in the wall rock along the quartz stringers. One small mass of resinous-brown sphalerite was found in quartz. The Cora Gibson vein can be traced for over 2,000 feet on the surface.

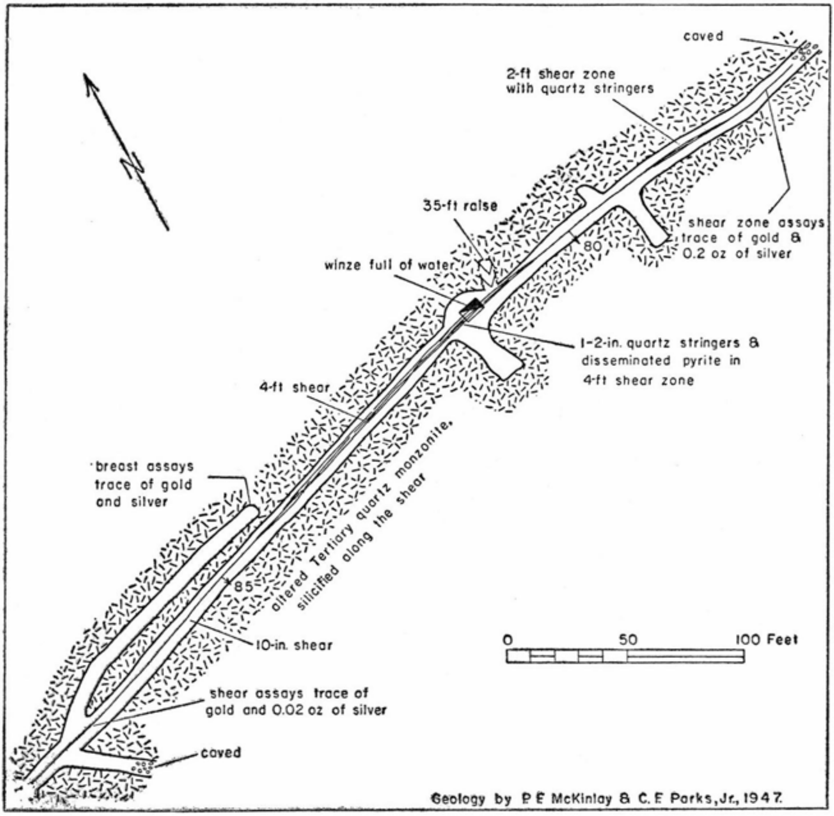


Figure 24

GEOLOGIC MAP OF THE MAIN ADIT OF THE INDEPENDENCE MINE

Memphis Mine

The Memphis gold mine is located on the east side of Bitter Creek, 4.3 miles from the town of Red River (fig. 19). A road extends from Red River up Bitter Creek to the mine.

The mine was first worked in the 1890's. The Memphis Red River Mining Co. operated the property for many years. This company owned eight patented claims (the Memphis, Cora Gibson, Cora Gibson No. 2, Homestake, Tennessee, Mammouth, Comstock, and Sheba), as well as several unpatented claims (fig. 25). Later, the mine was worked sporadically by a series of lessees. The Kershner brothers, of Red River, have held the mine for some time.

Four adits at different levels have been driven east along the persistent east-west Memphis vein (fig. 26). Three of the adits are now caved;

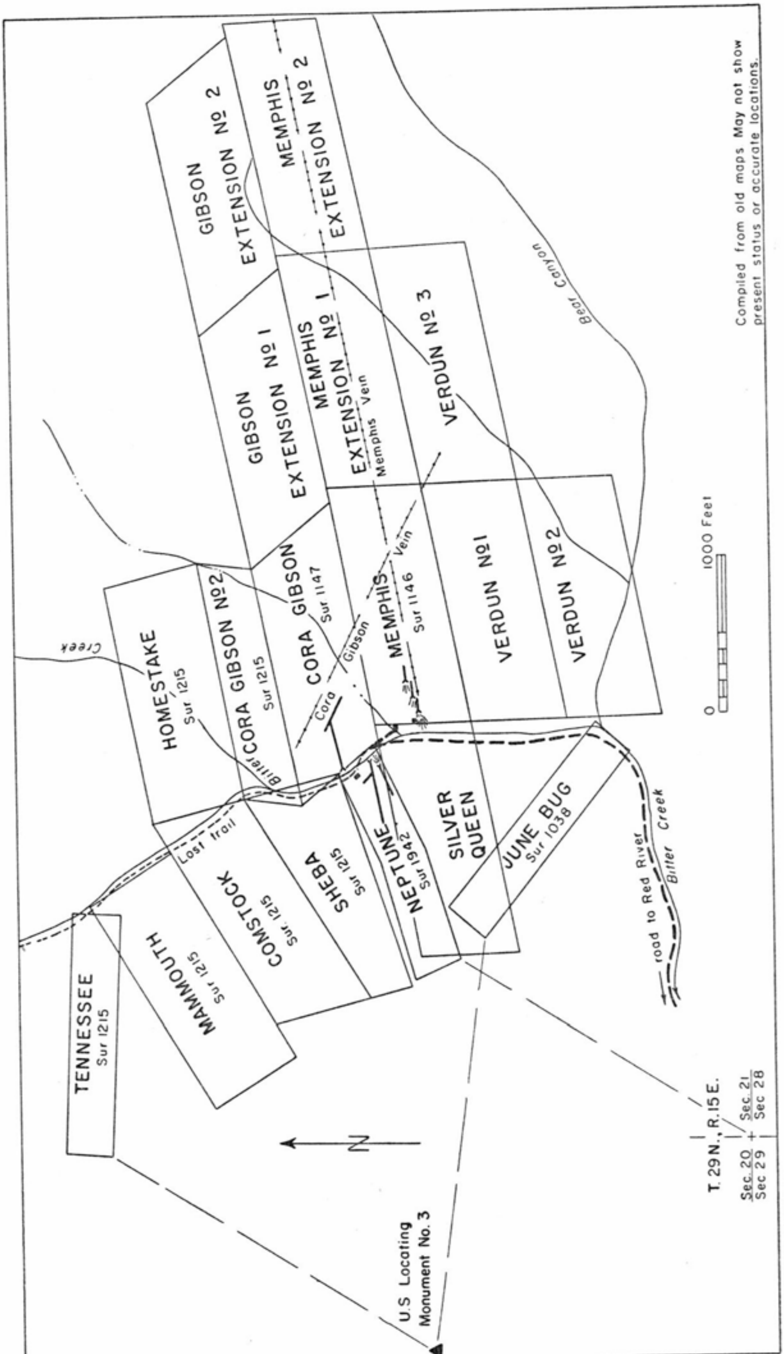


Figure 25
CLAIM MAP OF THE MEMPHIS GROUP AND ADJOINING PROPERTIES

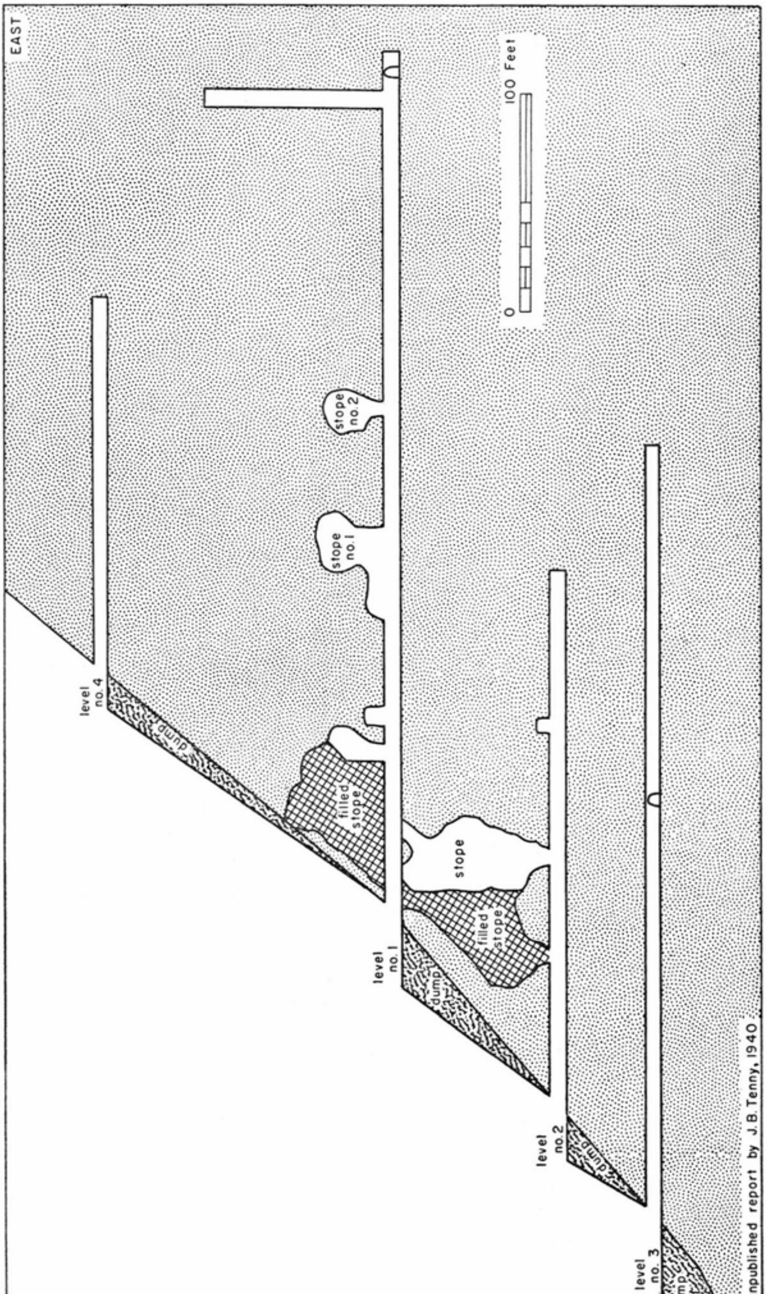


Figure 26

WORKINGS OF THE MEMPHIS MINE

Section along center line of Memphis vein, looking north.

TABLE 2. ORE RESERVES OF THE MEMPHIS MINE
(From unpublished report by J. B. Tenney, 1940)

LEVEL NO.	NUMBER OF SAMPLES*	AVERAGE VEIN WIDTH (feet)	AVERAGE VALUE GOLD & SILVER† ($/ton)	RESERVES				
					POSITIVE ORE (tons)	POSSIBLE ORE (tons)	TOTAL ORE (tons)	AVERAGE VALUE† ($/ton)
				Above No. 4 level:	.....	10,000	10,000	8.00
4	22	2.5	7.96					
				Between No. 4 & No. 1 levels:	7,300	5,200	12,500	13.87
1	47	3.5	19.78					
				Between No. 1 & No. 2 levels:	3,750	.....	3,750	12.39
2	..	..	5.00					
				Between No. 2 & No. 3 levels:	‡	‡	‡	
3	..	..	5.00					
				Dumps:	1,000	.....	1,000	7.96
				TOTALS	12,050	15,200	27,250	11.30

* All samples taken by cutting "V" channels across the vein.
† Gold at $35.00/oz; silver at $0.92/oz.
‡ Not estimated; grade too low.

only the No. 2 level (fig. 27) is open, for part of its length. Gold ore was mined from several stopes.

Until about 1914, much of the ore was treated at the June Bug cyanide mill on the Red River, 1 mile below the town of Red River. In 1915, a small quantity of ore was milled in a 3-ton-per-day cyanide plant that had been built on the property. What little ore was mined in later years was treated at various mills in the area or shipped directly to El Paso or Colorado smelters.

Although this mine has been one of the largest gold producers in Taos County, production has been small. From the size of the workings, it is estimated that less than 3,500 tons of ore averaging 0.4 ounce of gold per ton was mined. An unpublished report made in 1940 by J. B. Tenney gives a reliable estimate of ore reserves presently developed.

The Memphis vein is an east-west shear zone, dipping 60° S., in altered Tertiary rhyolite. It can be traced for over 2 miles on the surface. Locally the dips and strikes deviate greatly from the average. Numerous gray to white quartz stringers, commonly less than an inch thick, occur in the shear zone, forming sheeting parallel to the shear. The sheeted zone ranges from 1 to 6 feet in width, and averages about 3 feet. The quartz is drusy, coarsely crystalline, or cryptocrystalline. Irregular zones of brecciated wall rock cemented by quartz are common in the shear zone. Angular fragments of wall rock are also common in the quartz stringers. Specks and cubes of pyrite are disseminated through the quartz and wall rock. The gold values occur in the pyrite and residual limonite as native metal. Gouge is abundant. Argentite is reported (Reed, 1922, p. 25).

The breccia fragments enclosed by quartz and the wall rock along the quartz stringers have been silicified to a gray color. Postquartz

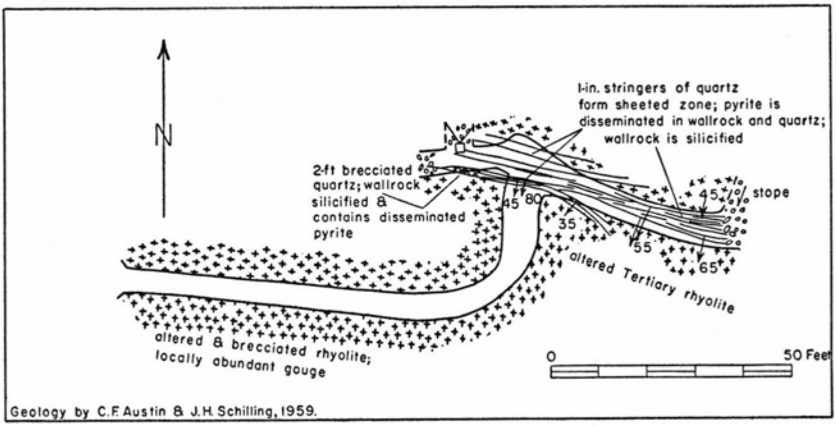


Figure 27

GEOLOGIC MAP OF THE NO. 2 LEVEL, MEMPHIS MINE movement along the shear zones has brecciated and offset the quartz stringers locally. The pyrite commonly is oxidized, especially near the surface; residual limonite and stains of transported limonite are widespread. Manganese stains also are abundant.

Neptune [Scavarda] Prospect

The Neptune gold prospect is located on the patented Neptune claim along the west side of Bitter Creek, some 400 feet northwest of the Memphis mine (fig. 19, 25). Work was done sporadically from 1895 until the 1940's by the Scavarda brothers, of Albuquerque. Nothing has been done in recent years.

An adit on the stream extends west for 600 feet; an 80-foot crosscut extends northwest 75 feet from the portal. The adit on the canyon side, 100 feet to the southwest, extends west-southwest for 160 feet. There are three short adits higher on the slope to the west. The workings are partially caved and filled with water. The dumps contain altered greenish-gray quartz monzonite, stringers of quartz, and brecciated monzonite enclosed in quartz. Pyrite, minor chalcopyrite, and rare sphalerite are disseminated through the quartz. The vein reportedly is 3 feet wide.

Silver Queen Prospect

The Silver Queen gold prospect is located on the west side of Bitter Creek opposite the Memphis mine (fig. 19, 25). In the 1910's and 1920's, the Reserve Mining and Milling Co. owned and worked the Silver Queen and Nellie R. claims. In 1948, the property was held by Frank Read, of Embudo. The present ownership is not known. The workings are now caved.

Reed (1922, p. 27-28) states:

> The Silver Queen claim is . . . on that [the Memphis] vein. The ore on this property is similar to the Memphis ore, but is more oxidized. . . . The Silver Queen is developed by an adit about three hundred feet in length, partly in ore; several short tunnels, all of which follow the vein; and an incline on the vein about thirty feet deep. A small amount of ore from this incline was treated at the [June Bug] mill. . . . The Nellie R., a fractional claim on the same vein, is developed by two short adits.

June Bug Prospect

The June Bug gold prospect is located on the west side of Bitter Creek, about 1,200 feet south of the Memphis mine (fig. 19). The Reserve Mining and Milling Co. owned and worked the patented June Bug claim (fig. 25), on which this prospect is located. The workings have been caved for many years.

According to Reed (1922, p. 28):

> There is a shaft about fifty feet deep which follows an apparently vertical fault outcropping on the property. The vein can be traced a short distance south of the shaft, then apparently disappears. A tunnel was driven on the

property in an attempt to locate the extension of this vein which is seven feet wide and contains good values in gold and silver. The quartz gangue is more massive and finer-grained than is common in this section of the district.

The country rock is altered greenish-gray quartz monzonite.

Dorothy Prospect

There is an old caved adit, abandoned for many years, on the east side of Bitter Creek, south of the Memphis mine and north of Bear Canyon (fig. 19). This is apparently on the Dorothy claim owned and worked in the 1920's by the Bitter Creek Mining Co., about which Reed (1922, p. 24) says:

> The tunnel on the Dorothy is about three hundred feet long and follows . . . [a] well defined fissure vein. The ore minerals are pyrite and small amounts of other sulfides. The quartz gangue is deposited in the fissures and replaces the country rocks for a short distance on either side.

Enderman Prospect

The Enderman prospect is located on the northwest side of Bitter Creek, 3.5 miles northwest of Red River (fig. 19). The road from Red River to the Memphis mine passes the cabin and only adit. August Enderman worked this property for many years. There has been no production.

The adit (fig. 28) follows a 2- to 4-foot-wide vertical shear zone striking N. 35° E., in Precambrian quartz-mica gneiss and granite gneiss. Abundant gouge and rare pyrite occur in the shear. Two channel samples across the shear zone and a grab sample of the dump contained traces of silver and molybdenum.

An open cut 20 feet west of the portal of the adit exposes abundant garnet and coarse biotite mica in the quartz-mica gneiss along a contact with Precambrian granite.

RED RIVER MINING SUBDISTRICT

The Red River subdistrict surrounds and includes the town of Red River. It embraces the areas drained by the lower reaches of Mallette Creek, Bitter Creek, Bobcat Creek, and Road Canyon northeast of Red River Canyon; Red River Canyon from Tenderfoot Gulch to Goose Creek; and the areas drained by Tenderfoot Gulch, Pioneer Creek, Placer Creek, and Goose Creek southwest of Red River Canyon (pl. 1). This subdistrict is part of the much larger Red River mining district (fig. 4).

NORTH OF THE RED RIVER

Ethel Prospect

The Ethel gold prospect is located behind the schoolhouse in the town of Red River, on the east side of Bitter Creek (pl. 1). This property has not been worked for many years. There has been no production.

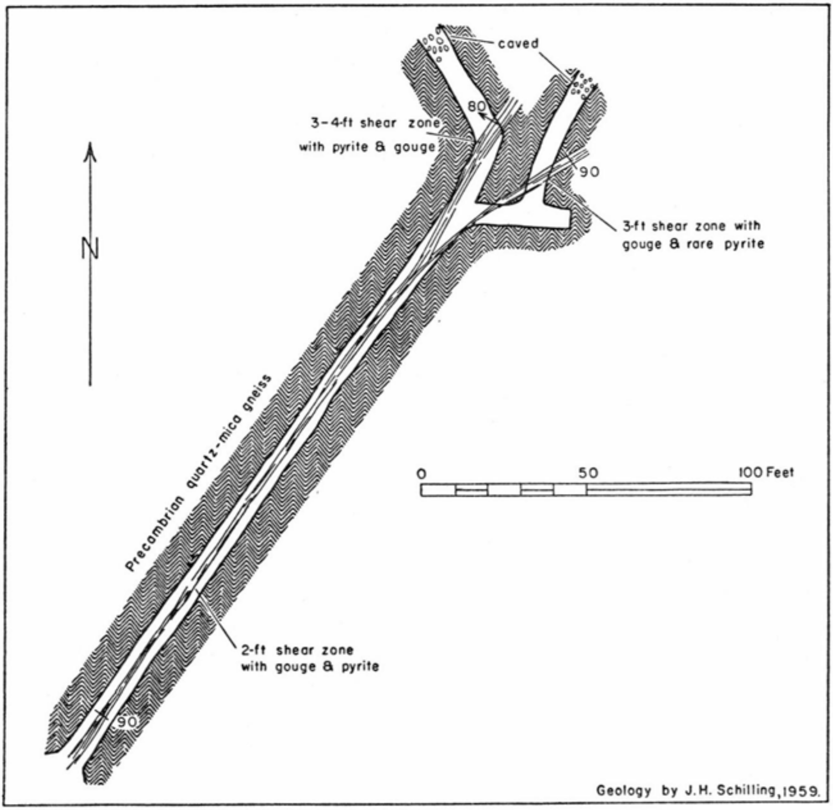


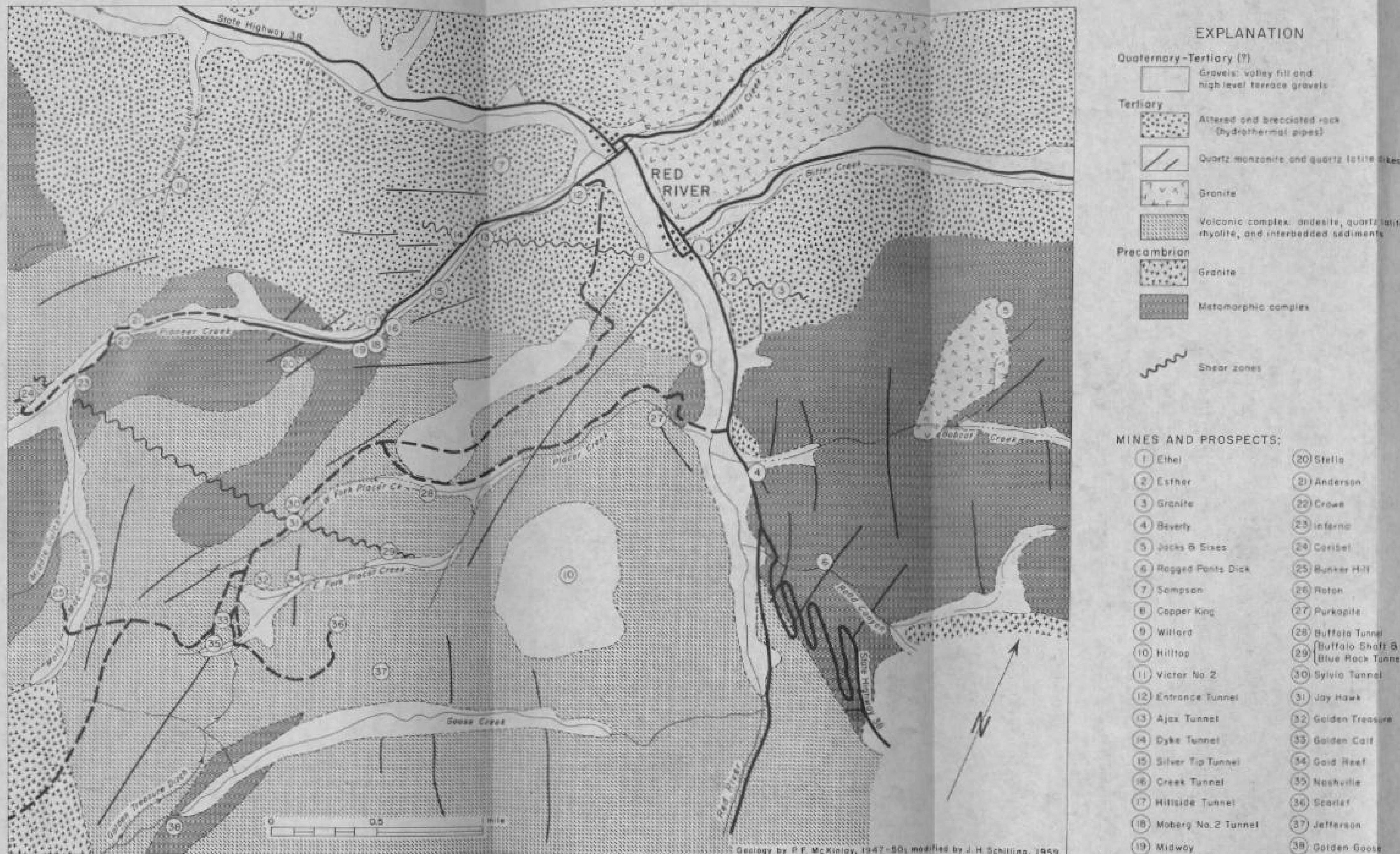
Figure 28

GEOLOGIC MAP OF THE ENDERMAN PROSPECT

An adit, now caved, extends southeast along a vertical shear zone in highly altered and brecciated Tertiary granite(?) porphyry. A persistent quartz stringer follows the shear zone. The quartz commonly is drusy. Small grains of pyrite are disseminated through the quartz and wall rock. Oxidation has altered much of the pyrite to limonite; the wall rock is stained brown and yellow.

Esther Prospect

The Esther lead prospect is located about 0.2 mile east of the schoolhouse in the town of Red River, on the northeast side of Red River Canyon about 0.1 mile northeast of State Highway 38 (pl. 1). The Esther claim was located in 1896. Some exploration work was done, and a small, crude mill was used to treat what little ore was found. The prospect was soon abandoned.



GEOLOGY, MINES, AND PROSPECTS OF THE RED RIVER MINING SUBDISTRICT

A 50-foot shaft, now caved, exposed an east-west shear zone, 4 feet wide, in altered and brecciated Tertiary granite(?). Fine-grained galena and chalcopyrite occur as 1- to 3-inch-wide streaks in soft gouge. Malachite stains are common.

Granite [Munden] Prospect

The Granite copper prospect is located about 0.3 mile east of the Esther prospect, less than 0.3 mile northeast of State Highway 38, in a small gulch extending northeast from Red River Canyon (pl. 1). This property has not been worked for many years. Some copper ore (chalcopyrite) containing molybdenite was produced from a 50-foot shaft, now caved. The ore minerals probably occur along the east-west, steeply north-dipping shear zone that cuts the altered Tertiary granite(?) at the prospect. The Copper King mine, some distance to the west, is on this same prominent shear zone.

Beverly Prospect

The Beverly gold prospect is located on the southeast side of the mouth of Bobcat Canyon, just northeast of State Highway 38 (pl. 1). This property has not been worked for many years; there has been no production.

An adit extends southeast along a brecciated and silicified Tertiary quartz monzonite porphyry dike in Precambrian metamorphic rocks. Quartz stringers follow fractures in the dike. Pyrite is disseminated through the quartz and monzonite. Limonite stains are common.

Jacks and Sixes Prospect

The Jacks and Sixes molybdenum prospect is located 11/2 miles east of the town of Red River (pl. 1). The prospect is over one-half mile north of Bobcat Creek, high on the west slope of a side canyon that extends north from Bobcat Canyon at a point 11/4 miles northeast of the mouth of the latter. It is inaccessible by vehicle.

There has been no production. Nothing else is known about the history.

There are several cuts and two adits along the contact between Precambrian metamorphic rocks and a large intrusive body of Tertiary granite. The granite is similar to the soda granite of lower Red River Canyon. The workings are near the northern end of the granite body that extends south to Bobcat Creek.

A cut in Precambrian metamorphic rocks near the top of the hill exposes a molybdenite-bearing vein, which appears to trend east-west and to dip steeply to the north. A 135-foot adit down the hill from this cut is now caved, but is said to have exposed the vein; molybdenite is present on the dump. A lower, 190-foot adit is open but is too short to intersect the possible downward extension of the vein. This lower adit is mainly in granite but cuts the granite-Precambrian contact; gouge along the N. 30° W.-striking, 50° NE.-dipping contact contains molybdenite "mud." A cut on the top of the hill contains patches of molybdenite. The workings are too limited to give any idea of the extent of the deposit. (Park and McKinlay, 1948, p. 31; and Philip McKinlay, personal communication.)

Ragged Pants Dick Prospect

The Ragged Pants Dick gold prospect is located along the north side of Road Canyon, about 0.4 mile east of the canyon mouth (pl. 1). Road Canyon extends east from the Red River at Tall Pine Camp, just south of the junction of the road to the head of Red River Canyon with State Highway 38. The canyon takes its name from the old wagon road, now impassable, from the town of Red River to Moreno Valley, which follows the canyon and passes this prospect.

First worked in the 1890's, the prospect has been abandoned for many years. A cabin still stands along the wagon road. Only traces of gold were found. There was no production.

Three short adits, now caved, extend northeast in Precambrian metamorphic rocks. A 40-foot-wide Tertiary quartz monzonite porphyry dike, striking N. 10° E., cuts the Precambrian rocks just east of the easternmost adit. Tiny cubes, specks, and veinlets of pyrite are disseminated sparsely through the rocks and rare vein quartz making up the dumps.

ALONG THE SOUTH SIDE OF RED RIVER CANYON

Sampson [McKeen] Prospect

The Sampson gold prospect is located a quarter of a mile south of the Red River, three-quarters of a mile west of Mallette Creek and the town of Red River (pl. 1). The prospect has not been worked for many years.

A 65-foot incline follows a dark-blue, vertical, N. 15° W. quartz vein, over 6 feet wide, in altered Tertiary quartz monzonite porphyry. An adit below the incline extends south along the vein for 125 feet. Angular fragments of the wall rock are enclosed in the quartz. Specks of gold-bearing pyrite are disseminated through the wall rock and the wall-rock fragments in the vein, and to a lesser degree through the quartz of the vein. Much of the quartz is coarsely crystalline. Both the wall rock along the vein and the wall-rock fragments in the vein are silicified to a dark-gray color. The vein carried as much as one-quarter ounce of gold per ton; the pyritized wall rock averaged 0.09 ounce of gold per ton. A postvein fault has brecciated the quartz along the east wall of the vein.

Copper King [Anaconda, Paxton] Mine

The Copper King copper "mine" is located at the town of Red River, just south of the Red River and opposite the mouth of Bitter

Creek (p1. 1). This was the first prospect to be worked in the Red River mining district. A group of men connected with the Waterbury Watch Co., of Waterbury, Connecticut, began to develop the property in 1867. The short Waterbury adit was driven south, reportedly along a copper-bearing zone. In 1879, the Copper King adit was driven S. 70° W. for over 200 feet along a copper-bearing zone. A small copper smelter was built at the mouth of Pioneer Canyon; the small furnace, or "jacket," was packed in in sections. After two trial runs, the operation was abandoned, apparently because of the high cost of fuel and other supplies, and the poor smelting practices used.

In 1896, the old Copper King adit was reopened. In 1903, a prospector named Paxton drove an adit, the Paxton crosscut, south for 870 feet, reportedly to intersect a second east-west zone containing copper and lead. He also sank a shaft for about 50 feet before it caved, became flooded, and was abandoned. Paxton also did some churn drilling and reportedly discovered primary copper ore at 600 feet.

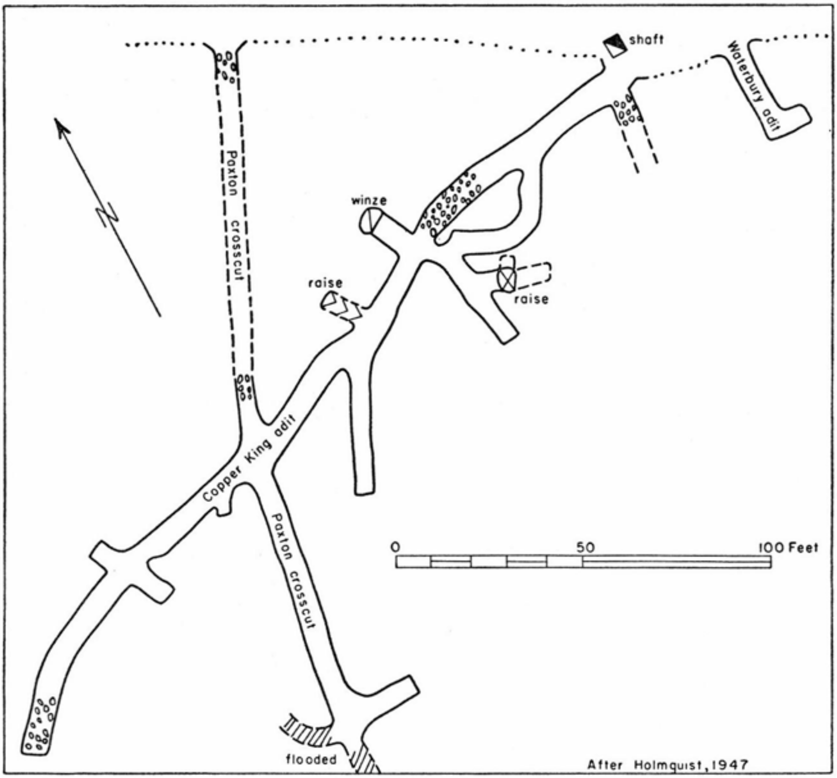


Figure 29
MAP OF THE COPPER KING MINE

For many years there was sporadic activity, including lengthening of the Paxton crosscut to 1,030 feet, and the driving of a drift from the crosscut along a copper-bearing zone reportedly encountered 875 feet from the portal.

In 1943, the U. S. Bureau of Mines (Holmquist, 1947) reopened and sampled the Copper King adit and 100 feet of the Paxton crosscut south of its intersection with the adit. It was necessary to drive a "runaround" to avoid a badly caved area in the Copper King adit. The copper content of the workings sampled proved to vary greatly and irregularly, both horizontally and vertically. Much of the area contains ore averaging 1 percent copper; a few areas average nearly 2 percent. Few assays showed more than 2 percent copper. At that time, the property was held by Richard Kelley, of Santa Fe, and Frank E. Munden, of Red River.

In 1956, the Taos Uranium and Exploration Co. reopened the Copper King adit. Shortly thereafter, while work was being continued, the adit caved. Operations were suspended, and no attempt has been made to reopen the workings again. All the workings now are caved.

The copper occurs in several shear zones that either follow Tertiary quartz monzonite dikes in altered Tertiary volcanic rocks or cut a large body of quartz monzonite in which the silicified shear zones have prominent dikelike outcrops. Other outcrops are rare and in highly altered rock, making identification difficult.

The main shear zone strikes N. 80° E. and dips 80° N. It can be traced for over a mile east-west and extends west through the Dyke prospect and east through the Esther and Granite prospects. At the Copper King mine, the main shear zone is over 70 feet wide and contains brecciated quartz monzonite. Much of the quartz monzonite is silicified; gouge is abundant. Malachite, azurite, and some tenorite occur in fractures, as well as in the more highly brecciated areas, as cement, enclosing fragments of silicified quartz monzonite and gougy material. A few quartz stringers follow fractures. Iron oxides apparently are absent (Holmquist, 1947, p. 3).

One or more cross-shears striking N. 20° E. and dipping 80°-85° W. intersect the main shear zone. These shear zones also are in quartz monzonite and contain the same type of mineralization as the main shear. A second east-west shear zone reportedly was found about 750 feet south of the main shear zone.

Chalcopyrite reportedly was encountered some 600 feet below the surface in a churn-drill hole; it is said to occur also with the secondary copper minerals near the south end of the Paxton crosscut. Molybdenite likewise is reported to occur in the mine.

Willard Prospect

The Willard (Williard?) gold prospect is located south of the Red River, one-half mile southeast of the Copper King mine and the town of Red River, and northwest of the mouth of Placer Creek (pl. 1). In the early 1900's, E. P. Westoby and Al Hedges owned and worked the three claims making up this property. About 10 tons of ore was treated in an arrastra, and some gold was recovered. The prospect has not been worked for many years. All the workings are caved.

When Fain (1910) visited the property, there was a 60-foot inclined shaft on a wide vein, a 120-foot adit intersecting the vein below the incline, and a 260-foot adit intersecting the vein at a depth of 900 feet. Reed (1922, p. 21) noted that there were 3 shafts and over a thousand feet of "tunnels" on the property, and that " a strong vein which contains free-milling gold" was being developed. Probably this vein is similar to the other gold lodes in this area.

Hilltop Gold Placer Prospect

An old shaft is located on the flat top of the hill 1 mile west-southwest of Tall Pine Camp on the Red River (pl. 1). The shaft was sunk 135 feet in high-level terrace gravels in a search for placer gold, but did not reach bedrock on which the gold, if present, probably would occur. These terrace gravels are over 1,500 feet above the Red River and probably were deposited during an early stage (late Tertiary?) of the formation of Red River Canyon.

TENDERFOOT GULCH

Victor No. 2 Prospect

The Victor No. 2 lead-silver-copper prospect is located along Tenderfoot Gulch about 1 mile south of the Red River (pl. 1). Tenderfoot Gulch is 2 miles west of the mouth of Pioneer Creek. The nearest road is State Highway 38 along Red River Canyon.

The Victor No. 2 claim was located in 1896 by a man named Higgins. The property was developed by several adits, a shaft, and shallow prospect pits. Reportedly, the prospect was abandoned because there was no market for the lead. Water in the shaft also caused trouble. The adits and shaft are now caved.

Two sets of shears cut the altered Tertiary(?) rocks at this prospect. One set parallels the northeast-trending Tertiary quartz latite and monzonite porphyry dikes that intrude the other rocks; the second set trends southeast. Stringers of quartz and streaks of gouge are common along the shears. Abundant pyrite and fine-grained galena, lesser chalcopyrite, and rare sphalerite and chalcocite occur with the quartz. Limonite and malachite stains are common. The richer ore, it is reported (Lindgren, 1910, p. 87), assayed 60 percent lead, 1 percent copper, 8 ounces of silver, and a trace of gold.

PIONEER CREEK

Entrance Tunnel Prospect

The Entrance tunnel is located along the east side of Pioneer Creek, 0.2 mile south of the Red River (pl. 1). The Pioneer Canyon road passes the prospect. This prospect probably was driven in a search for gold. There has been no production. The adit is open and extends S. 60° E. for about 75 feet in highly brecciated and altered Tertiary volcanic rocks. The volcanic rocks have been silicified and pyritized and are now limonite stained. At the breast, the adit is in Tertiary quartz monzonite; this probably is the same dike, striking N. 25° E., exposed on the slope above the adit.

Silver Tip **Group**

Much confusion has arisen as to what the Silver Tip Group of prospects includes. The name has been used in a number of ways. Apparently, as the name was employed generally, the Silver Tip Group included only the Ajax, Dyke, Silver Tip, and New York workings, which are located along the lower reaches of Pioneer Creek, Later, all the prospects along Pioneer Creek and in the area to the west, held for a number of years by Mrs. L. M. Smith, of Red River, Charles Young, of League, Texas, and R. T. Keeling, of Leona, Texas, were called the Silver Tip Group.

Ajax Tunnel Prospect

The Ajax tunnel is located along the east side of Pioneer Creek, 0.7 mile south of the Red River (pl. 1). The Pioneer Canyon road passes the adit. This gold (and copper?) prospect was driven in 1928. There has been no production.

The "tunnel" is open and entirely in Tertiary quartz monzonite porphyry (fig. 30). Disseminated pyrite is widespread. The monzonite is irregularly sheared and brecciated. Some pyrite and chalcopyrite are present in the shears; malachite stains are common.

A short, open adit about 150 feet south of the Ajax tunnel extends about 50 feet S. 70° E. in altered and highly brecciated quartz monzonite. Disseminated pyrite and malachite stains are common.

Dyke Tunnel Prospect

The Dyke Tunnel gold (and copper?) prospect is located along the west side of Pioneer Creek, 0.8 mile south of the Red River (pl. 1). The Pioneer Canyon road passes the prospect. There is a cabin at the "tunnel" portal and two short adits in the cliff just to the north. Nothing is known of the early history. The drift from the main tunnel was driven after 1948. There has been no production.

The tunnel is open and extends west in silicified Tertiary quartz monzonite containing disseminated pyrite (fig. 31). Several north-south shears cut the country rock. These contain gouge, quartz stringers, pyrite, and chalcopyrite(?), and are stained by limonite and malachite. The pyrite carries traces of gold.

The two smaller adits are open and extend west in silicified quartz

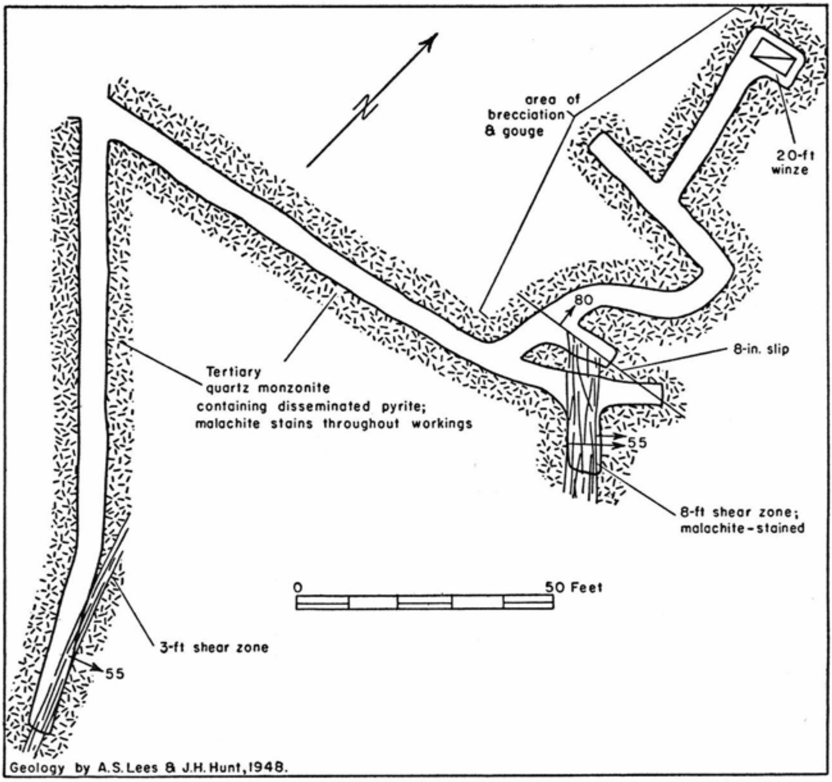


Figure 30
GEOLOGIC MAP OF THE AJAX TUNNEL

monzonite. The shears and mineralization found here are of the same type as those in the main Dyke tunnel.

The quartz monzonite has been silicified completely, making identification difficult. This highly silicified rock forms a prominent cliff known locally as the "quartz dike," or "quartzite dike." The two smaller adits are in this "dike." The main Dyke tunnel extends along the south edge of the "dike"; here silicification is less intense.

Silver Tip Tunnel Prospect

The Silver Tip tunnel is located on the east side of Pioneer Creek some 100 feet above the creek, 1.1 road miles south of the Red River (pl. 1). The Pioneer Canyon road passes this gold prospect. This is one of the oldest and largest workings along lower Pioneer Creek. Nothing is known of its history.

The adit is caved; the size of the dump indicates about 2,000 feet

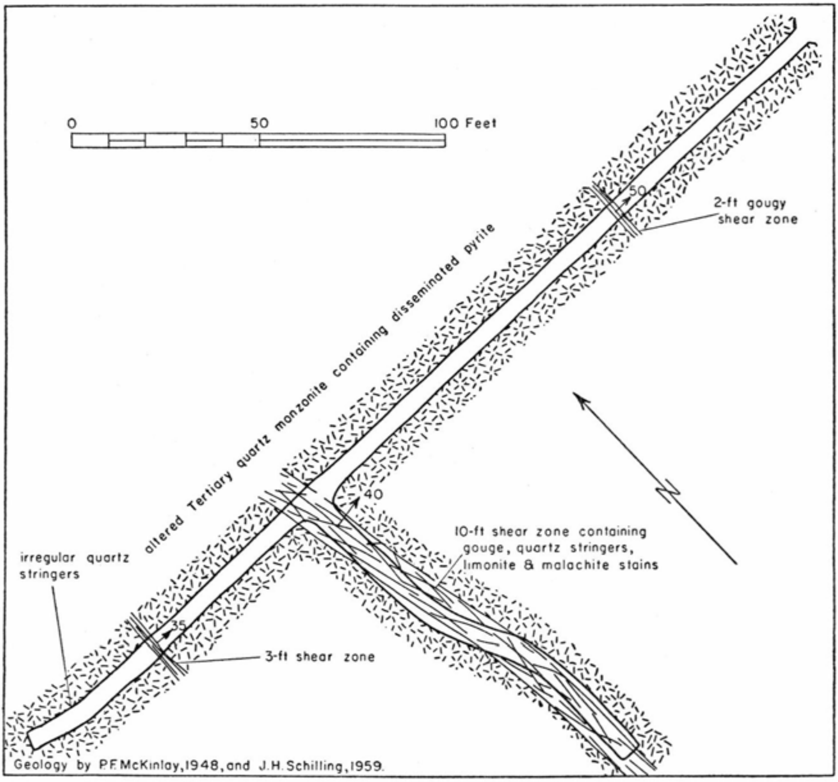


Figure 31
Geologic Map of the Dyke Tunnel

of workings. The adit is in altered and brecciated rock; the dump is mainly unaltered Tertiary quartz monzonite and latite porphyry, with lesser amounts of metamorphosed Pennsylvanian(?)-Permian(?) limestone and conglomerate. Some disseminated pyrite occurs in the rocks of the dump; no other ore minerals were observed.

Creek Tunnel Prospect

The Creek tunnel is located along the east side of Pioneer Creek, 1.4 road miles south of the Red River (pl. 1). The Pioneer Canyon road passes this gold prospect. There has been no production.

The adit (fig. 32) is open and cuts Tertiary quartz monzonite porphyry dikes(?) and Pennsylvanian(?)-Permian(?) limestone, shale, and conglomerate. North-south slips and shear zones showing considerable movement separate the quartz monzonite and sedimentary rocks. Gouge, quartz stringers, and some pyrite occur along the slips and shears. The pyrite carries traces of gold.

Hillside(?) Prospect

An uncaved adit, probably driven in a search for gold, extends about 120 feet S. 85° W. into the west side of Pioneer Canyon, a short distance south of the Creek tunnel (pl. 1). There is a cabin just north of the prospect. The adit is in highly to moderately altered Tertiary quartz monzonite. The monzonite is silicified, pyritized, and limonite stained.

Moberg Tunnel No. 2 Prospect

The Moberg tunnel No. 2 is located along the east side of Pioneer Creek, 1.5 road miles south of the Red River (pl. 1). The Pioneer Canyon road passes this gold prospect. The Moberg (Midway) group of claims, which included this adit, was held and worked for many years by Harry Moberg, of Red River. There has been no production.

The adit is in highly altered to unaltered Tertiary quartz monzonite dikes(?), and Precambrian granite gneiss and other metamorphic rocks. Some disseminated pyrite and quartz stringers were seen on the dump. The workings were open for only part of their length, which is estimated to total several hundred feet.

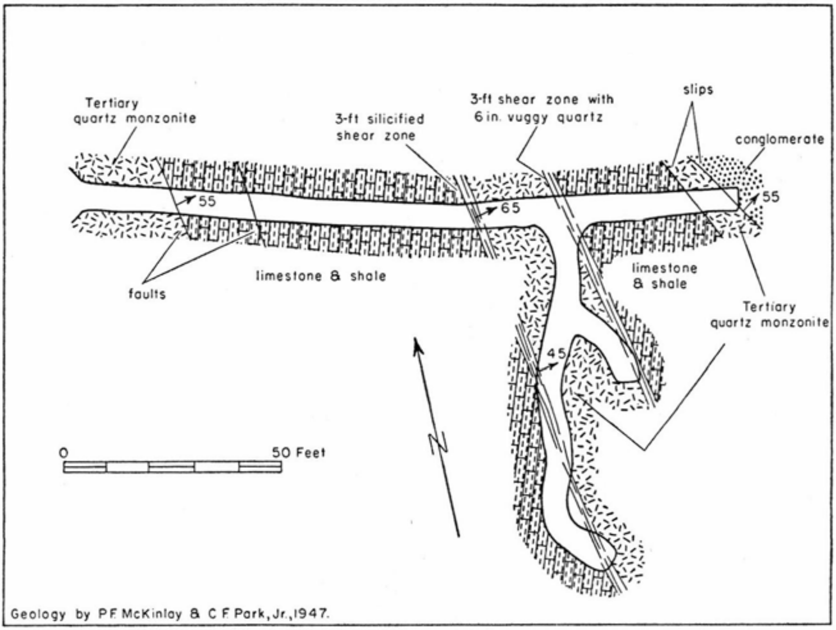


Figure 32
Geologic Map of the Creek Tunnel

Midway Prospect

The Midway tunnel is located along the southeast side of Pioneer Creek several hundred feet south of the Moberg Tunnel No. 2 (pl. 1). There are two cabins near the portal. A short adit, extending into the south side of the canyon, is located a few hundred feet to the southwest. This prospect, like the Moberg Tunnel No. 2, belongs to the Moberg (Midway) group of claims mentioned previously. In 1936, a 1-ton lot of gold ore was shipped to the Golden Cycle mill at Colorado Springs, Colorado. Additional production, if any, must have been small.

The Midway tunnel reportedly contains some 2,000 feet of workings. Only part of the workings were accessible. These expose altered and unaltered Tertiary quartz monzonite intrusives, and Precambrian granite gneiss and other metamorphic rocks. A number of north-south slips and shear zones cut the rocks. Gouge, pyrite and quartz stringers, disseminated grains of pyrite, and malachite stains occur in the slips and shears. The country rock commonly is silicified and contains disseminated pyrite.

The short adit to the south extends S. 20° E. for about 40 feet. It starts in Precambrian metamorphic rocks and ends in Tertiary quartz monzonite. Movement has taken place along the N. 10° W., 50° E.-dipping contact between the two rock types. Only minor disseminated pyrite was seen in the rocks.

Prospect West **of the Midway Tunnel**

A caved adit extends into the northwest side of Pioneer Canyon, 0.2 mile southwest of the Midway tunnel. The size of the dump indicates over 600 feet of workings. The dump is Tertiary quartz monzonite containing quartz stringers and disseminated pyrite. Much of the quartz monzonite is unaltered; the rest is highly altered and brecciated. Silicification, chloritization, and limonite stains are common.

Stella [Last Chance, Lulu, Mamie] Prospect

The Stella gold prospect is located 0.2 mile up a small side gulch that extends south from Pioneer Creek at a point 1.8 miles upstream from the Red River (pl. 1). A trail from the road along Pioneer Canyon provides access to the prospect. The property includes the patented Last Chance claim owned by William Baxter. Nothing is known of the history.

The main adit, now caved, is on the east side of the small side gulch at the contact of Precambrian rocks with overlying Tertiary(?) sedimentary rocks. The adit reportedly follows a north-south shear zone containing quartz stringers and disseminated pyrite. A 20-foot wide, northeast-trending quartz latite porphyry dike cuts the Precambrian and Tertiary(?) rocks. A 200-foot sequence of the sedimentary rocks (interbedded pink and gray tuff, arkose, red shale, gray limestone, and arkosic conglomerate containing metaquartzite pebbles) above the adit strikes N. 55° W. and dips 20° N.

Anderson Prospect

The Anderson gold prospect is located along the northwest side of Pioneer Creek, 2.7 road miles upstream (southwest) from the Red River (pl. 1). The Pioneer Canyon road passes the workings and cabin. Two short adits extend northwest; both are caved. The dump consists mainly of Tertiary quartz monzonite containing a little disseminated pyrite. McKinlay (personal communication) found a little Tertiary(?) tuff, sandstone, and limestone on the dump.

Crowe [Rock Garden] Property

The Crowe property is located on the southeast side of Pioneer Creek, 0.1 mile south of the Anderson prospect (pl. 1). Here there is a cabin, the foundation and a few timbers of a mill(?), and a 35-foot adit extending S. 50° E. in slope debris. Lee Crowe owned and lived on the property for many years.

Inferno Prospect

The Inferno gold prospect is located on the east side of Pioneer Creek, 3.3 road miles upstream from the Red River (pl. 1). The Pioneer Canyon road passes the main workings and building. The property consisted of seven patented claims (fig. 33). This prospect has not been worked for many years.

The main adit is caved; the size of the dump indicates several thousand feet of workings. The dump is composed of Tertiary quartz monzonite and Precambrian rocks, commonly silicified and containing quartz stringers and abundant disseminated pyrite. This prospect reportedly explored the same east-west quartz-vein system exposed on the Jayhawk claims to the east and in the Caribel mine to the west.

Caribel [Pratt] Mine

The Caribel gold mine is located on the west side of Pioneer Creek, 3.7 road miles upstream (southwest) from the Red River (pl. 1). The Pioneer Canyon road extends to the mine. The remains of the mill, an assay office, three bunkhouses, a cookhouse, barns, and several dwellings are located on Pioneer Creek. The caved mine workings are in the steep canyon slope to the west of the mill. There is a blacksmith shop and compressor house at the portal of the main adit. A switchback wagon road, passable by jeep, extends from the mill to the main workings.

Important work began about 1910, when the Caribel Milling and Mining Co. was organized to work the property. Extensive exploration work was done. In 1913, some ore was treated at the June Bug cyanide mill on the Red River. A small mill was built, but it operated for only

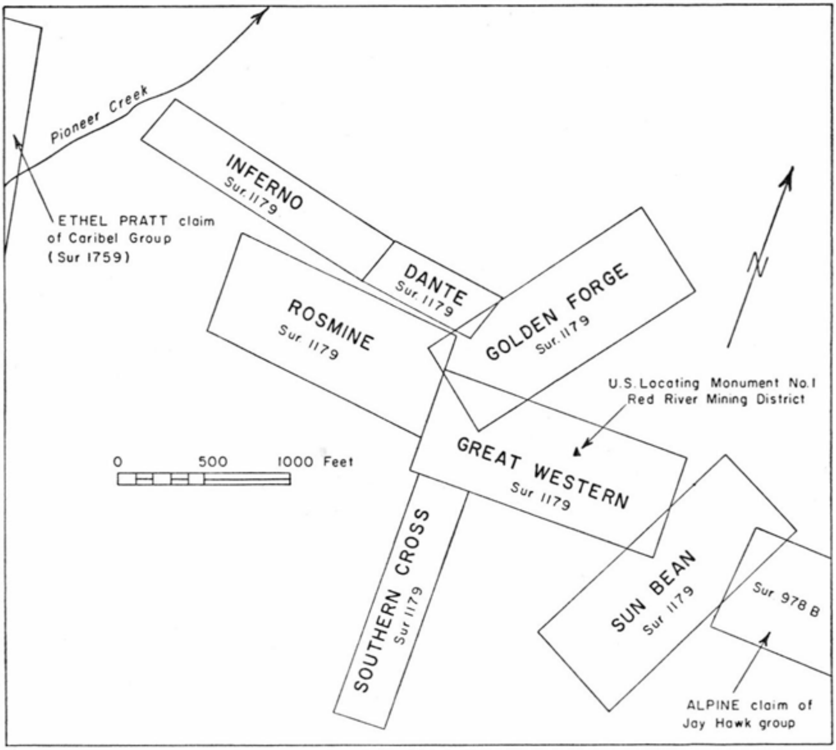


Figure 33
CLAIM MAP OF THE INFERNO GROUP

about 2 months, in the fall of 1921. Several hundred tons of ore averaging $18 per ton in gold and silver was treated, and several bars of gold-silver bullion were produced. Little work has been done since the mill closed. The property consisted of the Caribel group of 13 patented claims (fig. 34).

There are a number of shallow pits and shafts on the various claims. The main shaft has 5 levels: the 60-foot level, 80-foot level, 105-foot level, 145-foot level, and 175-foot level. Most of the work was done on the 105-foot level. The adit on this level extends west for about 1,500 feet. At a point about 600 feet from the portal, the adit is connected to the main shaft, some hundred feet to the north, by a drift. Drifts totaling several hundred feet extend north from the shaft on this same level.

The 25-ton cyanide mill was operated by water power. A Dodge crusher, 5-stamp battery, and ball mill were used to crush and grind the ore. The equipment has since been removed.

The main vein cutting the claims trends east-west and dips nearly vertically. It is formed by a series of more or less continuous quartz stringers along a shear zone. Some pyrite is found in the quartz and disseminated through the wall rock. Calcite also is present. Much of the pyrite has been oxidized to limonite. Manganese stains also are common. Both the pyrite and limonite carry gold; silver is reported from assays of the vein. The wall rock commonly is silicified. The main vein is part of the same vein system that extends east through the Inferno and Jay Hawk properties.

Several north-south, vertical shear zones intersect the main vein. These shears contain the same type of mineralization found in the main vein but are smaller and more irregular. Ore shoots commonly occur at the intersection of two shears.

The veins and shears cut Precambrian metamorphic rocks, Tertiary quartz monzonite porphyry and andesite, and Tertiary(?) tuffaceous sediments.

Bunker Hill Prospect

The Bunker Hill gold prospect is located 1 mile south of the Caribel mill, on the headwaters of Pioneer Creek (pl. 1). The eight unpatented

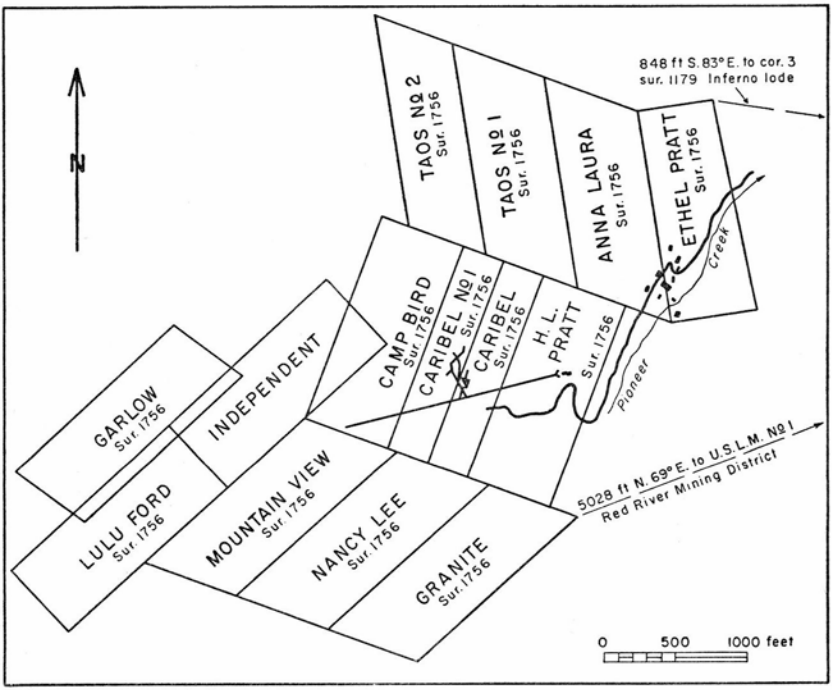


Figure 34

CLAIM MAP OF THE CARIBEL GROUP

claims making up this property are between Molly Mac and Middle Gulches (fig. 35). A half-mile road, branching from the Goose Lake-Placer Creek jeep road about 5 road miles from State Highway 38, extends to the main shaft. The prospect is difficult to reach by way of Pioneer Creek.

J. 0. Gill located the Bunker Hill and Alamo claims in 1900, and the Princess claim in 1904. He sank a 150-foot shaft on the Bunker Hill claim, but soon was forced to abandon work when water flooded the shaft. In 1916, Gill, J. L. Oldham, G. L. Oldham, and M. R. Oldham located the other five claims; however, little additional work was done. Nothing has been done since then. There has been no production.

This prospect was not visited. The shaft is now caved but reportedly explored a gold vein at the contact between Tertiary andesite and Precambrian granite and schist.

Raton Prospect

The Raton group of claims is located on the east side of Molly Mac Gulch, just east of the Bunker Hill claims (pl. 1). The road to the

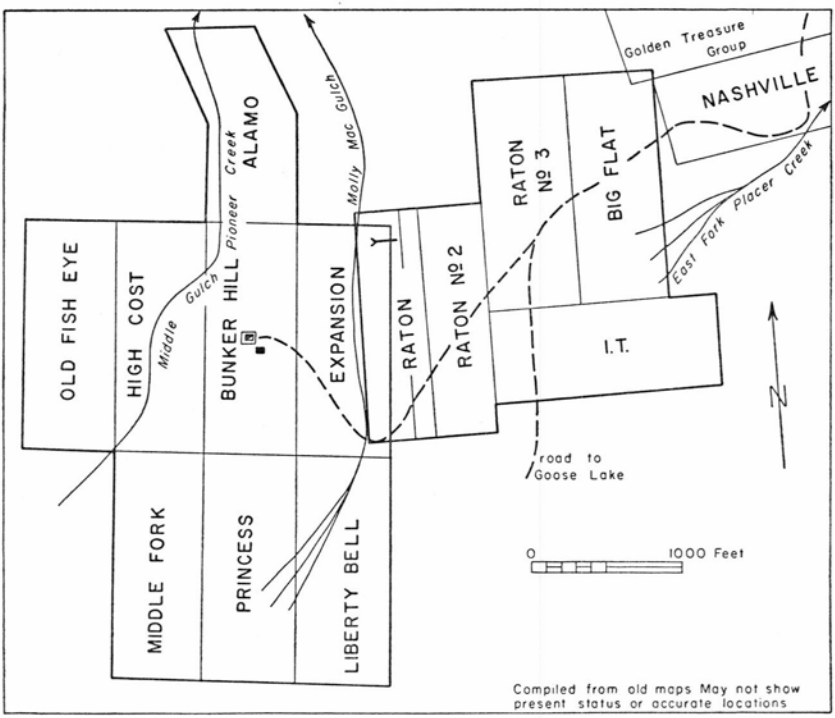


Figure 35
CLAIM MAP OF THE RATON AND BUNKER HILL GROUPS

Bunker Hill shaft passes through these claims. The 5 claims (fig. 35) making up the Raton group were located in 1913 by R. A. Oldham and N. K. Oldham. Little work was done. There was no production.

PLACER CREEK

Purkapile Prospect

The Purkapile prospect is located along the south side of Placer Creek, 0.2 mile west of the Red River (pl. 1). Carl Purkapile has worked this prospect for many years. The adit follows a shear zone in a Tertiary quartz monzonite porphyry dike cutting green Tertiary tuff. Abundant calcite and disseminated pyrite, fluorite, and a few quartz stringers occur in the shear zone. The country rock is silicified. (Philip McKinlay, personal communication).

Gold Placers Below the Buffalo Mine

A number of gold placer deposits have been worked on Placer Creek. Hydraulicking was used to mine the gravels at the forks of Placer Creek. Evidence of placer mining can be seen elsewhere along Placer Creek. There has been no activity for many years.

Buffalo [Silver King] Mine

The main adit (Buffalo tunnel) and surface plant of the Buffalo gold mine are on the West Fork of Placer Creek, along the Placer Creek jeep road, 2.4 road miles southwest of State Highway 38. The main shaft and old Blue Rock tunnel are south of the main adit along the East Fork of Placer Creek, 1 mile upstream from the junction of the East and West Forks (pl. 1).

The Blue Rock tunnel was driven north for several hundred feet along a north-south vein. This work also exposed an important east-west vein. Later, in 1910, the Buffalo New Mexico Mines Co. was formed to develop the property. This company took over the Blue Rock and Silver King claims (fig. 36) and located 13 additional claims. A shaft was sunk on the slope just north of the Blue Rock tunnel, and workings were driven from the shaft at several levels to explore the two veins. Water soon made further development difficult. In 1921, a drainage adit (Buffalo tunnel) was driven south from the West Fork of Placer Creek for over 3,500 feet, connecting with the shaft at a depth of 250(?) feet. The shaft was deepened to 322 feet, and drifting was done, mainly on the 160-foot and Tunnel levels. There are over 6,000 feet of workings in the mine. The adit and shaft are now caved.

A mill, powerhouse containing a steam engine and compressor, blacksmith shop, bunk-cook-house, and other structures were built at the portal of the Buffalo tunnel. The 25-ton mill was equipped with a Universal crusher, Ellis Chile-type mill, Wilfley table, and Card table. In 1929, 1,716 pounds of gold-silver concentrates was produced and shipped to the El Paso smelter. Recovery was poor. The mill burned in 1937. The mine has not been worked since the 1930's.

An east-west, vertical, 10- to 15-foot-wide vein extends west for over 2 miles through the Silver King (Buffalo), Jay Hawk, Inferno, and Caribel claims; to the east, a short distance beyond the Buffalo shaft, the vein is cut off by a fault. At the shaft, a 7-foot-wide cross vein extends S. 20° W. from the east-west vein. There is a large ore shoot at the junction of the two veins. These veins follow shear zones in Tertiary andesite tuffs and breccias. Several Tertiary quartz monzonite dikes cut the volcanic rocks.

The veins consist of quartz stringers in the shear zones. Gold-bearing pyrite occurs in the quartz and disseminated through the shears. The country rock in the shears commonly is silicified. Argentite and fine-wire silver reportedly were found. The gold and silver contents vary greatly within the vein. The richer ore reportedly contained from 0.5 to 0.7 ounce of gold and from 5 to 15 ounces of silver. A grab sample of ore on the dump assayed 0.09 ounce of gold and 7.71 ounces of silver.

Compton's Silver King [Sylvia Tunnel] Prospect

The Sylvia Tunnel gold prospect is located on the northwest side of the West Fork of Placer Creek, along the Goose Lake-Placer Creek jeep road, 3.4 road miles southwest of State Highway 38 (pl. 1). Charles E. Compton drove the adit in the early 1900's. There has been no production.

The adit is now caved; the dump indicates several hundred feet of workings. The adit reportedly cut several small gold veins in Tertiary andesite volcanic rocks.

Jay Hawk Mine

The Jay Hawk gold mine is located on the northwest side of the West Fork of Placer Creek, along the Goose Lake-Placer Creek jeep road, 3.5 road miles southwest of State Highway 38 (pl. 1). The mill is along the same road, 1.5 miles southwest of the highway.

The first work was done in 1895. The shaft had been sunk over 50 feet, and the adit driven over 300 feet, before 1904. The property consisted of three patented claims: the Jay Hawk, Alpine, and National (fig. 36). Some ore was treated in the June Bug mill on the Red River. In about 1910, the Caribel Milling and Mining Co. acquired the property. During the 1930's, the property was leased to various companies. A 35-ton flotation mill, which had been built earlier proved to be unsatisfactory. It is reported that less than 1,000 tons of ore was treated. Some gold-silver concentrates were produced. Ore was also shipped directly to a smelter.

The open adit is located at stream level. The 100-foot shaft is on the slope between the adit portal and the jeep road. The adit (fig. 37) follows an 8- to 14-foot-wide, S. 85° W., vertical shear zone in purple

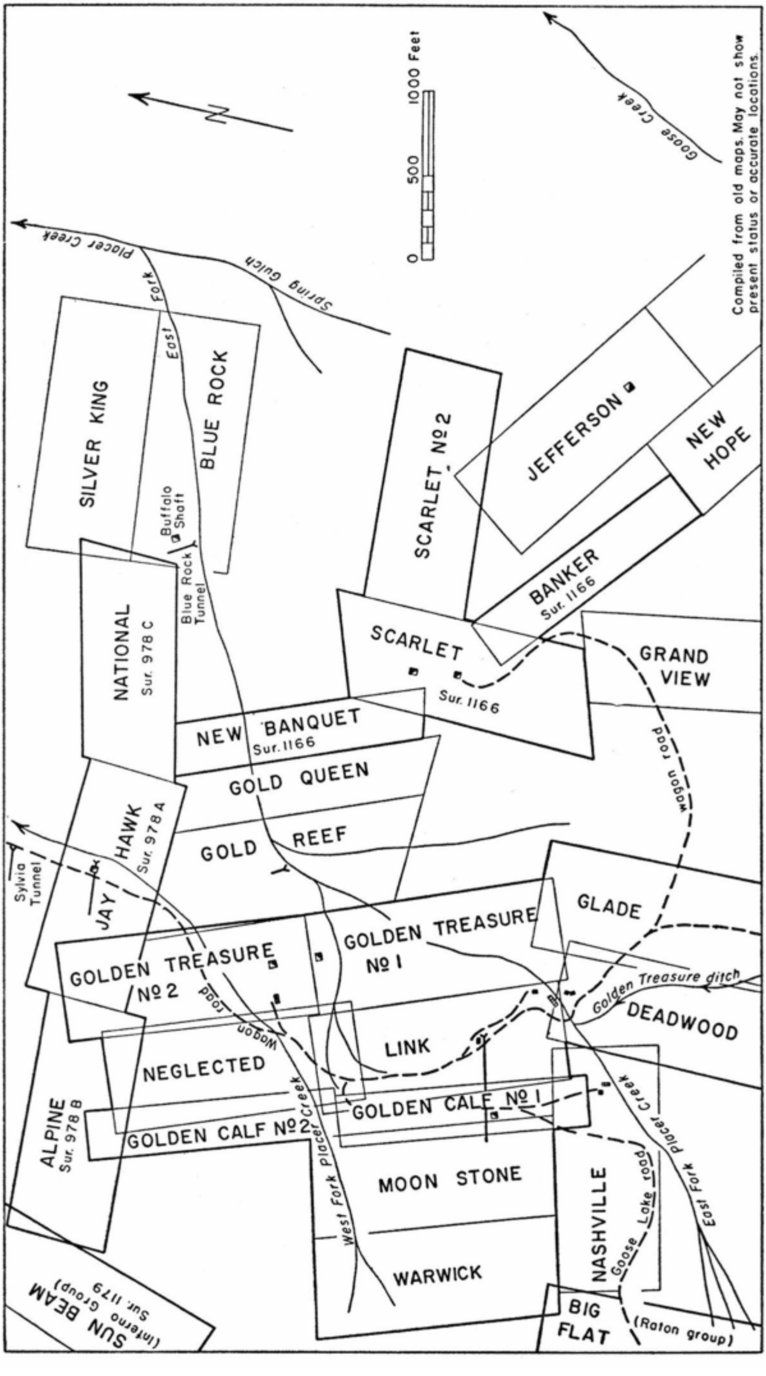


Figure 36

CLAIM MAP OF THE PLACER CREEK AREA

Including the Jay Hawk, Golden Treasure, and Scarlet groups.

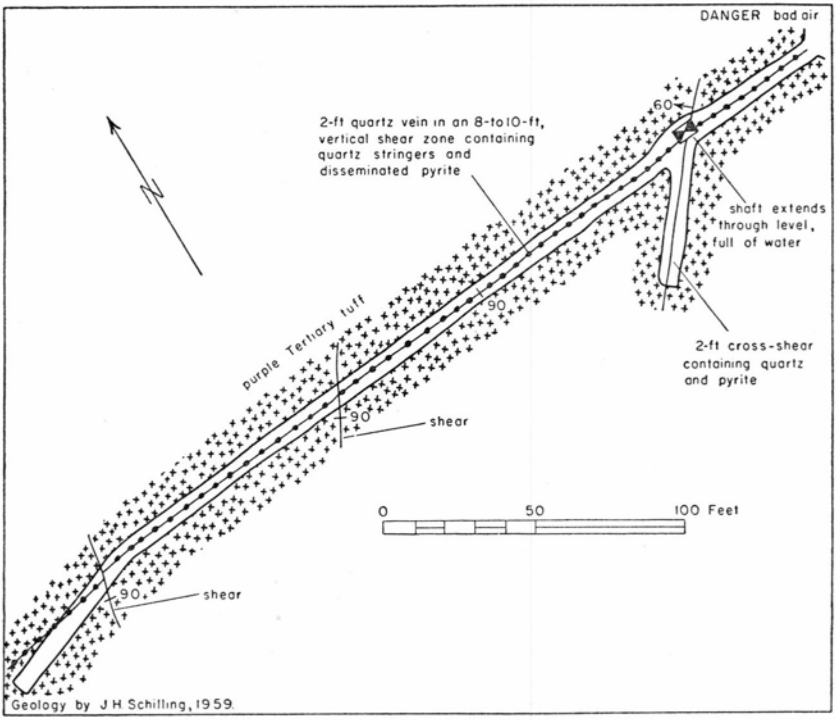


Figure 37
GEOLOGIC MAP OF THE JAY HAWK MINE

Tertiary tuff. This shear zone, called the National vein, can be traced east-west for over 2 miles, passing through the Buffalo mine to the east and through the Inferno and Caribel properties to the west. A 2-foot vein of quartz follows the shear and can be traced readily on the surface. Quartz stringers are common in the shear zone on both sides of the quartz vein. Gold-bearing pyrite occurs as small grains in the quartz and disseminated through the shear. Silicification is common. Rare galena, sphalerite, chalcopyrite, arsenopyrite, argentite, and ruby silver are said to be present. The shear zone reportedly averages 0.4 ounce of gold; silver values vary greatly.

A 2-foot-wide, N. 40° E., cross-shear containing quartz and gold-bearing pyrite has been explored by the shaft and a drift from the adit. Several other narrow, north-south shears cut the main, east-west shear.

Oldham Prospects

The Oldham gold prospects are located between the East and West Forks of Placer Creek (pl. 1 and fig. 36). The Golden Treasure shafts are east of the Goose Lake road on the divide between the two forks, 0.4 mile south of the Jay Hawk mine. The Golden Calf tunnel is 0.2 mile south of the Golden Treasure shafts; the Golden Calf shaft is 500 feet to the west of the tunnel, along the west side of the Goose Lake road.

The Golden Treasure No. 1 and 2 claims were located in 1895. A 150-foot shaft was sunk on the Golden Treasure No. 2 claim. Work was stopped while crosscutting from the bottom of this shaft when water flooded the workings. A shaft was sunk 75 feet on the Golden Treasure No. 1 claim, but water again forced suspension of further work.

In 1897, the Deadwood and Golden Calf No. 1 and 2 claims were located. A shaft was sunk on the Golden Calf No. 1 claim, but here also, excessive water stopped further sinking at 47 feet.

A 2-mile ditch was built to carry water from Goose Creek to an arrastra (powered by a water wheel) on the East Fork of Placer Creek Some ore from the workings was treated, but recovery was poor.

In 1914, the Golden Treasure Mining Co. was formed and acquired the seven claims (including the Golden Treasure, Golden Calf, and Deadwood claims) of the Golden Treasure group (fig. 36). Later the company located three additional claims: the Moonstone, Warwick, and Glade. An adit, the Golden Calf tunnel, was driven west to intersect at depth and unwater the Golden Calf shaft. Because of poor surveying, a connection was not achieved.

Much of the work on this property was done by the Oldham brothers: George L. Oldham, M. Read Oldham, and Richard A. Oldham. Little work has been done since the 1930's. The Golden Treasure group of claims is now held by Mr. and Mrs. Walter Hamilton, of Red River.

The shafts and adit are now caved. The geology of the Golden Calf workings is similar to that of the other gold prospects and mines on Placer Creek, quartz and pyrite along well-defined shear zones cutting Tertiary andesite tuff and quartz monzonite dikes. However, the mineralization at the Golden Treasure shafts reportedly differs in that the quartz stringers and disseminated pyrite occur in an irregularly shaped brecciated area, probably at the intersection of two shear zones.

Gold Reef Prospect

The Gold Reef gold prospect is located on the northwest side of the East Fork of Placer Creek, 0.1 mile northeast of the Golden Treasure shafts (pl. 1 and fig. 36). A caved adit extends northwest. The dump contains Tertiary andesite tuff and quartz monzonite, some of which is silicified and contains quartz and disseminated pyrite.

Nashville Prospect

The Nashville gold prospect is located 0.1 mile south of the Golden Calf shaft (pl. 1 and fig. 36). Several tons of ore was mined by August

Enderman from a small prospect pit and treated in an arrastra on the property. Although the claim has not been worked for many years, a cabin and the water wheel that powered the arrastra still are in good condition.

The prospect pit just east of the cabin is in a silicified Tertiary quartz monzonite dike containing disseminated pyrite and drusy quartz.

Scarlet Prospect

The Scarlet gold prospect is located one-quarter mile south of the East Fork of Placer Creek and the Buffalo shaft (pl. 1). An old wagon road connects this prospect with the Goose Lake road. The property consists of three patented claims (the Scarlet, Banker, and New Banquet) and the unpatented Scarlet No. 2 claim (fig. 36).

In the 1890's, several shallow pits and a shaft were made to explore the quartz-pyrite-gold veins exposed on the claims. Little additional work has been done since then.

The shafts are now caved. The geology is similar to that of the other gold prospects and mines in this area: quartz stringers and disseminated pyrite along silicified shear zones in Tertiary andesite.

GOOSE CREEK

Jefferson Prospect

The Jefferson gold prospect is located one-quarter mile north of Goose Creek, 13/4 miles west of the Red River (pl. 1 and fig. 36). The wagon road to the Scarlet claim passes 0.2 mile west of the Jefferson shaft.

At the turn of the century, a shallow shaft was sunk on the intersection of two shear zones in Tertiary andesite tuff containing quartz stringers and disseminated pyrite. Little additional work was done.

Golden Goose Prospect

The Golden Goose gold prospect is located on the south side of Goose Creek, 3 miles upstream (west) from the Red River (pl. 1). The property is accessible by a trail up Goose Creek or by a shorter trail from the Oldham prospects on the East Fork of Placer Creek.

Development consists of a 70-foot shaft and several short adits driven in the early 1900's. All the workings are now caved. A silicified, north-south(?) shear zone cuts Precambrian metamorphic rocks and contains greasy, gray quartz, small grains and cubes of pyrite, and some calcite. Limonite and manganese stains are common. The shear zone is brecciated less intensely than the shear zones in the andesite tuff along Placer Creek.

BLACK COPPER CANYON

Black Copper Mine

The Black Copper gold mine is located along the north side of Black Copper Canyon, which extends east from Red River Canyon 41/2

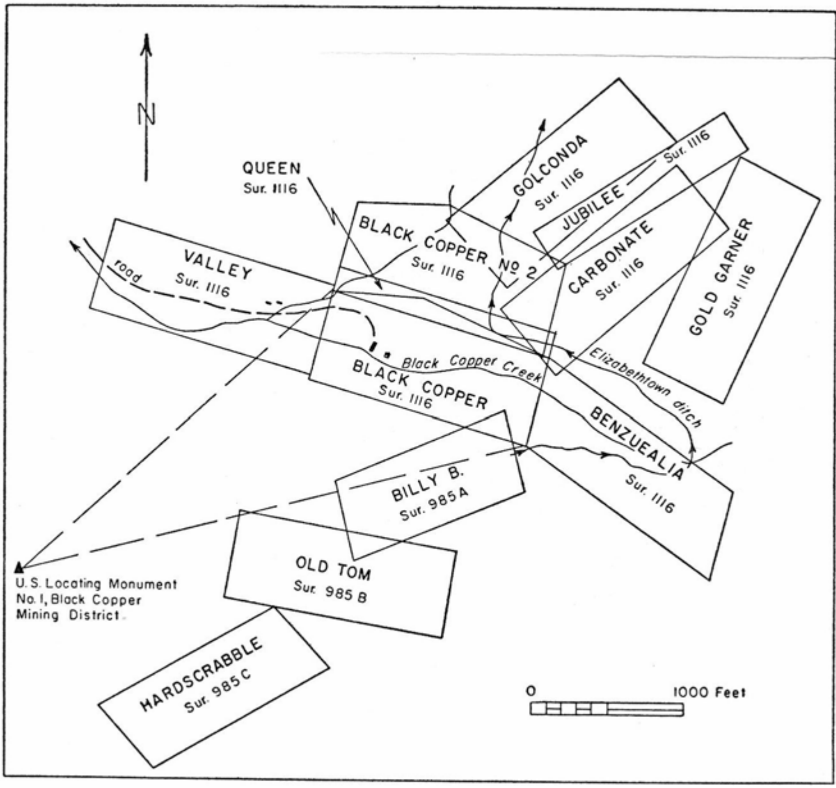


Figure 38

CLAIM MAP OF THE BLACK COPPER GROUP

miles upstream (south) from the town of Red River. A road extends three-quarters of a mile up Black Copper Canyon to the mine.

Development began in 1896. A shaft was sunk, drifts and crosscuts were driven from the shaft on five levels, and three adits were driven and connected with the upper two levels (fig. 39). A 5-stamp mill with amalgamation plates and a 3-deck Bartlett concentrating table were built.

Some stoping was done, and gold-silver ore was treated in the mill. By 1900(?), however, excessive water stopped operations. In later years, several partially successful attempts were made to unwater the mine; some mining was done on the upper levels, and several small shipments of ore reportedly were made. The total production is not known.

The longer two adits are now caved, and the shaft is filled with water to the upper (41-foot) level. The property, consisting of nine patented claims, is owned by 0. B. Siler, of Taos.

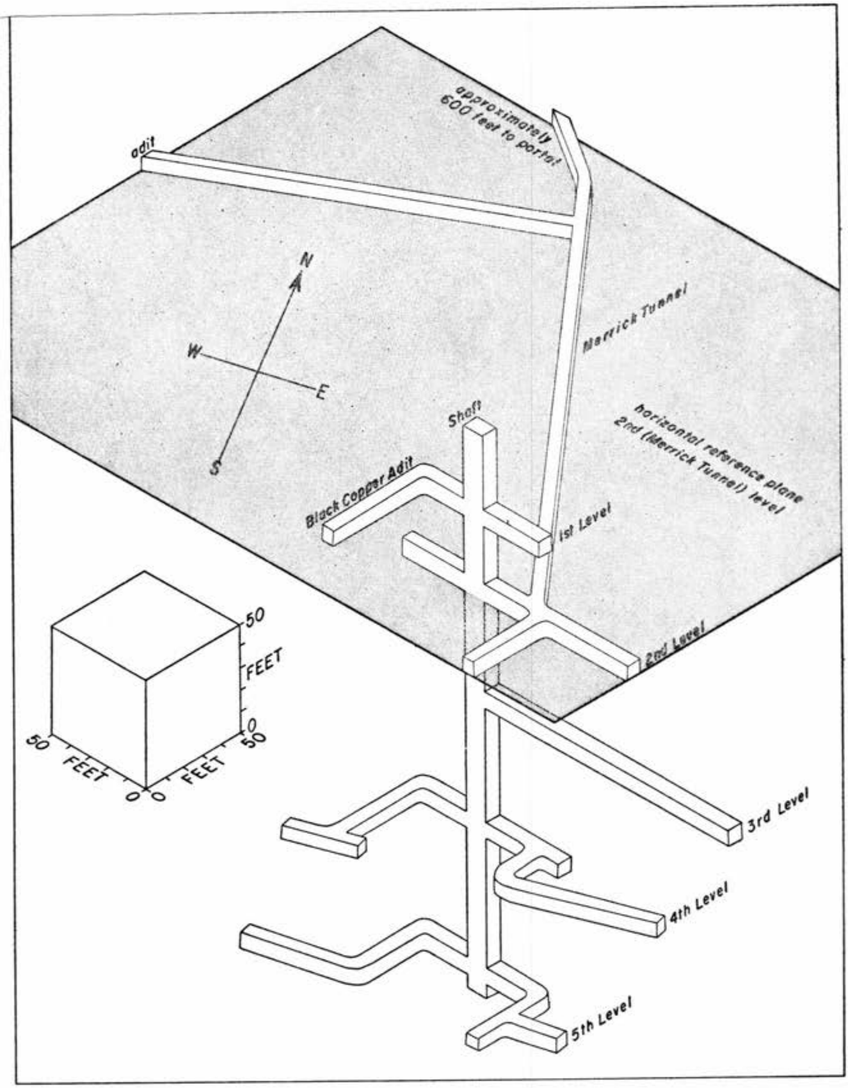


Figure 39
ISOMETRIC DIAGRAM OF THE BLACK COPPER MINE

A major, N. 20° E. fault cuts between the shaft and the two western adits. Gneissic Precambrian granite occurs on the southeast side of the fault and is cut by gray andesite(?) and greenish-black basalt(?) dikes. An intrusive body of Tertiary quartz monzonite porphyry is present on the northwest side of the fault. Surface exposures are poor.

One or more shear zones cut the Precambrian granite. A 1- to 3-footwide, nearly vertical, S. 70° E. shear zone is exposed in the discovery adit just east of the shaft; the various levels reportedly explored the downward extension of this shear. On the lower levels, gouge, drusy to cryptocrystalline quartz stringers, small grains and cubes of disseminated, gold-bearing pyrite, and some galena, chalcopyrite, sphalerite, and chalcocite occur in the shear zone. At the surface and in the upper levels of the mine, the pyrite is oxidized to limonite. Rich pockets of free gold reportedly were found in the oxidized zone.

Several narrow, vertical crossfaults, paralleling the major fault, cut the shear zone. These faults contain the same mineralization found in the shear zones but in much smaller amounts.

RIO HONDO MINING DISTRICT

The Rio Hondo (Twining, Arroyo Hondo) mining district includes the areas in the Taos Range drained by the Rio Hondo and the West Fork of the Red River, south and southwest of the Red River mining district (pl. 2 and fig. 4).

South Fork Mine

The South Fork gold "mine" is located at the junction of the South Fork with the Rio Hondo (pl. 2). The mine was operated in 1905. A 10-stamp cyanide mill was built, but the ore proved to be of very low grade, and operations soon stopped.

The main adit, now caved, is located high on the southeast side of Rio Hondo Canyon, 0.2 mile east of the mouth of the South Fork. The dump indicates over 2,000 feet of workings. The adit reportedly follows a narrow, silicified shear zone in Precambrian schist cut by northwest-trending Tertiary rhyolite porphyry dikes. Abundant pyrite and some chalcopyrite grains are disseminated in the shear. A number of caved workings above the main adit apparently explored the same shear zone. Malachite and limonite stains are common on the dump rocks.

A second adit, over 100 feet long, on the southwest side of the South Fork, one-quarter mile southeast of the Rio Hondo, follows a contact between Precambrian greenstone and a Tertiary rhyolite porphyry dike striking N. 20° W. Some pyrite occurs as disseminated grains in the greenstone.

A third adit, located just north of the Rio Hondo and just west of Manzanita Canyon, follows a 3-foot-wide shear zone striking N. 40° W. and dipping 50° SW. in Precambrian amphibolite and quartz-mica schist. The schistosity trends N. 30° W. and dips 80° SW. Quartz stringers, minor disseminated pyrite grains, and rare malachite stains occur along the shear zone. The face of the 100-foot adit reportedly is in Tertiary granite. A small prospect several hundred feet northwest is on the contact between the Precambrian rocks and the Tertiary granite stock to the west. Here, faulting has taken place along the malachite and limonite-stained contact, which strikes N. 45° W. and dips 70° SW.

Jack Pot Prospect

The Jack Pot prospect is located northwest of the ghost town of Amizette on the west side of Gavilan Canyon, one-quarter mile by road from the Hondo Canyon road (pl. 2). The prospect was worked in. the 1890's. There has been little activity since then.

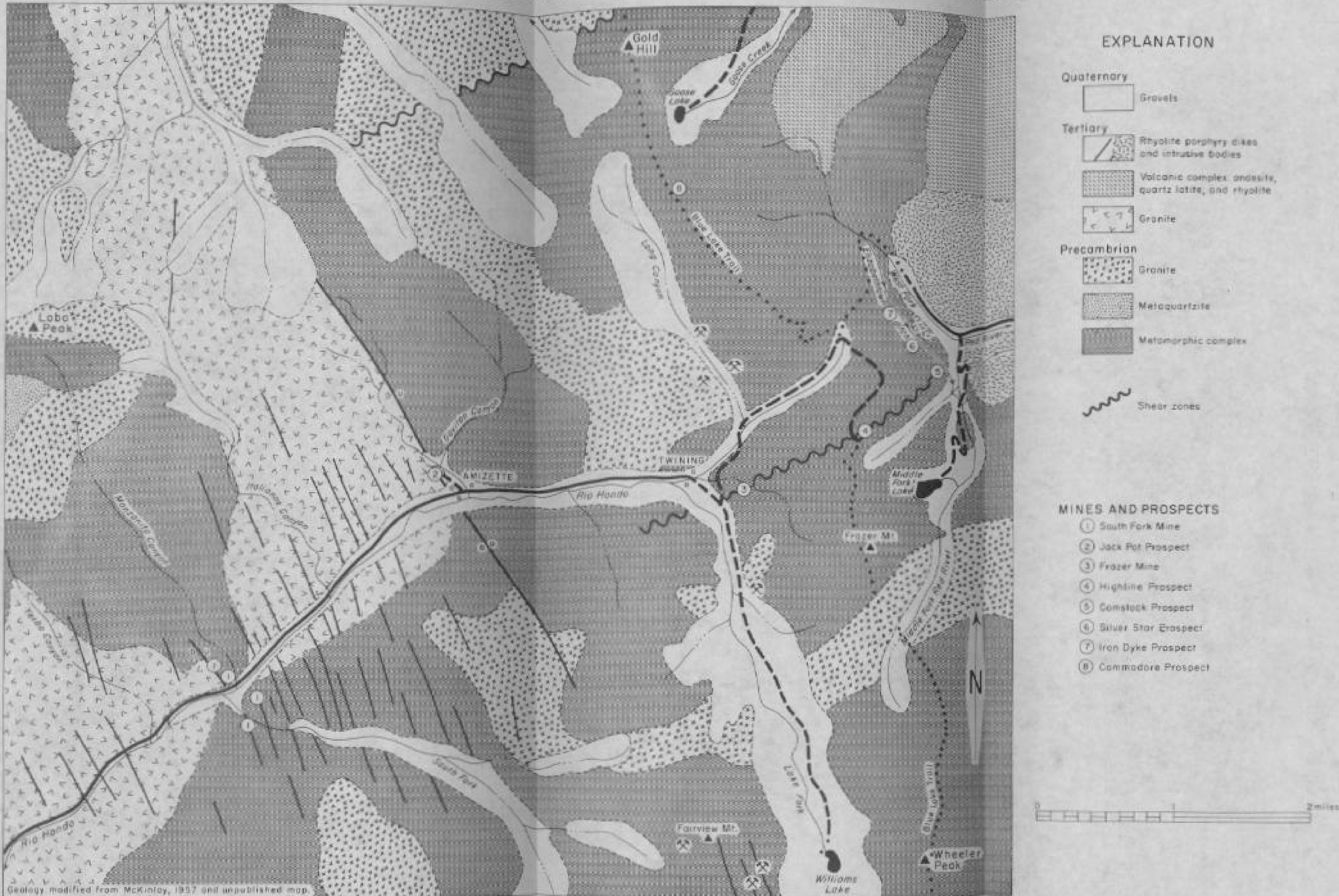
Three open cuts (caved adits?) and a shaft (now caved) explored a fault striking N. 50° W. and dipping 70° SW. Precambrian amphibolite occurs on the northeast side of the fault; Tertiary granite occurs on the southwest side. The granite and amphibolite on both sides of a well-defined fault plane are irregularly sheeted and brecciated. Stringers and pods of white, cryptocrystalline quartz up to 4 feet thick and 50 feet long follow this shear zone. Specular hematite, chalcopyrite, and some sphalerite and galena occur as disseminations and streaks in the quartz, and as cavity fillings in brecciated quartz and wall rock. Malachite and rare azurite coat fractures.

Other Prospects Near Amizette

A number of prospects were located in the vicinity of Amizette during the 1890's. By 1900, the town and most of the prospects had been abandoned. In these deposits, quartz, gold-bearing pyrite, specular hematite, and lesser chalcopyrite, galena, and sphalerite occur along shear zones in Precambrian rocks, usually along or near Tertiary rhyolite porphyry dikes.

Frazer [Twining] Mine

The Frazer copper mine is located high in the steep slope east of the ghost town of Twining (pl. 2). Considerable work was done around 1900 by the Frazer Mountain Copper Co. under the direction of William Frazer. A number of adits were driven. The main adit reportedly is 1,000 feet long, with an additional several hundred feet of crosscuts. A tramway connected the main adit with the mill, 300 feet lower in the canyon bottom at Twining. The mill was equipped with three rolls and five stamps, and Wilfley tables. A water wheel provided power. The I 6-tuyere copper-matte smelter used a mixture of coke and charcoal for fuel, and limestone and scrap iron as flux. The mill and smelter were operated in 1904 and yielded some production, but the plant was not



GEOLOGY, MINES, AND PROSPECTS OF THE RIO HONDO MINING DISTRICT operated in later years. Apparently the gravity-separation method used in the mill could not concentrate the copper minerals successfully.

The mill and smelter, as well as the bunkhouse, assay office, stables, and the hotel and dwellings of the town of Twining, have since been torn down.

In 1942, part of the workings were cleaned out by T. B. Everheart, but little additional work was done. In 1956, the Taos Uranium and Exploration Co. did some work. A mill was built to leach the ore. Operations soon stopped without any important attempt to develop the mine

The workings now are badly caved. The ore occurs in a 200-foot-wide shear zone trending N. 65° E. and dipping 80° N. in Precambrian talc schist and amphibolite. The shear zone can be traced for over a mile to the east and passes through the Highline and Comstock prospects. Pods and stringers of quartz and lesser calcite; grains and veinlets of chalcopyrite, pyrite, and bornite; and films of malachite, azurite, and chrysocolla occur along the shear planes and fractures. These minerals are most abundant in two 6-foot-wide zones separated by 80 feet of poorly mineralized to barren schist.

Prospect Along the Lake Fork

A caved adit with a large dump is located along the east side of the Lake Fork canyon, 1 mile south of Twining (pl. 2). The workings reportedly were driven in a search for copper. The adit is at the contact of Precambrian biotite granite gneiss and schist. Quartz and pink feldspar have been introduced into the highly chloritized and epidotized schist along the contact with the intruding granite. The adit follows a vein containing coarsely crystalline calcite. (Philip McKinlay, personal communication.)

Prospects on Fairview Mountain

A number of short adits are located on Fairview Mountain east of Williams Lake, at the head of the Lake Fork (pl. 2). Here small grains and cubes of pyrite are disseminated through brecciated Precambrian quartz-mica schist and amphibolite along a group of Tertiary rhyolite dikes trending N. 20°-30° W. The pyrite carries traces of gold.

Highline [Bull of the Woods] Prospect

The Highline copper prospect is located on the top of Bull of the Woods Mountain, 1 mile northeast of Twining (pl. 2). A jeep road from Twining extends to the mine.

The prospect was developed around 1900 by James Lynch, of Elizabethtown. A 50-foot adit, a 65-foot shaft, and several pits were made, but the inaccessible location hindered further work. Joe Cannard, of Red River, and Elmer Burch, of Taos, held the property for many years. In 1956, the Taos Uranium and Exploration Co. built a jeep road to the prospect and bulldozed a trench along the outcrop, but nothing further has been done.

A shear zone striking N. 70° E. and dipping 70°-80° N. cuts Precambrian talc schist, whose schistosity roughly parallels the shear zone. This same shear zone extends west through the Frazer mine and east through the Comstock prospect.

A 6- to 10-foot-wide zone within the shear zone contains 1- to 6-inch veins of white to gray, cryptocrystalline quartz and is stained green by malachite and chrysocolla. Rare azurite, cuprite, and chalcocite also are present. Limonite stains are common.

Comstock [Commonwealth, Copper Bell] Prospect

The Comstock copper prospect is located along the west branch of the Elizabethtown ditch, southwest of the junction of the West and Middle Forks of the Red River (pl. 2). Nothing has been done here for many years. The last known owners were Joe Cannard and Elmer Burch.

The adits are all caved. The workings explore the same shear zone found in the Highline prospect and Frazer mine to the west. Here, quartz stringers containing chalcopyrite, specular hematite, malachite, azurite, and chrysocolla follow the shear zone in Precambrian schist.

Silver Star Prospect

The Silver Star lead-silver prospect is located southwest of the West Fork of the Red River along the west branch of the Elizabethtown ditch, 500 feet northwest of the Comstock prospect (pl. 2).

Park and McKinlay (1948) state:

> Several prospect holes expose narrow irregular quartz veins. . . . The upper of two old adits is now caved but the lower, on the Elizabethtown ditch, goes into the hill several hundred feet. It is said that $500 in silver were recovered from about 6 tons of ore shipped to Colorado from the upper adit. Three quartz veins, each less than one foot wide, are exposed in a 15-foot zone at the portal of the upper adit. The general trend of the veins is N. 85° W. and the dip is 20° N. Fine-grained galena, one assay of which indicated about 18 ounces of silver per ton, is associated with the quartz. Green copper carbonate and limonite are found in fractures in the quartz.

The country rock is Precambrian talc schist.

Iron Dyke Prospect

The Iron Dyke prospect is located along the Elizabethtown ditch, northwest of the Silver Star prospect (pl. 2). The property has not been worked for many years. The only mineralization seen was specular hematite along fractures in Precambrian schist.

Commodore Prospect

The Commodore copper prospect is located about 1 mile south of Gold Hill, along the Blue Lake trail, on the ridge extending southeast between the West Fork of the Red River and Long Canyon (pl. 2). The last-known owner of the patented Commodore claim (survey No. 1326) was Elmer Burch, of Taos. Malachite stains and disseminated grains of pyrite and chalcopyrite are found in the Precambrian metamorphic rocks making up the dump of the caved shaft.

TRES RITOS HILLS Coal

Prospects Along the Rio Fernando de Taos

A coal prospect is located 200 feet above U. S. Highway 64, on the north side, 4 road miles east of the Taos plaza. An attempt has been made to mine coal from a carbonaceous lens in the Pennsylvanian Sandia formation. The "coal" is too impure and thin to have commercial value.

Other prospects in this area explore similar occurrences in the Sandia formation, but in no case has coal of commercial thickness or purity been found.

Limestone Quarries Along the Rio Pueblo

Near Angostura. Two small limestone quarries are located south of State Highway 3, 2 miles east of Angostura. Both quarries are in nearly flat-lying, medium-bedded, dark-gray, fossiliferous, finely crystalline limestone of the lower gray limestone member of the Pennsylvanian Madera formation. The rock breaks readily into 1- to 2-foot-thick blocks, which weather gray brown and are unstained. The limestone apparently was used locally as building stone.

At Tres Ritos. A small quarry is located north of State Highway 3, opposite the Agua Piedra Forest Camp at Tres Ritos. The quarry is in contorted beds of thin- to medium-bedded, gray, medium-grained, arenaceous limestone of the lower gray limestone member of the Pennsylvanian Madera formation. The rock breaks into 1/4- to 3-foot-thick blocks, which weather to an unstained gray-brown color. The blocks have been used locally as building stone.

PICURIS MINING DISTRICT

In this report, the Picuris mining district includes the entire Picuris Range (Prong), a triangular area bounded on the northwest by the Rio Grande, on the south by Embudo Creek and the Rio Pueblo, and on the east by the Rio Grande del Ranchos (fig. 40).

Harding Mine

Location and access. The Harding pegmatite mine is located in the S1/2 sec. 29, T. 23 N., R. 11 E. State Highway 75 passes 0.7 mile north of the mine (fig. 40); a side road to the mine leaves the highway at a point 7 miles east of Dixon.

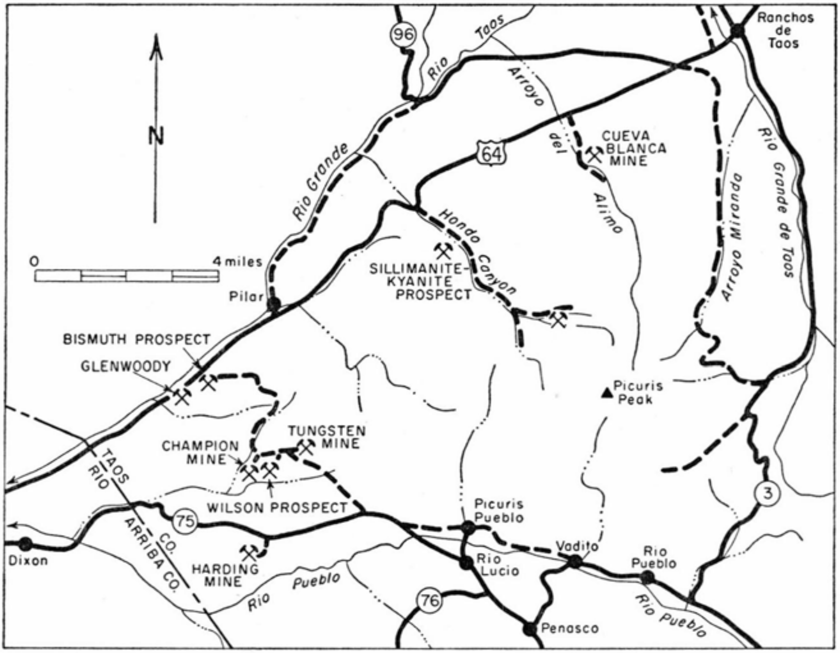


Figure 40

MINES AND PROSPECTS OF THE PICURIS MINING DISTRICT

See Montgomery (1953, pl. 1) for geology of this area.

History and production. Reportedly, the deposit was discovered about 1910 by Joe Peyer. The commercial possibilities of mining the lepidolite first were recognized *in* 1919. The Mineral Mining and Milling Co. leased the property from Joe Peyer and his two partners, and after some exploration by shot-core drilling, began mining in 1920. The raw lepidolite ore containing some spodumene was hand sorted, then shipped to Wheeling, West Virginia, where it was ground and used by the glass industry. In 1927, the Embudo Milling Co. completed a grinding plant at Embudo and at the same time took over the mining operations. In 1928, the property was transferred to the Pacific Minerals Co., Ltd., but in 1930 it again came under the control of the Embudo Milling Co. Operations stopped in 1930 after an estimated 12,000 tons of lepidolite-spodumene (lithium-bearing) ore, averaging 3.5 percent Li_2O, had been shipped.

In 1942, Arthur Montgomery visited the mine and was impressed with the possibility of mining microlite (a tantalum mineral). He acquired the Lilac No. 1 (patented in 1920), Lilac No. 2, and Pegmatite claims from the estate of the former owners (J. J. Peyer, A. H. Gossett, and Frank Gallup); leased from R. L. Thompson, of Albuquerque, and later relocated the Iceimg claim, from which optical calcite had earlier been mined; and acquired the Tantalite Nos. 1, 2, and 3 claims (later covered by placer locations, Tantalum Placers 1 and 2) from H. H. Bailey and associates, of Dixon. Subsequently, he also located the Lilac Nos. 3, 4, and 5 and Pegmatite No. 2 claims.

Montgomery began mining operations in December 1942 and continued mining microlite until the middle of 1947. Over 20,000 pounds of tantalum concentrates, averaging about 70 percent Ta_20_5, was produced. This mine is unique as the only substantial producer of microlite in the world. During this same period, 464 pounds of placer tantalite-columbite containing 43 percent Ta_20_5 and 36 percent Cb_20_5 was produced. In 1943, 31/$_2$ tons of white beryl was recovered from the dump, and an additional 24 tons was mined from a layerlike mass at the top of the pegmatite body at the west end of the quarry. A 40-ton carload of hand-sorted spodumene was shipped at about the same time. All of these strategic minerals were produced directly for the war effort with the encouragement of the War Production Board.

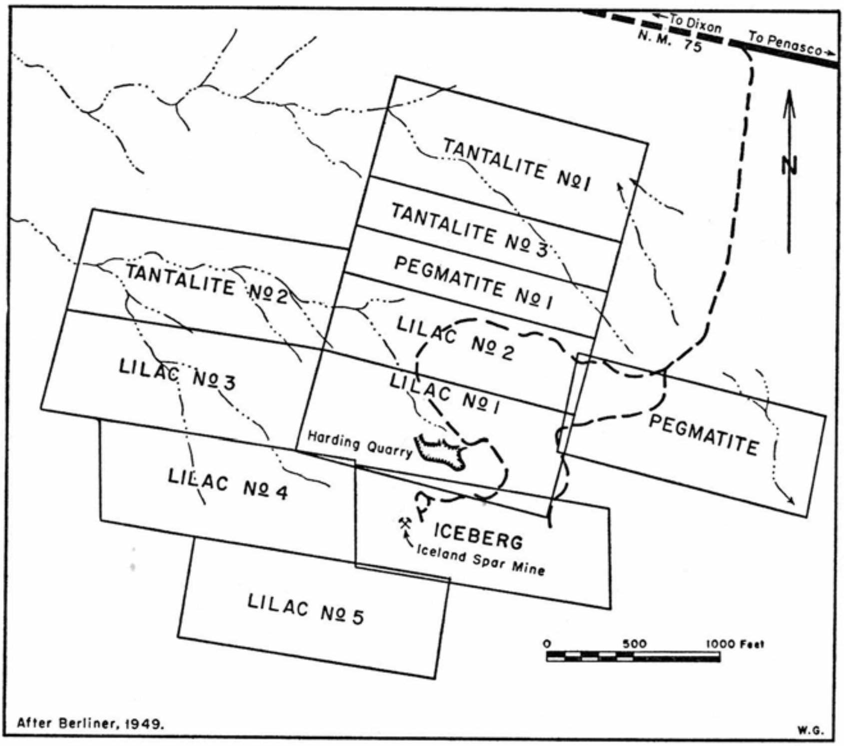


Figure 41

CLAIM MAP OF THE HARDING MINE AREA

Showing the Harding mine quarry and Iceberg mine.

In 1943, the U. S. Bureau of Mines explored the tantalum-bearing zone with 39 diamond-drill holes, totaling 4,371 feet, and outlined a large deposit of microlite and spodumene in the central portion of the pegmatite (Soule, 1946). After beryl was noted in certain cores, 26 trenches totaling 788 linear feet were cut in the outcrop of the beryl-bearing zone at the top of the pegmatite, west of the quarry. In 1948, the Bureau of Mines drilled seven additional diamond-drill holes in an attempt to extend the tantalum-bearing zone southwestward, but without success (Berliner, 1949).

From 1945 through 1947, John A. Wood was in charge of microlite operations, and a 10-ton mill was built on the Rio Grande at Rinconada to recover the microlite by spiral concentration (Wood, 1946). The mine was idle during 1948-1949.

In 1950 and 1951, the New Mexico Mining and Contracting Co. mined 806 tons of lepidolite ore and 249 tons of spodumene ore, averaging 4 percent Li_20.

Also in 1950, Montgomery and a partner (Flaudio Griego, of Dixon) began to develop and mine beryl from the upper margin of the pegmatite body at the west end of the quarry. From 1950 through 1959, a total of 848.3 tons of beryl averaging 10 percent BeO was produced and sold. Almost all of the production went to the national stockpile. From 1950 through 1955 alone, 752 tons of beryl was produced, amounting to more than 20 percent of the total U. S. production during this period!

In August 1959, the mine was leased to the Cordillera Mining Co., which plans to mine microlite, spodumene, and beryl, and to build a mill for the recovery of these minerals.

Mining. The lithium minerals (spodumene and lepidolite) have been mined mainly by quarry methods, although some ore was mined by "room and pillar" methods from workings in the south face of the quarry. In contrast, the beryl has been mined underground from adits and crosscuts by room-and-pillar methods. The tantalum ore (microlite and tantalite-columbite) has been mined both underground and in the quarry. Montgomery (1951) and Roos (1926) describe the mining methods in more detail.

Geology. The Harding pegmatite is a nearly flat, tabular body, plunging 6° SW., in steeply dipping Precambrian mica schist, amphibolite, and quartzite of the Vadito formation. It averages 55 feet in thickness, over 300 feet in breadth (NW.-SE.), and 3,000 feet downdip (SW.). Its upper half is well exposed along the south face of the quarry.

The pegmatite is layered, the thickness of the different layers varying greatly. Layers up to 5 feet thick of beryl-bearing quartz-microcline-muscovite-albite occur along the hanging and foot walls; the beryl is commonly white and generally lacks obvious crystal form. Below this beryl-rich layer, in the eastern part of the quarry, is a thick zone of quartz containing numerous crisscrossing laths of spodumene; beryl and microcline occur locally in this "lath spodumene" zone. Below the upper beryl-rich layer, in the central part of the pegmatite, is a zone of massive quartz, which in turn grades downward into a core of coarse-grained aggregates of microcline, quartz, and spodumene, with varying amounts of lepidolite, microlite, tantalite-columbite, albite, and muscovite. This is the main tantalum-lithium orebody. Here the spodumene occurs as equidimensional masses averaging 1 inch in diameter, in contrast to the huge laths of the lath-spodumene zone. The lepidolite has replaced microcline and spodumene, forming lepidolite-rich bodies in the core. The original lithology of the lower half of the pegmatite body has been obscured by albitization and local replacement of lepidolite, so that the present distribution of the various zones is asymmetrical. A few fracture-controlled albite-quartz replacement bodies containing some beryl, microlite, tantalite, and bismuth minerals cut the various layers but are too small to be of economic value. (See Jahns, 1951, for a more detailed description.)

Beryl has been mined mainly from the hanging-wall zone, where continuous tabular masses of beryl weighing over 100 tons have been found. The lithium minerals have been mined from concentrations of lepidolite and spodumene near the top of the core, as well as from the lath-spodumene zone. The tantalum minerals occur at the base of the lath-spodumene zone as small, high-grade concentrations of yellow microlite grains in lepidolite; they also occur in the core as grains of disseminated microlite, tantalite-columbite, and minor hatchettolite, which form the main "spotted rock" orebody. Much of the tantalum ore mined came from the high-grade shoots.

Iceberg [Iceland Spar] Mine

The Iceberg optical calcite mine is located 300 feet southwest of the Harding mine quarry (fig. 41). The deposit was discovered in 1931 by Juan A. Brown, of Dixon. In 1939, the possible value not being known, the surface showing was blasted. Although some of the calcite was ruined, some optical-grade calcite was exposed. Mining was first done in 1939, after the claim had been sold to R. L. Thompson, of Albuquerque, by Brown and H. H. Bailey, of Dixon. Thompson leased the property to E. M. Stanton and J. W. McCoy, of Santa Fe, who did most of the mining. About 850 pounds of optical-grade calcite was mined, trimmed, and shipped, mainly to the Bausch and Lomb Optical Co. The biggest piece mined weighed 5 pounds 8 ounces. There is no record of further production.

The deposit is on the Iceberg claim now held by Arthur Montgomery as the relocated Iceberg Spar claim, and is included as part of the Harding mine property.

Iceland spar occurred as a lenticular, pipelike body in Precambrian amphibolite schist and quartzite of the Vadito formation. The body was about 30 feet long (NE.-SW.) at the surface, had a maximum width of over 9 feet near the center, and dipped 70° SE. with a steep pitch to the northeast. The walls of the body are brecciated and altered to a depth of from 1 to 3 feet. The body itself was anhedral calcite; no euhedral calcite was found. There were three types of calcite: (1) white calcite; (2) clear, colorless calcite containing the optical-grade spar; and (3) banded pink calcite. Much of all three types was twinned; much of the clear, colorless calcite was of no value for this reason. Some of the calcite crystals were huge; one is estimated to have weighed at least 30 tons, and possibly 40 tons. (Kelley, 1940.)

Kelley (1940) believes that a "vigorous gaseous escape from depths" formed a breccia pipe. The calcite was then deposited by hydrothermal action, which also replaced the breccia fragments that filled the pipe.

Champion Mine

The Champion copper mine is located along the line between secs. 17 and 20, T. 23 N., R. 11 E., on the ridge extending west from Copper Hill (fig. 40). It is accessible by a dirt road branching northwest from State Highway 75, 3.9 miles west of Penasco.

Although copper-stained quartz veins in this area had been known for some time, no attempt was made to develop them on any scale until 1900, when the Copper Hill Mining Co. began operations. This company drove a 350-foot adit and sank 180- and 60-foot shafts. A 100-ton mill burned soon after its completion. Practically no stoping was done.

The Champion Copper Co. took over the Champion, Oxide King, Sunset, Jumbo, and Aztec claims (survey No. 1049A) of the Copper Hill Mining Co. and attempted to continue development of the deposit. A 25-ton mill equipped with a crusher, rolls, and Wilfley table was built, and some ore was milled during 1916-1918. Small shipments of concentrates and direct smelting ore were made to El Paso and Pueblo smelters, but returns were poor; at least one shipment was of too low grade to to cover the smelting charges. The venture having proved unsuccessful, work stopped in 1920. Total production apparently was small.

In 1955, the Aztec Copper Co. shipped some copper-bearing silica flux to the El Paso smelter.

The mineral deposit consists of several copper-gold-silver-bearing, glassy quartz veins, trending north-south, in the Precambrian metaquartzite member of the Ortega formation. Pyrite, chalcocite, cuprite, malachite, chrysocolla, and limonite occur in the veins; argentite and tetrahedrite also have been reported. The limonite probably is an oxidation product of pyrite, and often contains gold values. The chalcocite occurs as solid, steely gray masses rather than as soft, sooty coatings. The workings do not extend below the zone of partial oxidation. The metaquartzite and thin interlayered schists making up the vein walls show no wall-rock alteration. (Lindgren, 1910, p. 89-90.)

The 350-foot adit in the Champion claim follows a vertical, north-striking vein. The vein ranges from 8 inches to 3 feet in width; splits and forks are common. Near the breast, the vein carried good silver values, which were attributed to argentite. South of the adit, a 180-foot shaft in the Oxide King claim was sunk to explore the same(?) north-striking vein, which here dips 50° W.

Wilson Prospect

The Wilson prospect is located 0.4 mile east of the Champion mine, along the ridge extending west from Copper Hill (fig. 40). It is accessible by the same road as the Champion mine. Nothing is known of the history; there is no record of production.

Several shallow shafts and prospect pits explore a north-striking vein in metaquartzite and thin interlayered schists of the Precambrian Ortega formation. The vein is of the same type as those at the Champion mine. It is copper and iron stained, and reportedly carries gold values. Limonite streaks in the wall rock are said to contain some free gold. (Lindgren, 1910, p. 90-91.)

Tungsten [Wichita(?)] Mine

The Tungsten mine is located in sec. 16, T. 23 N., R. 11 E., 1.1 miles northeast of the Wilson prospect, along the ridge extending west from Copper Mountain (also called Green Mountain or La Sierrita). A jeep road extends to this mine (fig. 40). The Champion Copper Co. produced some tungsten ore from the mine during World War I under the stimulus of high wartime prices. During 1955, six tons of tungsten ore was mined from the Wichita mine, which probably is a new name given to the Tungsten deposit.

There are several small caved shafts and pits. The main shaft is about 100 feet deep. The mineralization is similar to that at the Champion mine and Wilson prospect. The dump at the main shaft is metaquartzite and glassy vein quartz containing fibrous, satiny-brown tourmaline and coarse tabular crystals of wolframite, stained green by malachite and chrysocolla. There are a number of wolframite-copper pits in the metaquartzite along the top of the ridge east of the main workings; these pits expose mineralization similar to that at the main workings, although wolframite is less abundant.

Bismuth Prospect

A bismuth prospect is located in the top of cliffs along the southeast side of the Rio Grande Canyon, 2 miles southwest of Pilar. Although it is only a short distance from U. S. Highway 64, rugged cliffs and talus slopes make access extremely difficult from this quarter; however, the same road that provides access to the Copper Hill-Copper Mountain area extends to within a short distance of the prospect.

The deposit is owned by Delfino Medina and Bernabe Gurule, of Penasco. Little work has been done. A small production of secondary bismuth minerals was made about 1950.

The bismuth occurs as bluish secondary oxide minerals along quartz veins in Precambrian Ortega metaquartzite.

Prospects in Cliffs East of Pilar

A number of small adits and pits are located in the cliffs above and just east of U. S. Highway 64 at Pilar (fig. 40). Here pegmatite bodies and quartz veins cut Precambrian metaquartzite of the Ortega formation. The metaquartzite is very micaceous near the pegmatites. The workings apparently were made in a search for mica and other valuable minerals. There has been no production.

Glenwoody [Cieneguilla] Camp

This camp takes its name from the bridge which spans the Rio Grande 3.0 miles south of Pilar (fig. 40). A Government bridge stood here until it was burned by the Apache Indians in the late seventies. In 1902, W. M. Woody, of the Glen-Woody Mining and Milling Co., began to develop what was believed to be a huge low-grade gold deposit in the quartzite forming the cliffs along the southeast side of the Rio Grande. He laid out a townsite west of the river, built a bridge on the piers of the old Government bridge, and built a 50-ton, experimental, water-powered, cyanide mill east of the river. Although it was claimed that the ore ran $1.40 to $3.00 a ton in gold, the best recovery by the mill was reportedly only 40 cents a ton (Lindgren, 1910, p. 91). Operations were soon abandoned.

Gold is said to occur in Precambrian metaquartzite of the Ortega formation, which crops out over an extensive area along the southeast side of the Rio Grande Canyon from the Glenwoody bridge to Pilar (Montgomery, 1953, pl. 1). No attempt was made to verify the gold content during this study. Many quartz veins cut the metaquartzite and may carry gold values.

In recent years, some of the reddish-brown schist layers in the metaquartzite were mistakenly claimed to contain lepidolite. Because the micaceous, faintly purple schist has a slight resemblance to lepidolite, and because of the presence of lepidolite in pegmatites of the Picuris Range, a great deal of unwarranted interest was generated by the possibility that this area might contain a huge lithium deposit. Unfortunately, the schists contain no lithium.

Hondo Canyon Sillimanite-Kyanite [Lund's] Prospect

The Hondo Canyon Sillimanite-Kyanite prospect is located in the N1/2 sec. 25, T. 24 N., R. 11 E., along the south side of Hondo Canyon, about a mile southeast of U. S. Highway 64 (fig. 40). A dirt road extends southeast from Highway 64 up Hondo Canyon and passes within a few hundred feet of the workings.

In 1943, the property consisted of two unpatented lode claims, the Margaret Louise and the Eleanor Mary. Abe Bowring, of Taos, held and worked the property in recent years. Several trenches have been cut, exposing beds bearing sillimanite-kyanite; there are no underground workings. In recent years, a number of trenches have been made northwest of the older trenches; these are visible from U. S. Highway 64. There has been no production.

The trenches expose a 5- to 10-foot-thick sillimanite-kyanite-bearing schist layer in Precambrian Ortega metaquartzite. The coarse, gray to pink schist strikes east and dips 40° S. It is made up of streaks of gray quartz, gray and pink needles of sillimanite, blue-gray blades of kyanite, silvery plates of muscovite mica, and minor specks of ilmenite, magnetite, and hematite. The kyanite and sillimanite are oriented parallel with, and form part of, the schistosity, commonly occurring in continuous streaks.

In 1943, the U. S. Bureau of Mines took three samples across the schist layer (table 3). Laboratory tests at Rolla produced concentrates

TABLE 3. SAMPLES OF SILLIMANITE-KYANITE SCHIST FROM THE HONDO CANYON PROSPECT

(From unpublished report, U. S. Bureau of Mines)

NO.	LENGTH (feet)	MINERAL COMPOSITION (percent)		ANALYSIS (percent)			
		SILLIMANITE	KYANITE	ALO,	Si02	Fe208	TiO,
1	7.0	15	36	40.9	50.3	5.9	0.3
2	7.0	20	27	38.5	55.8	6.2	0.6
3	6.0	27	2	28.8	64.5	4.7	0.4

containing more than 90 percent combined sillimanite and kyanite, with 1.5 percent or less iron oxide, flotation methods being used to remove quartz and mica, and magnetic separation to remove the iron minerals. The material is suitable for use in refractory mortars and plastics, but because of the iron content is unsuitable for glass manufacture.

Prospects Along Upper Hondo Canyon

Several small caved adits and prospect pits are found in a side canyon near the head of Hondo Canyon (fig. 40). A logging road extending southeast along Hondo Canyon passes these workings 4 road miles from U. S. Highway 64.

The workings prospect several quartz veins containing silver-bearing galena. The veins cut Precambrian muscovite-biotite-garnet phyllite of the Rinconada schist member of the Ortega formation. Spongy masses of limonite occur along the veins at the surface.

Cueva Blanca [White Cave] Mine

The Cueva Blanca mine is located just east of the mouth of Arroyo del Alamo canyon at the northwest edge of the Picuris Range (fig. 40).

A dirt road extends south from U. S. Highway 64 two and a half miles to the mine.

For many years, clayey material has been dug from several pits and used locally as wall finish or plaster. The tonnage removed has not been great.

The soft, soapy, clayey, grayish to yellowish-white material consists of pyrophyllite, kaolin, and lesser muscovite mica (Montgomery, 1953, p. 61-62). Apparently this material was formed when thin layers of Precambrian sillimanite-kyanite-muscovite gneiss were caught up and pulverized, along with the surrounding Precambrian metaquartzite of the Ortega formation, during faulting along the south-trending Alamo Canyon tear fault, and then hydrothermally altered.

RIO GRANDE PLACER DISTRICT

Placer gold occurs in the river bed, flood plain, terrace, and bolson gravels along the Rio Grande (fig. 4). The most promising area includes the Rio Grande Gorge and Canyon from the mouth of the Red River south to the county line, and the valleys of the Red River, Lama Canyon, Alamo Canyon, Garrapata Canyon, San Cristobal Creek, and the Rio Hondo, from the Rio Grande Gorge to the west front of the Sangre de Cristo Mountains.

The river-bed and flood-plain gravels have yielded most of the small amount of gold that has been recovered. Small placer mining operations have been carried on intermittently since Spanish colonial times at many spots along the various streams. The gold is coarse and flaky; there is little fine gold. Colors are usually about the size of small pinheads. Nuggets worth up to a dollar are found occasionally. The particles range from 700 to 900 fine in gold, and from 100 to 300 fine in silver. Along the Rio Hondo, the gravels have been prospected by shallow shafts; values range from 0.20 to 0.35 cents (gold at $35 an ounce; silver at 900 an ounce) per cubic yard.

In the early 1930's, a floating dredge was built to work the river channel of the Rio Grande near the Taos Junction bridge on State Highway 96. The dredge was operated for a few weeks, but the presence of abundant, and often huge, basalt boulders mixed in the gravels made dredging almost impossible, and the operation was soon discontinued.

NO AGUA MINING DISTRICT

The No Agua mining district includes a crescent-shaped area extending from San Antonio Mountain (Peak) southeast to No Agua Mountain, and from there east to the Rio Grande Gorge west of Questa (fig. 4 and 42).

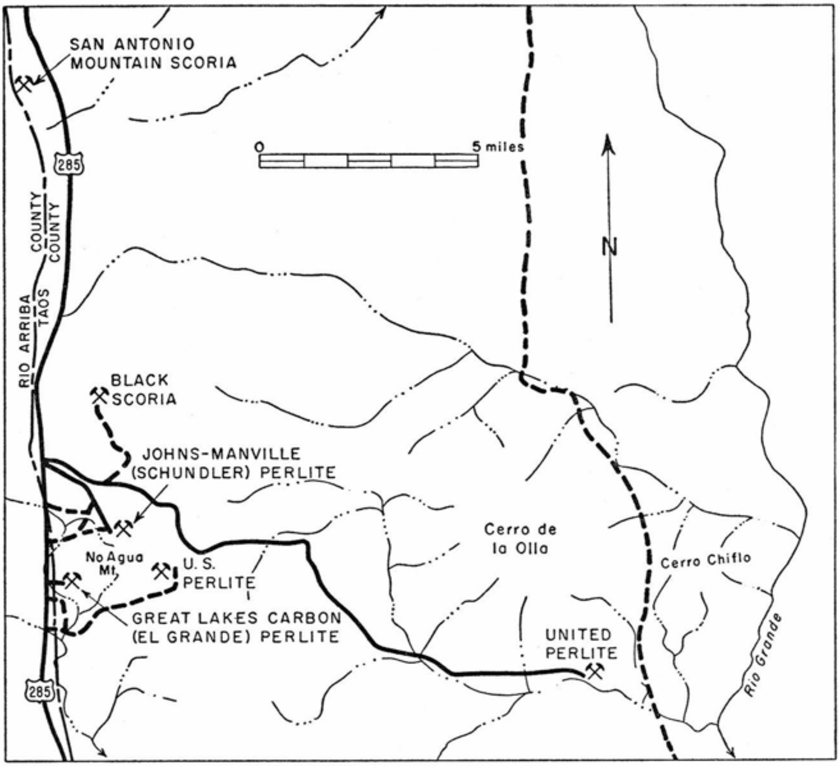


Figure 42
MINES OF THE NO AGUA MINING DISTRICT

San Antonio Mountain Mine

The San Antonio Mountain scoria mine is located in a group of low-lying hills on the northeast side of San Antonio Mountain (Peak), one-quarter mile west of U. S. Highway 285, 18 miles north of Tres Piedras (fig. 42). The mine was operated between 1950 and 1955. During this period, 300 to 400 railroad carloads of scoria was shipped from Antonito yearly, and a large additional tonnage was used locally. The mine has been inactive since 1955.

The extensive scoria deposit apparently is an eroded parasitic cinder cone that was formed during the eruption that produced San Antonio Mountain. No attempt was made to estimate the size of the deposit. The scoria fragments are red and, less commonly, gray to black, pumiceous to coarsely cellular, and range from sand size to over 6 inches in diameter. Bedding is well defined, obscure, or absent. A few basalt bombs are scattered through the deposit.

Black Scoria Mine

Scoria has been mined from a small pit 11/2 miles east of U. S. Highway 285 and 3 miles north of the Johns-Manville (Schundler) perlite mill. A road has been extended north to the mine from the United Perlite haulage road (fig. 42). Scoria was mined here during 1958 and used to surface the United Perlite haulage road.

The deposit is in a group of low-lying hills, which are the eroded remnants of a cinder cone. The size of the deposit was not estimated. The scoria is black, most commonly coarsely cellular, and is predominantly from one-half inch to 6 inches in size. The scoria is poorly to well bedded and contains some basalt bombs. The purer material is covered by 1 to 2 feet of mixed soil and caliche-stained scoria, which in turn is overlain by several feet of soil.

No Agua Perlite Deposit

Geology. No Agua Mountain embraces a cluster of four subconical hills encircling a breached central valley (fig. 42). The Johns-Manville mine is on the northern hill, the Great Lakes Carbon (El Grande) mine is on the southwestern hill, and the U. S. Perlite mine is on the eastern hill.

Extensive bodies of commercial-grade perlite occur in the hills. This remarkably uniform perlite is pale brownish gray to gray, pumiceous, nonperlitic (no "onionskin" texture), slightly porphyritic, and flow banded, with elongated vesicles and short crosscutting tension fractures. Its physical characteristics are similar to those of the Socorro, New Mexico, perlite. Fragmental varieties occur locally in the more typical material. There is over 100 million tons—probably several hundred million tons—of readily minable, commercial-grade perlite in the No Agua deposit.

Gray to blue-gray, perlitic ("onionskin") perlite containing numerous small obsidian nodules, massive rhyolitic breccia, and fragmental spherulitic rhyolite overlie(?) and are associated with the perlite bodies. The impure, obsidian-bearing perlite is common around the eastern and southern margins of the hills, but is distinctly separate from the commercial-grade, pumiceous perlite.

The structure and overall form of this volcanic mass suggest that it is a volcanic dome. The dome probably was formed during the late stages of the Pliocene-Pleistocene volcanic activity that occurred over the area of what is now the Taos Plateau. Possibly the material making up the dome was extruded from several vents and coalesced to form one mass.

Johns-Manville [Schundler, No Agua] mine. The perlite mine and mill of the Johns-Manville Perlite Corp. are located just east of U. S. Highway 285, 7 miles north of Tres Piedras (fig. 42). The No Agua Mountain perlite deposit was discovered in October 1948 by M. B.

Mickelson. F. E. Schundler and Co., Inc., built a mill and began mining in August 1951. In September 1959, the Johns-Manville Perlite Corp. bought the mine and mill. The property covers over 2,000 acres.

Bulldozers and rippers are used to mine the perlite in the open pit. Trucks haul the rock the short distance to the mill. Here, the perlite is passed through two jaw crushers and two oil-fired rotary dryers, and onto the primary screen. The coarse, over-size fraction from the primary screen is passed through cone crushers and rod mills, and fed onto the final screens with the fines that passed through the primary screen. This final screening separates the perlite into the various required sizes of granules, which are stored in different bins; any over-size material is fed back into the cone crushers and rod mills; under-size "dust" is removed by mechanical air separators. As much as 600 tons of perlite has been processed in a day.

The screened and classified perlite is hauled 23 miles by truck to the rail-loading facilities at Antonito, Colorado. The different sizes of granules are stored in separate "silos." During loading, the material can be drawn simultaneously from any or all the silos at differing rates, and then mixed to produce any blend required. At present, none of the perlite is being expanded before shipping.

Great Lakes Carbon [El Grande] mine. The El Grande perlite mine and mill are located just east of U. S. Highway 285, 6 miles north of Tres Piedras and 11/2 miles south of the Johns-Manville mine and mill (fig. 42).

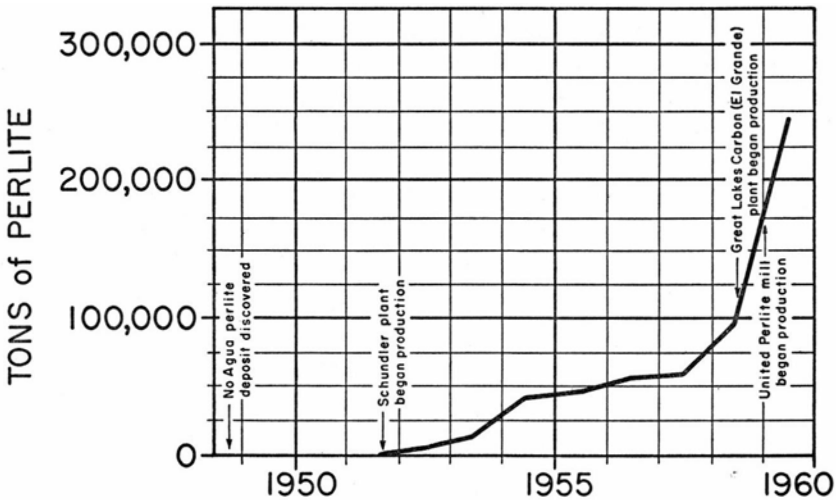


Figure 43

PERLITE PRODUCTION OF THE NO AGUA MINING DISTRICT

Production shown for yearly periods ending June 30. From annual reports of the State Inspector of Mines.

The mill began operation in July 1958 with a capacity of 30 tons per hour. Mining and milling methods are similar to those of the Johns-Manville operation described above. A loading-blending plant is maintained on the Denver & Rio Grande Western RR. at Antonito, Colorado, 24 miles to the north. At present, none of the perlite is being expanded before shipment.

U. S. Perlite mine. The U. S. Perlite Co. has a small mine on the east side of the No Agua deposit, 3 miles east of U. S. Highway 285 (fig. 42). A small expanding plant is located at the mine. Several railroad cars of the expanded perlite are being shipped monthly from the railhead at Antonito, Colorado. At present, no unexpanded perlite is being shipped.

United Perlite Mine

The United Perlite Corp. perlite mine and mill are located about 10 miles east-southeast of the No Agua Mountain perlite mines, 31/2 miles west of the Rio Grande (fig. 42). A 15-mile haulage road connects the mine and mill with U. S. Highway 285.

The mill began operation in January 1959. Mining is done by open-pit methods. The mill is similar to the Johns-Manville and Great Lakes Carbon mills at No Agua Mountain; it has a capacity of 30 tons per hour. A loading-blending plant is located on the Denver & Rio Grande Western RR. at Antonito, Colorado, 36 road miles from the mill. Only unexpanded perlite is being shipped.

The perlite occurs in several rounded to subconical hills resembling the hills making up No Agua Mountain. Like the No Agua deposit, the perlite probably was extruded as a volcanic dome during the late stages of Pliocene-Pleistocene volcanic activity. Reportedly, the physical characteristics of the perlite are similar to those of the No Agua deposit.

The extent of the deposit has not been determined. The tonnage of commercial-grade perlite probably is considerably less than that of the No Agua deposit, but certainly amounts to tens of millions of tons.

Future Possibilities and Guides for Exploration and Development

This section discusses briefly the future possibilities of the mineral resources of Taos County and gives guides for exploration and development. The possibilities and guides are not given for individual mines and prospects. Although some economic factors are mentioned, economic considerations (mining, milling, and smelting practices and costs, transportation, markets, uses, etc.) are not covered in any detail.

In order to evaluate the possibilities fully and to plan exploration properly, the sections on Mineral Deposits, Mines and Prospects, and Base Maps and Aerial Photographs should be consulted.

PEGMATITE MINERALS

The possibility of finding pegmatite minerals that can be mined profitably is lessened by the very small percentage of the known pegmatites that contain sufficiently abundant valuable minerals. The Culebra Range and northern part of the Taos Range are the most favorable area for exploration because of the abundance of pegmatites and lack of thorough previous exploration. Other areas, however, should not be ignored. Any search can be restricted to areas of Precambrian rock, with strong emphasis on areas in or near Precambrian granite, and secondary emphasis on areas where foliation is well developed. Geologic maps by McKinlay (1956, pl. 1, and 1957, pl. 1) and Montgomery (1953, pl. 1 and 2) will aid exploration in the Taos and Picuris Ranges.

Tantalite-columbite placer deposits occur in arroyos draining the Harding pegmatite. The possibilities of finding other such placers, especially in the Picuris Range, should be considered.

TUNGSTEN

Tungsten deposits minable on a small scale probably occur; the possibility of finding a large deposit appears remote. A search should be made for wolframite in the Precambrian quartz veins and for huebnerite in Tertiary quartz-molybdenite veins. One favorable area is Copper Hill and Copper Mountain in the Picuris Range; wolframite has been mined here, but intensive exploration and development have not been done. The potentials of other areas cannot be evaluated properly without more study.

MOLYBDENUM

The possibility of locating new minable molybdenite deposits is good enough to make a detailed examination, including drilling, worth while. The possibility of finding large, low-grade disseminated deposits is much greater than that of discovering even moderately large, high-grade vein deposits.

The most favorable area for exploration is the belt of altered and brecciated rocks extending east across the Taos Range along the Red River. Within this area, the most favorable environments are in the surrounding rocks or margins of the Miocene(?) soda granite and in similar granite bodies where open fractures are most abundant. Stocks of this type of granite crop out in Flag Mountain, at the Questa Molybdenum mine, along lower Mallette and Bitter Creeks, and in Bobcat Canyon. If a stock has been deeply eroded, any molybdenite deposits that were present may also have been removed. Other, apparently older Miocene(?) granite bodies found elsewhere in the Taos Range apparently are barren, and are not favorable areas for exploration.

Any new deposit probably will contain some pyrite, gold, and copper sulfide, possibly in sufficient amounts to be recovered profitably as byproducts.

COPPER

The possibility of finding new minable copper deposits is great enough to warrant detailed exploration. Two distinct types of deposits deserve attention.

Copper deposits of moderate size may occur in Precambrian quartz veins and Tertiary chalcopyrite veins. The copper-bearing shear zone extending east from the Frazer mine (pl. 2) in the Rio Hondo mining district, and the copper-rich shear zone extending west from the Copper King mine (pl. 1) in the Red River mining subdistrict are favorable for prospecting; however, either drilling or underground exploration and development are necessary to determine if minable grades and tonnages of copper ore are present.

Large, low-grade disseminated deposits of copper may occur in the altered and brecciated areas along the Red River. Pyrite and some chalcopyrite are present as disseminated grains and veinlets throughout the areas of alteration. How much copper was present before oxidation and erosion took place is not known. At present, the pyrite-bearing rock is being eroded so rapidly that oxidation does not decompose much of the pyrite and chalcopyrite; where oxidation does take place, most of the decomposition products are carried out of the area by surface drainage. Thus, a zone of secondary enrichment may be lacking or thin. It is not known, however, whether these processes have been active on their present scale since the deposition of the sulfides, and more detailed study, followed by physical testing, will be necessary to evaluate the possibilities properly. Within the altered and brecciated zone, areas near or in the margins of the Miocene(?) granite bodies are favorable environments for prospecting (see discussion of source rocks, p. 26). Molybdenite and gold may occur in sufficient amounts to be economically important as byproducts.

LEAD-ZINC

The possibility of finding lead-zinc deposits that can be mined except on a small scale is remote. Limestone or other rocks that might contain large metasomatic deposits were not found in contact with Tertiary granite stocks. No lead-zinc deposits have been reported in the limestones of the Tres Ritos hills.

GOLD

Some of the gold placers in the Rio Grande Placer and Red River mining districts, although of low grade, may be extensive enough to be mined profitably with modern equipment. Thorough sampling and testing are needed to determine the possibilities. In many of the placers, especially those along the Rio Grande, the numerous large boulders mixed with the gravel would make mining by certain methods difficult, if not impossible.

The possibility of finding lode-gold deposits rich enough to be mined profitably is remote. The gold veins in the Taos Range have been prospected extensively. Although some rich pockets of gold were discovered, none were large or rich enough to be worked profitably. Nor are the gold deposits spaced closely enough so that large-scale, mass mining would be profitable. Moreover, since the early 1900's, mining costs have increased more than sevenfold, whereas the price of gold has less than doubled, rising from $20 to only $35 per ounce. There is no reason to believe that the gold deposits will become richer or larger with depth. The ore at depth will be more refractory (more difficult and expensive to extract from the ore) than the free-milling ore in the oxidized zone at the surface.

SILVER

The possibility of finding minable silver deposits in Taos County is remote. In the Tertiary and Precambrian hydrothermal veins, silver occurs, commonly in galena, in sufficient amounts to be economically important as a byproduct.

ALUNITE

Alunite probably occurs in the altered areas along the Red River in the Taos Range. Extensive sampling is needed to confirm its presence and extent. The possibility of exploiting any deposit found as a source of potassium salts and aluminum will depend on future economic trends and will require careful study.

IRON

The possibility of mining the disseminated iron oxides in the Precambrian rocks of Taos County cannot be evaluated until (1) the deposits have been outlined; and (2) the grade, distribution and percentages of magnetite, ilmenite, and hematite, and tons of ore in each deposit have been determined. Maps by McKinlay (1956, pl. 1, and 1957, pl. 1) and Montgomery (1953, pl. 1) will be useful in planning exploration.

FLUORITE

Fluorite is widespread but not abundant in the Tertiary veins; it is doubtful that deposits will be found in Taos County large or rich enough to make profitable mining possible except on a very small scale or with the recovery of fluorite as a byproduct.

REFRACTORY MINERALS

Large tonnages of kyanite and sillimanite occur in the Picuris Range in layers in the lower quartzite member of the Precambrian Ortega formation. Tests indicate that concentrates suitable for refractory mortars and plastics can be produced from these deposits. Whether a market can be found that would make profitable mining possible is not known. Prospecting should be concentrated in these kyanite-sillimaniterich layers. The northern layer in Hondo Canyon is the most favorable because it contains the highest percentage of the refractory minerals. Maps by Montgomery (1953, pl. 1 and 2) show the distribution of the lower member of the Ortega formation.

GRAPHITE

Huge tonnages of graphite-rich gneiss and schist occur in Precambrian rocks of the Taos Range. Under present economic conditions, however, the rock cannot be mined profitably because of the competition from richer natural deposits and because of the increasing use of cheaply produced synthetic graphite. Prospecting should be restricted to areas of nongranite Precambrian rock, with strong emphasis on the area extending northeast from lower Cabresto Creek to the mountain front. Maps by McKinlay (1956, pl. 1, and 1957, pl. 1) indicate the distribution of these rocks in this area.

PERLITE

The outlook for finding new deposits of commercial-grade perlite is good. However, present known reserves and the readily expandable mining and milling facilities of existing producers can handle market requirements for many years; thus the economic factors, except under special conditions, are unfavorable for further exploration at this time. Any future search should be restricted to the volcanic centers on the Taos Plateau. These centers stand up above the flat plateaus as hills and peaks. Some perlite bodies may be completely buried under other volcanic rocks.

SCORIA

The possibility of finding minable scoria deposits is good. However, scoria is being mined nearer the major markets. Because transportation accounts for a big fraction of total costs, it is doubtful, therefore, that Taos County deposits could be mined competitively at present, except on a small scale for local use. Any future search should be restricted to the volcanic centers on the Taos Plateau. These centers stand up above the flat plateau. Aerial photographs would be useful in spotting favorable areas. Vegetation and soil cover partially hide known deposits, but scoria fragments are scattered over the surface.

ROCK AGGREGATE

Sand and gravel suitable for most uses are abundant in the bolson deposits of the Taos Plateau and in flood plains, terraces, and glacial moraines along the valleys in the Sangre de Cristo Mountains. Crushed rock can be obtained from a variety of rock types in the mountains, as well as from the basalt flows on the plateau. Because of the variety, abundance, and widespread occurrence of rock aggregate, specific guides cannot be given without knowing where and how the aggregate is to be used.

CEMENT AND LIME

Limestone for cement and lime is abundant in the Tres Ritos hills. However, because of the distance from markets and the lack of railroad transportation, the limestone of Taos County is not a commercially competitive source of cement or lime, except for small-scale local use.

COAL

Deposits of coal in Taos County are too small to be mined, except possibly on a very limited scale for local use.

URANIUM

The possibility of finding minable uranium deposits in Taos County is poor. The geologic environment is not favorable for deposits of the Colorado Plateau type, nor is there any reason to believe that pitchblende-bearing veins would be found.

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Index

Numbers in boldface indicate main references.