Geology and Placer-Gold Deposits of the Jicarilla Mountains, Lincoln County, New Mexico

GEOLOGICAL SURVEY BULLETIN 1308

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By KENNETH SEGERSTROM *and* GEORGE E. RYBERG

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A description of the geologic framework, extent, and grade of placer deposits of the area

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GEOLOGY AND PLACER-GOLD DEPOSITS OF THE JICARILLA MOUNTAINS, LINCOLN COUNTY, NEW MEXICO

By KENNETH SEGERSTROM and GEORGE E. RYBERG

ABSTRACT

The Jicarilla Mountains are underlain by a probable laccolith of intermediate composition, chiefly granodiorite, about 25,000 feet across, which is partly unroofed and partly covered by a sequence of Permian rocks injected by sills. Two other laccoliths or stocks lie east of the main intrusion. A potassium-argon analysis on biotite from a sample of the intrusive rock gave a radiometric age of 37.3±1.5 million years (late Eocene or early Oligocene). Contact metamorphism has locally transformed limestone to calc-silicate rocks, and some of the metamorphosed rock has been replaced by magnetite. Minor vein deposits of specularite and sulfides, and small disseminations of pyrite have been precipitated from hydrothermal solutions. Some of the pyrite and specularite contains minor (<1 ppm) gold.

Placer-gold deposits, clearly of local derivation, extend ramplike down the north slope of the main mountain mass. Their host is a fanglomerate facies of the Ogallala (?) Formation of Pliocene age. With a probable area of 5-6 square miles and an average thickness of 15 feet, the auriferous fanglomerate represents a huge low-grade gold resource—perhaps the largest in New Mexico. Fanglomerate near the south (upstream) end of the deposit, with an area of 420 acres and thicknesses of 7-10 feet, has an estimated volume of 5,400,000 cubic yards and an average grade of 0.043 ounce gold per cubic yard and thus contains about 8 short tons of gold.

INTRODUCTION

Geologic studies in the Jicarilla Mountains have shown that the gold placers are found in the Ogallala(?) Formation, which in this area is a fanglomerate of local derivation, and in the Holocene alluvium. Gold in the placers was derived through selective concentration of gold in minor vein deposits and low-grade disseminations in the upper Eocene or lower Oligocene laccoliths and sills of the Jicarilla Mountains. The gold in the placers, though generally low grade and fine grained, constitutes one of the largest resources of gold in New Mexico.

LOCATION, ACCESS, AND POPULATION

The Jicarilla Mountains constitute an area of about 54 square miles in Lincoln County, south-central New Mexico, between lat 33° 47′ N. and 33° 56′ N. and between long 105° 37′ W. and 105° 45′ W., including practically all of T. 5 S., R. 12 E. The Ancho-Jicarilla mining district occupies the north-central part of the Jicarilla Mountains. The area is approximately 100 miles south-southeast of Albuquerque, N. Mex., and 155 miles north-northeast of El Paso, Tex. Carrizozo, the county seat of Lincoln County, is about 20 miles southwest of the area (fig. 1). The Jicarilla Mountains should not be confused with the Jicarilla Apache Indian Reservation, which is in northwestern New Mexico.

Most of the area is in the Lincoln National Forest, and at the time fieldwork was being done access was dependent on Forest Service Road 72. This graded road, unsurfaced for the most part, traverses the entire length of the Jicarilla Mountains, from White Oaks to Ancho, connecting at either end with short paved spur roads from U.S. Highway 54. A privately maintained road extends southward from Wilson Ranch, through a grazing-permit area, along the west edge of the mountains. In 1972 a new road from Ancho to the Ancho Rico Consolidated mine

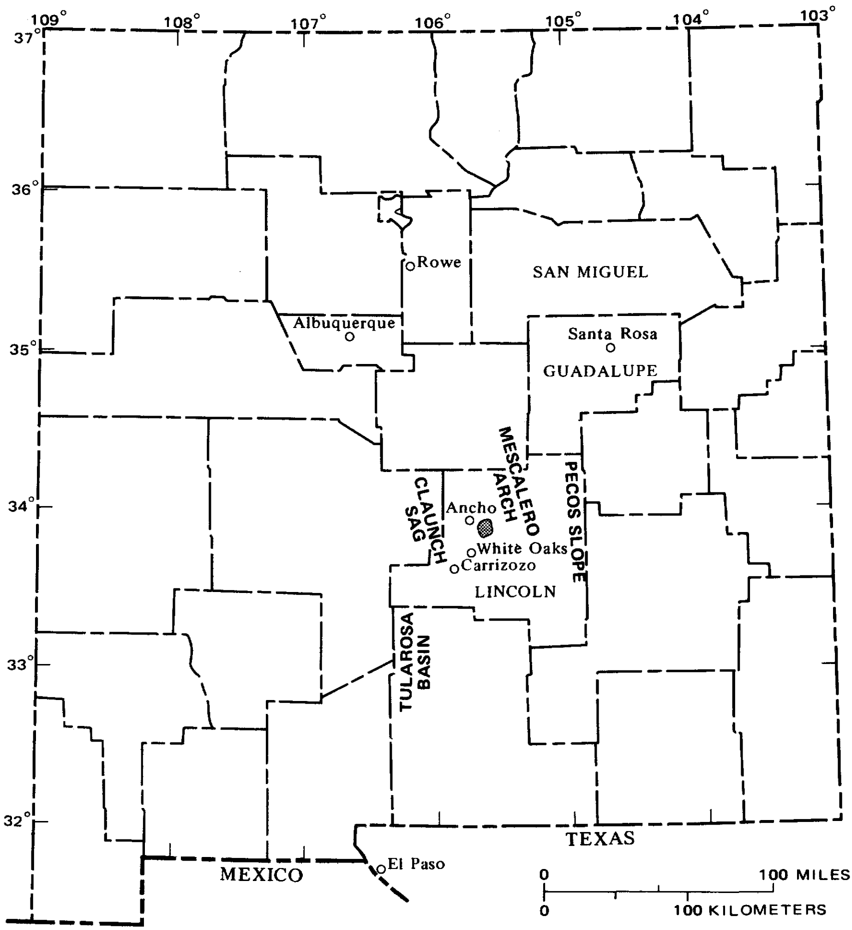

FIGURE 1.—Index map of New Mexico, showing features mentioned in text and the area of this report (patterned).

was under construction. Four-wheel-drive vehicle roads give access to much of the eastern part, but an area of 8-10 square miles along the west flank of the highest part of the range is reached only on foot or horseback.

Three places within the mapped area are populated: the Wilson Ranch, in the north; the mining hamlet of Jicarilla, in the central part; and the Foster Ranch, in the southeast. Several abandoned homesteads are scattered through the area.

TOPOGRAPHY, DRAINAGE, AND WATER SUPPLY

The Jicarilla Mountains extend along the divide between the Pecos River drainage, to the east, and the north end of the undrained Tularosa Basin, to the west. The mountains lie along the east edge of the Basin and Range physiographic province of Fenneman (1931) and border the Great Plains province.

Three massifs make up the maturely dissected Jicarilla Mountains: the largest one occupies the south-central part of the mapped area and culminates in Ancho Peak and Monument Peak; a lesser massif occupies the east-central part and culminates in Jicarilla Peak; another, at the northeast corner of the area, is dominated by Jacks Peak. Intervening saddles about 1,000 feet deep separate the three mountain masses.

The highest and lowest points in the area are, respectively, Ancho Peak, 7,830 feet above sea level, in the central part of the area, and Coyote Canyon, about 6,150 feet at the west edge of the area. The steepest relief is at Jacks Peak, 7,548 feet above sea level, which is flanked by vertical cliffs 200-300 feet high. Between the top of Monument Peak and a tributary of Coyote Canyon is a drop of about 1,300 feet in less than 2 miles.

All drainage is intermittent, and there are no naturally flowing springs or seeps. Windmills provide small local water supplies and indicate that a limited subsurface flow exists in major gulches and canyons. A diesel pump installed at the Paden-Prichard windmill, near the head of Ancho Gulch, produced 30 gallons per minute in 1970. The many earthen stock tanks in the region generally dry up during the winter and spring. The meager water supply has always inhibited placer mining in the area.

CLIMATE

The climate is semiarid and benign. At Ancho, altitude 6,115 feet, near the northwest corner of the area, where records have been kept since 1909, the average annual precipitation is 14.19 inches (U.S. Dept. Commerce, 1970, p. 219). Rainfall and snowfall increase with altitude above sea level, so inasmuch as the Jicarilla Mountains are higher than Ancho, the precipitation data for Ancho are somewhat low for the mapped area.

PREVIOUS GEOLOGIC STUDIES

Despite the long history of mining activity in the Jicarilla Mountains, the region has been referred to only briefly in geologic literature, and no detailed geologic maps have been published. Some of the ore deposits were briefly described by Jones (1904, p. 176-177), Lindgren, Graton, and Gordon (1910, p. 183-184), Darton (1928, p. 86-94), and Lasky and Wootton (1933, p. 77). Five iron mines in the Jicarilla district were mapped and described by Kelley (1949). Reconnaissance mapping of the area at a scale of 1:31,680 by R. L. Harbour, of the U.S. Geological Survey, was incorporated into the geologic map of New Mexico (Dane and Bachman, 1965), published at 1:500,000 scale. Lode-gold mines and placer workings, as well as an intrusive contact in and near upper Ancho Gulch, were described by Griswold (1959), whose report also contained a claim map of the lode deposits (1959, pl. 11). An adjacent area to the north of the Jicarilla Mountains was studied by Budding (1963, p. 203-208). The White Oaks area to the south was being mapped in detail by M. E. Willard, of the New Mexico Bureau of Mines, at the time the present report was prepared (1971-72).

FIELDWORK

Ryberg spent about 90 days mapping an area of about 70 square miles during October 1964 to June 1966. This work and related petrographic studies were incorporated in a thesis (1968), which included a geologic map at a scale of 1:63,360 and two structure sections.

Segerstrom worked about 4½ months in the field during October 1969 to September 1970, mapping the area and sampling the placer-gold deposits. As no topographic map of the area was available, the mapping was done on color airphotos and transferred stereoscopically to a black-and-white orthophotomap at a scale of 1 inch to 1,600 feet (1:19,200). The altitudes of about 80 points were determined by two matched altimeters; one was read at ½-hour intervals at a bench mark in Ancho, whereas the other was read directly at the point whose altitude was sought. All readings were adjusted for relative humidity and temperature.

Most names of geographic features of the Jicarilla Mountains were lacking or in error on the only existing large-scale map of the area, a planimetric map by the U.S. Forest Service. Consequently, 11 names of undisputed local usage were submitted to the Regional Engineer of the U.S. Forest Service in Albuquerque, N. Mex., who in turn recommended their approval to the U.S. Board on Geographic Names. The approved names, properly designated on plate 1, are as follows:

Ancho Gulch	Little Nugget Gulch	Soldiers Gulch
Ancho Peak	Little Pine Canyon	Spring Gulch
Big Pine Canyon	Monument Peak	Warner Gulch
Jicarilla Peak	Rico Gulch	

ACKNOWLEDGMENTS

Grateful appreciation is given to V.C. Kelley, A. M. Kudo, and J. P. Fitzsimmons, of the Geology Department of the University of New Mexico, for their aid and counsel in the planning and completion of Ryberg's unpublished thesis. C. B. Read, of the U.S. Geological Survey, was also helpful.

M. E. Willard, of the New Mexico Bureau of Mines and Mineral Resources in Socorro, N. Mex., recommended that the U.S. Geological Survey study the Jicarilla Mountains. Willard and G. U. Green, formerly of the Bureau, participated in Segerstrom's first field trip to the area. H. N. Harrison III, a graduate student from Louisiana State University, capably assisted Segerstrom in the field. J. N. Faick, consulting geologist of Tucson, Ariz., was a frequent companion and contributor during the placer studies. Larry Lynch and E. M. Lynch, local placer-mine operators, and P. J. van Waveren, operator of the Ancho Rico Consolidated mine, were generous in furnishing data from their operations. Lloyd Hoskins provided information about several of the local diggings.

E. J. Young, of the U.S. Geological Survey, contributed in the field and in the laboratory to studies of igneous rocks from the Jicarilla Mountains. H. A. Tourtelot, also of the Survey, separated gold from two of our gravel samples and studied the size and shape of the gold particles.

SEDIMENTARY ROCKS

Sedimentary rocks exposed in the Jicarilla Mountains, as shown on plate 1, range in age from the Glorieta(?) Sandstone and San Andres Limestone, of Permian age, to the Ogallala(?) Formation, of Pliocene age. In the northwestern and western parts of the mapped area the San Andres is overlain disconformably by the Artesia Formation, of Permian age, which in turn is overlain disconformably by the Santa Rosa Sandstone and Chinle Formation, of Triassic age. The Chinle is overlain unconformably by the Dakota Sandstone and Mancos Shale, of Cretaceous age. The exposed thickness of all the bedrock sedimentary units totals nearly 1,800 feet. Gravels of the Ogallala(?) Formation, having a maximum thickness of about 90 feet, truncate these formations and the igneous rocks that intrude them in the north-central part of the area.

The distribution of map units on plate 1, where nearly all intrusive contacts are in the San Andres Limestone, differs greatly from that shown for the Jicarilla Mountains on the geologic map of New Mexico (Dane and Bachman, 1965), where these contacts are in the Yeso Formation.

PERMIAN ROCKS

GLORIETA(?) SANDSTONE AND SAN ANDRES LIMESTONE

Outcrops of a sandstone probably equivalent to the Glorieta Sandstone, of Early Permian age, are restricted to the western part of the area; they consist of white to light-tan fine- to medium-grained massive quartzose sandstone interbedded with a subordinate amount of light- to medium-gray limestone. The sandstone is noncalcareous for the most part. Its local thickness does not exceed 90 feet, but the Glorieta is 136 feet thick at its type locality, Glorieta Mesa, 1 mile west of Rowe, San Miguel County, N. Mex. (Needham and Bates, 1943).

The overlying San Andres Limestone, of Early Permian age, locally has two members—a lower, limestone member and an upper, gypsum member—which crop out in the Jicarilla Mountains. About 2 miles west of the mapped area, in sec. 15, T. 5 S., R. 11 E., the San Andres is 841 feet thick.

Outcrops of the resistant limestone member, about 415 feet thick, are widely distributed throughout the mapped area. The member consists of light- to dark-gray thin- to thick-bedded limestone interbedded with clean quartzose sandstone near the middle of the section and with gypsum near the top.

The poorly resistant gypsum member, about 335 feet thick, has been removed by erosion throughout most of the area, but outcrops are still preserved along lower Rico Gulch and along an adjacent stretch of the road between Ancho and Jicarilla. The member consists of massive- to thick-bedded white gypsum interbedded with light-gray limestone.

ARTESIA FORMATION

The poorly resistant Artesia Formation, 376 feet thick and of Guadalupian (Early and Late Permian) age, lies disconformably on a karst surface of the San Andres Limestone. The Artesia has been stripped from the main Jicarilla Mountains by erosion, and outcrops in the mapped area are restricted to the south side of lower Ancho Gulch and to a narrow strip across the southwest corner of the area. In these areas the formation consists of buff to light-brown and orange-red to red fine- to coarse-grained friable calcareous sandstone and siltstone and a few thin beds of gypsum.

There has been considerable confusion in the past regarding the terminology and correlation of this sequence. The name Bernal Formation was applied to closely similar, probably equivalent beds in San Miguel County, N. Mex., by Bachman (1953). In western Lincoln County others have identified this sequence as the Chalk Bluff Formation (Allen and Kottlowski, 1958; Griswold, 1959), as the Whitehorse Group (Bates, 1942), and as the upper clastic member of the San Andres Formation (Wilpolt and Wanek, 1951).

The Chalk Bluff Formation, named by Lang (1937, p. 855-857), had no lower limit. It included evaporitic rocks assigned by Tait and others (1962) to several formations in the Artesia Group. The term "Chalk Bluff" was abandoned by Hayes (1964). The Whitehorse Group was defined as a formation in northwestern Oklahoma, and the name was applied to rocks in southeastern New Mexico by Lewis (1938) despite correlation problems.

At the suggestion of Philip T. Hayes and Charles B. Read, of the U.S. Geological Survey, the Stratigraphic Studies Committee of the Roswell Geological Society undertook a study of this problem. As a result of this investigation, Tait and others (1962) proposed the term "Artesia Group" to apply, in New Mexico and west Texas, to all shelf rocks above the San Andres and below the Ochoan Series. The group included, in ascending order, the Grayburg, Queen, Seven Rivers, Yates, and Tansill Formations. Because there are no complete exposures of the Artesia in the area, a subsurface section in Humble Oil and Refining Co.'s Federal Bogle well 1, sec. 30, T. 16 S., R. 30 E., was designated as the reference well.

The term "Artesia" has been found acceptable by the U.S. Geological Survey and is used in the "Geologic Map of New Mexico" (Dane and Bachman, 1965). The State geologic map labels this sequence "Artesia Group, undivided" in the Jicarilla Mountain area.

In the Jicarilla Mountains this sequence, because of its homogeneity, is more appropriately considered as a single formation rather than a group. Therefore, in conforming to Article 16 of the Code of Stratigraphic Nomenclature (Am. Comm. Stratigraphic Nomenclature, 1961, p. 654), we have used the term "Artesia Formation" for this unit in the Jicarilla area. Article 16 states, "Change in rank of a rock-stratigraphic unit does not require redefinition of its boundaries or alteration of the geographic part of its name."

TRIASSIC ROCKS

SANTA ROSA SANDSTONE

The Santa Rosa Sandstone, about 170 feet thick and of Late Triassic age, disconformably overlies the Artesia Formation in the mapped area, where its distribution is restricted to the western foot of the Jicarilla Mountains. The formation consists of reddish-brown to brown and, in a few places, white to tan coarse- to medium-grained calcareous sandstone interbedded with red to brown calcareous siltstone and shale. The sandstone is crossbedded in part and has a few pebble conglomerate beds.

The type locality of the Santa Rosa, as defined by Darton (1922) is along the Pecos River at Santa Rosa, Guadalupe County, N. Mex.

CHINLE FORMATION

The poorly resistant Chinle Formation, about 200 feet thick and of Late Triassic age, conformably and gradationally overlies the Santa Rosa

Sandstone in the vicinity of the lower and middle stretches of Coyote Canyon and its tributaries and near lower Ancho Gulch. Elsewhere in the mapped area the unit has been removed by erosion. Where present, the unit consists of purplish-red to brown thin-bedded friable sandstone and some interbedded siltstone, shale, and pebble conglomerate. A few beds are grayish or light green. Silicified wood is locally abundant.

The Chinle Formation was named by Gregory in 1915 and described by him in the following year (1916, p. 79) for exposures in the Chinle Valley in northeastern Arizona.

CRETACEOUS ROCKS

DAKOTA SANDSTONE

In Coyote Canyon and lower Ancho Gulch the Dakota Sandstone, of Early Cretaceous age, forms a caprock having a slight angular unconformity with the relatively soft underlying Chinle Formation. At those places the highly resistant Dakota consists of tan to light-brown medium- to coarse-grained quartzose sandstone that has interbeds of gray shale and siltstone near the top. Some carbonized and silicified plant remains were noted in the sandstone and siltstone. A nearly complete section, 140 feet thick, was measured about a mile west of the northwestern part of the mapped area.

The type locality of the formation is near the town of Dakota, Dakota County, Nebr., where it was named and described by Meek and Hayden (1862).

MANCOS SHALE

The Mancos Shale, of Late Cretaceous age, is restricted to a small area on the south edge of the Jicarilla Mountains. At this locality the formation is represented by a few tens of feet of dark-gray shale which apparently conformably overlies the Dakota Sandstone. Though the New Mexico geologic map (Dane and Bachman, 1965) shows a small exposure of Mancos along Coyote Canyon, this was not found by the authors.

The Mancos was named by Whitman Cross (1899) for strata near the town of Mancos, in southwestern Colorado.

TERTIARY DEPOSITS

OGALLALA(?) FORMATION

A profound unconformity separates the well-lithified "bedrock" formations from the overlying Ogallala(?) Formation, of Pliocene age. Slightly lithified fan gravel, sand, and silt deposits that vary from gray to yellow brown and white, thicken and widen outward from the central mountains of the area, especially toward the north. Within a mapped area of 8 square miles the maximum thickness of fanglomerate is about 90 feet.

The formation in the Jicarilla Mountains is apparently a locally derived fanglomerate consisting of coarse gravel, sand, silt, and minor amounts of clay which are largely unsorted and unstratified but are somewhat indurated. Lenses of torrentially bedded stream deposits a few feet thick and a few tens of feet long are locally interbedded with poorly sorted fan deposits. Reddish-brown soil developed on top of the fanglomerate is impregnated with caliche, (calcium carbonate) 6 inches to 1 foot below the surface, and another caliche zone occurs about 6-8 feet below the surface. The clasts are angular to subrounded and attain a maximum dimension of about 3 feet. About 80-90 percent of clasts larger than sand size are monzonite or allied intrusive rock; the remainder are chiefly limestone. Boulders of magnetite as large as 1 foot across are common, even near the north edge of the area, where they are several miles from their presumed source.

The matrix of the fanglomerate is slightly indurated sand, silt, and clay. Heavy-mineral grains constitute 1-2 percent of the matrix, and about 70 percent, by weight, are magnetic. The magnetic fraction consists of magnetite and minor amounts of ilmenite. The nonmagnetic heavy-mineral grains are, in order of abundance, hematite (specularite), hornblende, epidote, zircon (in euhedral, doubly terminated crystals), pyrite, apatite, sphene, and gold (generally in grains 10μ or less in diameter). The pyrite occurs in a ratio of about 1 grain of pyrite to 20 of hematite. Pyrite and gold almost certainly become more and more diffuse outward from the mapped area and eventually become undetectable. No garnets were found in the deposit.

The age of the fanglomerate in the Jicarilla Mountains has not been determined by paleontological means, inasmuch as fossil plants and animal remains are lacking, or by radiometric means, inasmuch as neither ash beds nor lava flows have been found in the formation. In the northwestern part of the mapped area, north and east of Wilson Ranch, the Ogallala(?) forms high terrace remnants 250-300 feet above lower Ancho Gulch. Here, the relationship of the remnants to present drainage indicates that the fan deposits are considerably older than present-day stream deposits. The slope of the depositional surface of the fanglomerate is well portrayed along section *C-C′* (pl. 1), where the slope is 3 percent near the upper end and about 1 percent in lower parts to the north.

We agree with Budding (1963, p. 203-204), who suggested that the fanglomerate may be equivalent to the Pliocene Ogallala Formation along the Pecos slope as described by Bretz and Horberg (1949, p. 477-480). The name "Ogallala Formation" was first used by Darton (1899, p. 741-742) for the uppermost division of the Tertiary deposits of western Nebraska, where the formation consists of calcareous grit, sandy clay, and sand 150-300 feet thick.

QUATERNARY DEPOSITS

Alluvium is being deposited by intermittent streams in the valleys eroded in the Ogallala (?) and older formations. The alluvium unconformably overlies the Mancos and older formations, but it does not overlie the Ogallala(?), because the regional base level for erosion and deposition has been considerably lowered since the Ogallala(?) gravels were deposited. Much of the alluvium that is in large enough patches to be shown on the map is reworked Ogallala(?); thus, it contains the finer constituents of the older gravels, including second-cycle placer gold. In lower Ancho Gulch the deposit is reddish, because of an admixture of silt derived from the Chinle Formation, and consists of at least 20 feet of silt containing sparse lenses of sand. At the heads of valleys in the Jicarilla Mountains the alluvium is largely grus derived from monzonite.

Talus in the northeast corner of the area consists of great blocks of intrusive rock from Jacks Peak which lie helter-skelter in thick slopewash debris along the foot of the peak and conceal the contact between the igneous body and the overlapping Ogallala(?) Formation.

TERTIARY IGNEOUS ROCKS

At least two-thirds of the mapped area is underlain by intrusive rocks; extrusive rocks are completely absent. Most of the intrusive rocks grade in composition from monzonite to granite or syenite, but a few are mafic and form dikes. Except for the dikes, no distinction is made on the map among the different compositional types of igneous rock.

In the southern, central, and western parts of the area the common type of igneous rock is light-gray to grayish-orange granodiorite porphyry containing large pale-yellowish-gray plagioclase phenocrysts and smaller dark-green to black hornblende, and quartz phenocrysts set in a fine crystalline groundmass.

A representative sample of granodiorite porphyry (J54) collected one-half mile southeast of Jicarilla, in the N½ sec. 23, T. 5 S., R. 12 E. (pl. 1), consists of about 65 percent phenocrysts and 35 percent groundmass. A thin section shows that the phenocrysts are zoned calcic

TABLE 1.—*Rapid-rock analyses, in percent, of*

[N, not detected. Analyzed by G. W. Chloe, P. L. D.

Sample (pl. 1)	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O+
J1	64.2	15.8	2.3	2.3	1.7	2.2	4.8	3.0	1.5
J11	64.6	17.5	2.2	.84	.57	.89	4.9	6.8	.90
J15	56.0	15.9	4.7	2.8	2.0	3.7	5.7	3.0	1.2
J17	57.7	15.8	4.8	3.1	3.7	4.0	5.3	2.9	.82
J19	61.8	16.7	2.0	2.6	1.8	3.3	5.4	3.2	.95
J53 ·	60.9	16.2	3.4	2.8	2.6	3.9	4.7	3.0	1.1
J54	65.6	16.5	2.4	1.3	1.2	2.7	5.0	2.9	1.1
J101	63.2	17.8	3.3	.20	.22	2.7	5.6	3.5	.40

[1] $\frac{SiO_2 + Na_2O + K_2O}{FeO + Fe_2O_3 + MgO + CaO}$ Used to determine rock name, according to classification of Segerstrom and Young (1973).

oligoclase (An_{28-32}), 40 percent; hornblende, 15 percent; biotite, 5 percent; quartz, 3 percent; and magnetite, 2 percent. The plagioclase phenocrysts are 3-8 mm across, whereas the other phenocrysts are 1-4 mm across. The groundmass, chiefly orthoclase, has an average grain size of about 0.1 mm. The plagioclase and groundmass are moderately sericitized, and the hornblende is partly chloritized. A nearly identical thin section was cut from sample JR28, in the NE¼ sec. 17, T. 5 S., R. 12 E. From a rapid-rock analysis of sample J54 (table 1), a felsic-mafic index of 9.7 was computed; this value falls in the granodiorite range (7 to 10) and is close to the quartz monzonite range (Segerstrom and Young, 1973). Sample J1, from the NW¼ sec. 2, T. 6 S., R. 13 E., is similar to JR 28 and J54, but it has more quartz phenocrysts (10-15 percent) and fewer hornblende and biotite phenocrysts (5-10 percent, 1-3 percent); its felsic-mafic index is 8.4. Sample J19, from the SW¼ sec. 22, T. 5 S., R. 12 E., is another "typical" feldspar granodiorite porphyry; its index is 7.3. Fracture coatings of epidote are common throughout the outcrop area of feldspar porphyry.

Medium- to dark-gray fine-grained monzonite and quartz diorite porphyry crop out in Little Pine Canyon (J15) and on the southeast slope of Ancho Peak (JR50). The monzonite porphyry (JR50) consists of about 75 percent phenocrysts, 0.4-3 mm across, and 25 percent groundmass, average grain size 0.1 mm. Phenocrysts are sodic andesine (An_{28-34}), 25 percent of the rock; orthoclase, 10 percent; hornblende, 20 percent; biotite, 10 percent; quartz, 5 percent; and accessories, chiefly sphene, 5 percent.

The Jicarilla Peak massif, in the east-central part of the mapped area, is composed of fine-grained monzonitic to quartz dioritic rocks that have as much as 5 percent disseminated opaque minerals, which impart a salt-and-pepper appearance. Sample JR20, with a range in grain size from 0.2 to 1 mm, is an altered rock made up of sericitized feldspar, 75 percent; chloritized hornblende, 15 percent; quartz, 5 percent; and

eight samples of unmineralized intrusive rock

Elmore, J. L. Glenn, James Kelsey, and H. Smith]

H_2O^-	TiO_2	P_2O_5	MnO	CO_2	Total	Felsic-mafic index[1]	Rock name
0.59	0.47	0.27	0.06	0.58	100	8.4	Granodiorite.
.40	.26	.14	N	.08	100	17.0	Granite.
.15	.77	.53	.10	3.4	100	4.9	Monzonite-quartz diorite.
.38	.72	.50	.12	.05	100	4.2	Monzonite.
.55	.82	.37	.07	.34	100	7.3	Granodiorite.
.42	.70	.23	.06	.05	100	5.4	Quartz diorite.
.40	.33	.24	.07	.05	100	9.7	Granodiorite.
.21	.40	.19	.13	1.8	100	11.3	Quartz latite.

opaque minerals, chiefly magnetite, 5 percent. Similar-appearing samples J17 and J53, from the same massif, have felsic-mafic indices of 4.2 and 5.4, respectively (table 1).

In the Jacks Peak massif, in the northeastern part of the mapped area, the intrusive rocks range in composition from quartz syenite to diorite. A light-colored medium-grained cliff-forming quartz-bearing syenite (J11) underlies the highest part of Jacks Peak. The rock has grain sizes of 1-5 mm and contains many miarolitic cavities. Perthite, a complex intergrowth of sanidine and sodic andesine (An_{32}), comprises 80-90 percent of the rock; quartz comprises 5-10 percent; biotite, about 5 percent. Accessory minerals include magnetite, sphene, and apatite. The felsic-mafic index of sample J11 is 17, which is in the range of granite (table 1). A biotite-rich quartz monzonite crops out in the same area and is similar to J11 in its texture and in the presence of miarolitic cavities. The quartz monzonite is largely composed of perthite, but it has 15 percent or more mafic minerals, including hornblende, biotite, and pyroxene; it has very little quartz. Sample J50, from the SE¼ sec. 36, T. 4, S., R. 12 E., was used for radiometric dating because of its unusually high biotite content, about 30 percent.

A gray augite diorite porphyry (JR16) crops out southwest of the summit of Jacks Peak, in sec. 1, T. 5 S., R. 12 E. Phenocrysts 4-6 mm across compose 35 percent of the rock and are set in a felted groundmass. Augite and andesine (An_{40-42}) with overgrowths of orthoclase each constitute about 35 percent of the phenocrysts; other rock constituents include orthoclase, 23 percent; epidote, 5 percent; magnetite, 2 percent; and trace amounts of apatite and calcite. Semiquantitative spectrographic analysis shows that this sample has one of the highest copper contents, 100 ppm (parts per million), and the highest chromium content, 200 ppm, of all the analyzed rocks from the Jicarilla Mountains (table 2).

Sills of intermediate composition crop out in peripheral parts of the Ancho Peak-Monument Peak massif. The thicker sills generally are indistinguishable in outcrop from the main intrusive mass or masses with which they are allied. However, thin sills tend to be much finer grained or even aphanitic. Sample J101 from a sill 2 feet thick (too small to be shown on the map), along Rico Gulch in sec. 10, T. 5 S., R. 12 E., is light gray and aphanitic, and it contains as much as 70 percent oligoclase (An_{23}), somewhat less than 10 percent sanidine, and as much as 20 percent quartz.

Very few dikes occur in the area, and only five are of mappable size: two cut the Ancho Peak-Monument Peak laccolith southwest of Ancho Peak, and three cut sedimentary rocks in the north-central part of the area. The dikes range in width from a few inches to about 100 feet, generally strike east to northeast, and are nearly vertical. Most dikes are fine-grained diorites. Typical is a dark-gray dike (JR44), in the

TABLE 2.—*Partial semiquantitative spectrographic analyses, in parts per million, of 24 samples of unmineralized intrusive rock*

[Determination limit for each element is shown in parentheses. N not detected; L, detected but below limit of determination. Analyzed by J. L. Harris]

Sample (pl. 1)	Co (5)	Cr (10)	Cu (2)	Mo (3)	Ni (5)	Pb (10)	Sc (5)	V (10)	Y (10)
J1	7	30	50	N	10	30	15	100	50
J11	20	30	50	N	10	20	7	30	50
J15	20	70	15	3	20	N	15	100	30
J17	15	30	3	N	10	N	15	150	50
J19	7	20	2	N	7	7	10	70	50
J53	10	20	5	N	10	N	15	100	50
J54	N	15	20	5	3	30	10	50	50
J101	N	10	3	N	N	10	5	30	50
JR16	20	200	100	N	30	10	50	150	30
JR20	30	100	70	N	50	10	30	200	50
JR26	5	N	10	N	10	20	7	70	30
JR28	5	N	10	N	10	10	7	70	20
JR31	20	30	50	N	15	30	15	150	30
JR33	5	N	20	N	10	50	7	100	30
JR44	70	150	100	N	150	15	30	300	30
JR49	N	30	5	N	15	10	10	100	20
JR50	L	N	100	N	5	10	7	70	20
JR51	L	N	50	15	7	20	10	70	30
JR60	10	100	50	N	50	50	15	100	30
JR79	10	30	20	N	10	20	15	100	30
JR90	L	N	15	N	7	10	10	70	20
JR120	30	50	50	N	20	20	30	200	30
JR123	L	N	20	N	7	10	10	100	30

NW¼ sec. 33, T. 4 S., R. 12 E., consisting of 35 percent augite, 32 percent andesine (An_{32-34}), 25 percent hornblende, 7 percent magnetite, and about 1 percent calcite. This rock contains high copper (100 ppm), nickel (150 ppm), chromium (150 ppm), and vanadium (300 ppm), as shown in table 2.

A potassium-argon anaysis on biotite extracted from monzonite at locality J50 (SE¼ sec. 36, T. 4 S., R. 12 E.) yielded an age of 37.3±1.5 million years (analysis by R. F. Marvin, H. H. Mehnert, and Violet Merritt, U.S. Geol. Survey, June 1971). This age determination indicates a very late Eocene or very early Oligocene age for the monzonite. No other age determinations are known of the rocks or minerals from the Jicarilla Mountains.

CONTACT METAMORPHIC ROCKS

A light-greenish-gray very fine grained tactite is exposed at the south end of the Jacks Peak massif, near diorite (JR16) in the SE¼ sec. 1, T. 5 S., R. 12 E. The metamorphic aureole, formed in the limestone of the San Andres Limestone is only a few tens of feet wide and consists of actinolite, tremolite, epidote, and minor amounts of quartz; garnet and other calc-silicate minerals which commonly occur in tactite seem to be absent. The tactite was not mapped separately from the San Andres.

Elsewhere in the mapped area the contact-metamorphic effect is limited to marmorization, and metamorphic aureoles are not more than a few feet wide. The dark-gray crystalline limestone or marble consists of calcite crystals, as much as 1 mm across, and about 2 percent magnetite. Garnet was reported in recrystallized limestone at the head of Warner Gulch, NW¼ sec. 26, T. 5 S., R. 12 E. (Griswold, 1959, p. 88), but has not been found elsewhere.

STRUCTURE

The Jicarilla Mountains rise along the northern part of the complexly faulted Mescalero arch, which is bordered by the Claunch sag to the west and the Pecos slope to the east (fig. 1). Structural disturbances caused by igneous intrusion have modified the arch structure in the vicinity of the three massifs that make up the Jicarilla Mountains. The Jicarilla intrusives lie approximately midway along a group of Tertiary plutons which extends north to south across Lincoln County.

The main intrusive, which underlies the massif of Ancho and Monument Peaks, appears to be a laccolith about 25,000 feet across and 2,500 feet thick (section *A-A'*, pl. 1). Other than a few dikes, no crosscutting relations were observed. Exposures along the flanks of the intrusive indicate that a domed and wrinkled pile of sills and interlayered sedimentary rocks, about 2,500 feet thick, formerly covered the laccolith. Individual sills range in thickness from 2 to 500 feet. The central part of the domed edifice is flat, and the outer flanks are steep (30°-45°).

Smaller and more elongate intrusives underlie the Jicarilla Peak and Jacks Peak massifs, where doming of the overlying sedimentary beds is also evident. We do not know whether these two intrusive bodies are laccoliths or stocks. Folded sills lie on their flanks.

Synclines ring the flanks of the Ancho Peak-Monument Peak laccolith. A double plunging, branching syncline on the southwest flank, along Coyote Canyon, has folded the Dakota Sandstone. This syncline (section *B-B'*, pl. 1) appears to be a result of doming that took place on both sides of the structure. The syncline is split into two branches by the doming effect of a small intrusive apophysis in the W½ sec. 5, T. 6 S., R. 13 E. Sills are also involved in the formation of the synclines on the southeast and northwest flanks of the main laccolith (section *A-A'*). On the northeast flank, separating the Ancho Peak-Monument Peak laccolith from the Jicarilla Peak and Jacks Peak plutons, is a syncline whose axis approximately follows Little Nugget Gulch; the syncline apparently lies between the domes associated with the adjacent intrusives. It plunges north and is truncated by the Ogallala(?) Formation.

Four faults partly circumscribe the main Ancho Peak-Monument Peak intrusive to the north, south, and southwest. Along each fault the downdropped block is on the side away from the intrusive body. The greatest displacement is along the northern fault; there, the Dakota

Sandstone is faulted against the Artesia Formation, and the minimum displacement exceeds the thickness of the Triassic section, about 370 feet. Displacements on the other circumscribing faults are of the order of 100-200 feet.

In the central and north-central parts of the area some of the contacts between igneous and sedimentary rocks are fault contacts which strike northeast. Three of the faults are shown in section *A-A′* and have probable displacements of about 50-200 feet. In the E½ sec. 10 and the W½ sec. 11, T. 5 S., R. 12 E., a northeast-striking fault has brought the San Andres Limestone into contact with the Ogallala(?) Formation.

Throughout the mapped area most steeply dipping joints and dikes strike northeast, although many have a northerly trend in the Jicarilla Peak and Jacks Peak massifs. Veins and stringers in the lode-mining zone near Ancho Peak tend to strike northwest, even where more-prominent unmineralized joints strike northeast; in conjunction with these steeply dipping joints, veins, and dikes is a third set of subhorizontal joints.

At a few exposures, northwest fractures are slightly displaced by northeast fractures, and the relatively flat fractures may well represent sheeting. From early to late the sequence of fracture formation is probably: (1) northwest, (2) northeast, and (3) subhorizontal.

GEOMORPHOLOGY

The core of the Jicarilla Mountains has been eroded to the late-mature stage, in contrast to the Ogallala(?)-blanketed area immediately to the north, which is in a youthful stage of erosion. The Ogallala(?) Formation was deposited when the local base level was higher than at present. Uplift of the Jicarilla Mountains changed the depositional environment of the Ogallala(?) to an erosional environment, so new stream courses were superposed on the cover of fanglomerate. The trunk stream, Ancho Gulch, which drained northward before and during deposition of the Ogallala(?), began draining westward and eroding the Ogallala(?) fan deposits and cutting into the buried ridges of older bedrock—a process which has continued to the present time, although at decelerating rates.

Ancho and Rico Gulches were eroded in bedrock to depths as much as 20 feet below present valley floors before alluviation could finally outstrip erosion. The alluvial fill is a mixture of reworked Ogallala(?) fanglomerate and grus and of other materials removed directly from the older bedrock.

In the Jicarilla Mountains, unroofing and erosion of the slightly mineralized laccolith and other intrusives, with concomitant deposition and reworking of clastics along streams, led to placer concentrations of magnetite and gold. A reconstruction of the presumed shape of the Ancho Peak-Monument Peak laccolith by projection indicates that present exposures are near the roof of the laccolith. The interlayered sill-sedimentary pile which overlay the main pluton and which has been eroded was probably 2,000-3,000 feet thick, as judged from exposures on the flanks of the domed edifice. If this is so, then the volume of eroded material was at least 10 times the present volume of derived placer gravels, or fanglomerate. Assuming that the lighter fractions were transported outside the placer area, the remaining heavier fractions represent a tenfold increase from their original concentration in the pluton.

MINERAL DEPOSITS

The Ancho-Jicarilla mining district is largely restricted to the east half of T. 5 S., R. 12 E., an area of about 20 square miles. Gold placers are the most extensively mined resource, but iron deposits on the north, east, and south fringes of the district have also been exploited. Lode-gold mining has been very minor. The district is in the northernmost part of the Lincoln National Forest and is all public domain except for a few patented claims in and near the E½ sec. 27, T. 5 S., R. 12 E. Secs. 3, 10, 11, 14, 15, 22, 23, 24, and 26 have largely unpatented claims, which reflects the high interest that this district has generated among prospectors, investors, and speculators. Because of frequent changes in names and boundaries of claims, no claim map is included in the present report, but some of the names of placer diggings, mines, and prospects which have persisted through the years are shown on plate 1.

HISTORY AND PRODUCTION

GOLD

Placer mining for gold started in the Ancho-Jicarilla district as early as 1850 (Jones, 1904, p. 177) when Mexican-American prospectors hauled in water and washed the gravels in bateas, shallow wooden pans about 1½-2 feet in diameter. Anglo-American prospectors began working in the district in 1880, and at that time the first attempts were made to find the lode source of the placer gold (Lindgren and others, 1910, p. 183). A supply town, Jicarilla, with a few stores and a post office, was established in the SW. cor. sec. 14, T. 5 S., R. 12 E., and several buildings still remain at this site. In 1903 the American Placer Co. operated a large dredge west of the post office, but the operation was unsuccessful (Jones, 1904, p. 177-178). A mill for ore treatment was built in 1905-6 by the Wisconsin Milling and Smelting Co. (Lindgren and others, 1910, p. 184), but no significant tonnage was treated. The years 1904-16 showed a sharp decline in annual placer gold production, from 972 to 31.5 ounces (U.S. Geol. Survey, 1883-1924). Gold-mining activities ceased completely during World War I and remained dormant during the 1920's. Placer production to 1931 probably had a total value of $90,000 according to Lasky and Wootton (1933, p. 77).

In the depression years of the early 1930's, scores of men moved into the gulches of the Jicarilla Mountains and mined and washed the gold-bearing gravels by hand, using water from melted snow in winter and water hauled in barrels during the summer months. The increase in the price of gold from $20 to $35 per ounce in 1933 was an added incentive. The mineral resources volumes (U.S. Bur. Mines, 1924-31; 1932-60) probably do not give an accurate record of the production of gold in the Ancho-Jicarilla district during the 1930's, because most of the gold was sold in small lots to merchants at Jicarilla, Ancho, and Carrizzo. However, these statistics give some notion of the rise and fall of placer gold production in the district during the depression and pre-World War II years. No production was reported through the 1920's, and only 20.27 ounces was reported for 1931; placer production was reported for 1933-42 as follows:

	Number of mines	*Gold (fine oz)*
1933	68	236.02
1934	84	327.81
1935-36	63	309.09
1937	47	184.20
1938	45	162.20
1939	55	203.00
1940	54	178.00
1941	19	178.00
1942	8	36.00
Total		1,814.32

The total production of 1,814 ounces reported for the decade was worth $63,500 calculated at $35 per ounce. During the same period, these placer mines reportedly produced 143 ounces of silver.

According to the mineral resources volumes of the U.S. Bureau of Mines (1932-60), in 1935 a power shovel and other equipment were moved to the Ancho placer, but they operated only a short time; in 1936 a power shovel and special sluicing installation were operated from November 1 to December 31 at the Ancho and Rico claims, and a power shovel and Ainlay-bowl recovery plant were moved to the Turner Moodey claims, about 1 mile east of Jicarilla; in 1938 machinery was used at a few placers to handle the gravel. Inasmuch as 300 or more men, some with families, eked out a living by working the gravels during the 1930's, the true production must have been several times greater, or perhaps many times greater, than reported in the mineral resources volumes. The extensive churning of gravels, shown by an overprint pattern on plate 1, was mostly done during this period.

No lode-gold production is credited to the Jicarilla district in any of the mineral resources volumes except the one for 1933, when 82.62 ounces of gold was reported as recovered from ores produced in the Lucky Strike mine and in another, unnamed mine. Many shafts and adits were dug for gold at the turn of the century and during the 1930's; most of these are at the head of Ancho Gulch and on the ridge south of Ancho Peak (pl. 1). None of these prospects have an recorded production.

Plagued by lack of water, difficulty of extraction of the exceptionally fine grained gold, and higher priorities elsewhere, the placer miners left the Jicarilla Mountains when the United States became involved in World War II, and they never came back in force.

A major program exploring and testing the gold placers was inaugurated by E. M. Lynch and his son, Larry, in 1958. About 200 shafts, pits, and back-hoe cuts were made, mostly in the SE¼ sec. 15 and the NE¼ sec. 22, T. 5 S., R. 12 E. A pilot mill with a capacity of 2-3 cubic yards per hour was built by the Lynch family 3,200 feet west-southwest of the Jicarilla townsite, and with frequent modifications it was operated intermittently until it was dismantled in 1971. About 3,000 cubic yards of -¼-inch gravel was treated in the mill during its 8 or 9 years of use (Larry Lynch, oral commun., April 10, 1972). No gold was sold.

Wade White, a mine operator from Silver City, N. Mex., came to the district in 1960, cut and sampled three large bulldozer trenches, and drilled six wells in search of water. Because these wells were all dry, the operation was terminated (J. N. Faick, written commun., 1969).

In 1965-67 a program of exploration and testing was conducted by Dr. G. U. Green, formerly a professor of geology at the School of Mines in Socorro, N. Mex. Under his direction about 40 pits, 10 of which reached bedrock, were dug in the fanglomerate and alluvial gravel, and 20 holes were drilled. A pilot mill with a capacity of 100 tons per day was built about 1 mile north-northeast of the Jicarilla townsite. The mill was operated for about 5 months in 1966 and was subsequently dismantled. No gold was sold.

IRON AND COPPER

Spurred by heavy war demand, the mining of magnetite from the contact-metamorphic aureole on the west side of Jacks Peak began in 1918 and was conducted by the Beech Brothers for several years. Practically all the reported production for 1918-21, 3, 290 tons, was from the Jack No. 1 mine (NW¼ sec. 36, T. 4 S., R. 12 E.). The ore shipments averaged 56.2 percent iron (Kelley, 1949, p. 158-159).

After two decades of quiescence of mining in this area, U.S. involvement in World War II brought about a short-lived revival of interest in the iron deposits of the Jicarilla Mountains. This time several companies participated, but only 2 years of production ensued, 1942 and 1943. Most of the iron was produced from four mines: Jack No. 3 mine (SW¼ sec. 36, T. 4 S., R. 12 E.), 446 tons; Magnetite mine, later called Polly mine (SE¼ sec. 26, T. 5 S., R. 12 E.), 2,514 tons; Zuni mine (near east edge sec. 4, T. 6 S., R. 13 E.), 829 tons; and Hoecradle mine (NW¼ sec. 13, T. 5 S., R. 12 E.), 595 tons (Kelley, 1949, p. 161-165). The average tenor of ore produced during this period was between 55 and 60 percent iron. After 1943 there was no further production of iron ore in the region until 1972.

Several prospects in the southern and western parts of the area attest to the sporadic exploration for copper through the years. In 1970-71 a little malachite for jewelry making was produced from a pit in the NW¼ sec. 21, T. 5 S., R. 12 E.

In the spring of 1972 a new program of exploration, exploitation, and beneficiation was undertaken by the newly formed Ancho-Rico Consolidated Mining Co. Plans were made for road building, iron mining, placer-gold mining, water development, and, eventually, construction of a mill for extraction of gold from placer deposits. A few truckloads of magnetite ore were hauled from the Ancho-Rico Consolidated mine, in the SW¼ sec. 27, T. 5 S., R. 12 E., over a new road from the north, but the iron deposit was lenticular and small, and by 1973 the entire program had been abandoned.

MINERALOGY

Hypogene ore minerals occur in steeply dipping veins and (or) as disseminations in granodiorite, quartz monzonite, and related rocks of the main laccolith; they are virtually absent in the intrusions of Jicarilla Peak and Jacks Peak and in sedimentary rocks of the region. In approximate order of decreasing abundance, the minerals are specular hematite, pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, and gold.

Specularite occurs in narrow veins and stringers throughout the intrusive masses and is typically present as steel-gray plates as much as 2 cm across, some of them hexagonal in outline.

Pyrite occurs in veins and stringers as euhedral crystals rarely more than 3 mm across, generally in a gangue of quartz or rarely in a gangue of calcite, and it is disseminated locally through the intrusive rock in cubes and pyritohedra ranging in size from a few tenths of a millimeter to 2 mm. Pyrite, both disseminated and in veins, is distributed mostly within a broad belt extending northwestward through secs. 26 and 27 and the SW¼ sec. 22, T. 5 S., R. 12 E. Generally, disseminated pyrite is marginal to the pyrite veins and grades outward into slightly altered host rock. However, near the Paden-Prichard windmill is a relatively large zone of quartz monzonite porphyry containing 5-10 percent disseminated pyrite which is not clearly related to individual veins. Arsenopyrite accompanies the pyrite in fracture fillings, but it is generally not more than a few percent as abundant as the pyrite. Chalcopyrite, sphalerite, and galena are associated with pyrite to a minor degree in the vein deposits but not appreciably in the disseminated bodies.

In heavy-mineral fractions of pyritized intrusive rock from localities J29, J33, and J52 (pl. 1), gold content was determined to be 0.8, 0.4, and 0.2 ppm, respectively. Each of the samples amounted to 5-10 percent of the whole rock. The method of determination was fire assay and atomic absorption, and the analysts were A. W. Haubert, W. D. Goss, and J. A. Thomas, of the U.S. Geological Survey. The gold probably occurs in solid solution or as inclusions in the pyrite. A 20-pound sample of pyrite-impregnated granodiorite from the Paden-Prichard windmill contained no detectable gold; the detection limit was 0.1 ppm (C. R. Sewell, written commun., April 1972).

Pyrite and the other sulfide minerals of the district occur in freshly eroded outcrops at the bottoms of gulches, but on ridges and most slopes, where oxidation has been more effective, the sulfides are seen only in mine workings and on mine dumps.

Ore minerals known to occur in pyrometasomatic deposits in the region are, in order of decreasing abundance, magnetite, pyrite, and chalcopyrite. The magnetite is massive and replaces limestone and (or) tactite along and near intrusive contacts. Parts of limestone beds which are bounded by fractures are almost completely replaced, so small ore bodies of nearly pure magnetite have been found. In places, pyrite is very finely disseminated in tactite and limestone, and both pyrite and chalcopyrite tend to be minor contaminants in the magnetite bodies.

Gossans developed on pyritic veins commonly contain limonite or goethite, both as pseudomorphs after pyrite. Malachite and chrysocolla occur rarely as thin coatings on granodiorite or monzonite or on magnetite ore. Oxidized lead and zinc minerals were not recognized in the area.

The intrusive rocks have been hydrothermally chloritized, silicified, and sericitized, but alteration is not as pervasive as might be expected in a mining district. As noted by Griswold (1959, p. 77), "Hydrothermal alteration was not intense; the rock is only slightly bleached in its mineralized portions."

Heavy-mineral concentrates, constituting 1-4 percent of placer material less than one-fourth inch in diameter, consist of magnetite, specular hematite, hornblende, epidote, augite, sphene, apatite, zircon, pyrite and gold. The magnetite is derived from intrusive rocks, where it is an accessory mineral, rather than from the pyrometasomatic deposits; the same is true of the sphene, apatite, and zircon. The zircon occurs as minute doubly terminated crystals. Specularite occurs as platelets, or flakes; "flour" gold probably adheres to some of the flakes, which tend to float off during further concentration of the heavy-mineral concentrate. Some of the gold grains in the concentrate were probably washed out of gossans. Gold has reportedly been found adhering to quartz in pan concentrates, but this occurrence was not noted by us. Fineness of the placer gold is about 920 (Lasky and Wootton, 1933, p. 77); most of the impurity is attributable to silver content.

OCCURRENCE, GRADE, AND AMOUNT OF PLACER GOLD

Gold is known to occur in gravel, sand, and silt of the Ogallala (?) Formation from the head of Ancho Gulch to a little north of the township line between T. 5 S. and T. 4 S., a distance of more than 4 miles, and in other gulches on the east and southeast flanks of the main Jicarilla Mountains. It also occurs in modern alluvium which has been deposited in channels cut below the Ogallala (?) surface. The total area of known or probable placer-gold deposits is 5-6 square miles. The gold is known for its generally fine grain size and difficulty of extraction. It is also known for its erratic vertical distribution throughout the deposit; the gold is not particularly concentrated in channels or on bedrock. Such a distribution of placer gold is in keeping with the poor sorting in the local facies of the Ogallala (?) Formation. Representative samples of workable size are difficult to obtain.

Two samples collected from a bulldozer trench 45 feet deep, in the NW¼ sec. 14, T. 5 S., R. 12 E., illustrate how extremely erratic the local gold distribution may be. Vertical channels from which the two samples were cut were only about 20 feet apart, yet one of the samples, J7, contained 0.44 g gold in 24.95 kg fanglomerate (about 0.5 oz/ton), and the other, J6A, contained 0.036 g in 5.42 kg fanglomerate (about 0.05 oz/ton). Sample J7 was ground in the ball mill and treated in the gold saver owned by the Lynch family, where it may have been accidentally contaminated.

Gold particles in sample J7 ranged from a maximum of 2 mm in diameter and 0.15 mm in thickness to less than 230 mesh (61 μ). Gold flakes as thin as 0.05 mm, as well as gold rods, were recovered from the 35-, 60-, 120-, 230-, and –230-mesh fractions. At the same locality, sample J6A, intended to duplicate J7, was taken but was not run through the ball mill and gold saver. Gold recovered from J6A by simple gravity means, including elutriation, was all essentially equidimensional, rough surfaced, or spongy and was 1 μ-10 μ in diameter; the seven gold particles that were recovered aggregated less than 0.001 g (H. A. Tourtelot, written commun., June 4, 1970). Most of the gold detected in other samples by fire assay is megascopically invisible in the untreated sample and evidently occurs in grains smaller than 10 μ in diameter. Even the largest nuggets that have been reported are small and very rarely exceed one-sixteenth inch (2,000 μ or 2 mm) in diameter.

Separate and independent tests by the Lynch interests and Dr. Green indicate that only about one-fourth or one-third of the placer gold occurs as free particles and that the rest occurs on thin laminae of specular hematite which tend to float off during washing operations. To demonstrate how incomplete the recovery of gold has been in the past, material from the old depression-era tailings piles in upper Ancho Gulch was treated by the Lynch interests in their pilot mill; a significant recovery of gold resulted. To accomplish this, the nonmagnetic fraction of the heavy-mineral concentrate was finely ground in order to free gold particles trapped in the specularite.

In about 1934 E. L. Fersten, of the Lincoln Dredging Co., tested Ancho Gulch for a distance of 6,650 feet upstream from the Jicarilla townsite. Channel samples, which were taken from surface to bedrock in 126 pits averaging 7-8 feet in depth, had a density of 1.5 tons per cubic yard and an average grade of 0.0225 ounce gold per cubic yard. Total gold recovered from the samples averaged $0.53 per short ton (calculated at $35/oz). Comparable tests by the Lynch interests and Dr. Green for the same area gave an average value of $1.58 per short ton.

A suite of 10 50-pound samples from a traverse line in upper Ancho Gulch, in NE¼ sec. 22, T. 5 S., R. 12 E. (pl. 1), was taken by J. N. Faick and Segerstrom in 1970. These samples were taken from different depths in four pits alined at right angles to Ancho Gulch, for a distance of 800 feet; they represent a traverse across the middle of the area tested 36 years earlier by the Lincoln Dredging Co. and more recently by the Lynch interests and Dr. Green (preceding paragraph). Each sample was air-dried, weighed, and screened, and the +¼-inch sizes were discarded. A gravity and magnetic separation was made on a Wilfley table. The nonmagnetic heavy-mineral fraction was finely ground in a ball mill and then washed and recirculated for further removal of magnetic and less heavy components. The resulting concentrate, believed to contain all the gold present in the original sample, was treated by fire assay and atomic absorption. The results are shown in table 3.

TABLE 3.—*Gold content of samples from test traverse across Ancho Gulch*

[Gold determined by fire assay and atomic absorption by W. D. Goss, L. B. Riley, and J. A. Thomas. Average gold-silver ratio about 16:1]

Sample (pl. 1)	Test pit	Sample locality and description	Gold (ppm)
JF132	1	Southeast side of road; top 4 ft; soil and gravel	1.13
JF133	1	4-6 ft below surface; strongly calichified gravel	1.39
JF134	2	Top 3 ft; soil and gravel	3.42
JF135	2	3-5½ ft below surface; transported clastic material, relatively uncalichified	.82
JF136	2	5½-6 ft below surface; weathered monzonite bedrock with admixture of transported material	.09
JF139	3	Southeast side of watercourse; top 3 ft; soil and gravel	.30
JF140	3	3-5 ft below surface; weathered monzonite bedrock with admixture of transported material	.60
JF141	4	Top 3 ft; soil and gravel	.53
JF142	4	3-5 ft below surface; gravel	.51
JF143	4	5-10 ft below surface; gravel, down to monzonite bedrock	1.19

Average grade of the 10 samples was 1.00 ppm, or about 0.043 ounce per cubic yard, assuming an average density of 1.5 tons per cubic yard of fanglomerate. Average grade of the top samples was more than 50 percent higher than that of the bottom samples, but conclusions from these results are risky because the gold grains are distributed erratically, both horizontally and vertically.

We estimate that about 1.58 million short tons of auriferous fanglomerate, with an average grade of 1 ppm, is present along and within 750 feet of upper Ancho Gulch from near the Jicarilla townsite to a little south of the section line between secs. 22 and 27, T. 5 S., R. 12 E. This estimate is based on an area of 100 acres, an average thickness of 7 feet, and a density of 1.5 tons per cubic yard. It agrees approximately with estimates of E. L. Fersten (unpub. records, Lincoln Dredging Co., 1934) and J. N. Faick (oral commun., 1970); however, our estimated grade is about twice as high as that of Fersten and half as high as that of Faick.

Auriferous fanglomerate and alluvium also occur along and near lower Ancho Gulch, Little Nugget Gulch, Rico Gulch, Spring Gulch, and Warner Gulch. Spot tests on grab samples indicate that Little Nugget Gulch and Rico Gulch, and their environs, offer better possibilities for additional reserves than do Warner Gulch, Spring Gulch, and the broad areas adjacent to lower Ancho Gulch. About 4 million short tons of auriferous gravel, estimated to contain about 1 ppm gold, occur along and near (within 750 ft of) Rico Gulch in the W½ sec. 15 and the SE¼ sec. 10, T. 5 S., R. 12 E. This estimate is based on an area of 7½ million square feet (about 160 acres), an average thickness of 10 feet, and a density of 1.5 tons per cubic yard. A similar area, thickness, and grade is estimated for Little Nugget Gulch and vicinity. Supporting data for the Rico and Little Nugget estimates of grade are given by Dr. G. U. Green as follows (oral commun., April 17, 1972): 500 fire assays on hand-dug samples from the Little Nugget-Rico area, which were concentrated in Lynch's mill, gave slightly less than 2 ppm; 2,000-2,500 fire assays on machine-dug samples from the same area, which were concentrated in the Ancho Mining Co. mill (near the section line between secs. 11 and 14, T. 5 S., R. 12 E.), gave "spotty results, but the average result was considerably lower than 2 ppm."

In summary, deposits in three areas totaling 420 acres—upper Ancho Gulch (100 acres), Rico Gulch (160 acres), and Little Nugget Gulch and vicinity (160 acres)—have an average thickness of 7-10 feet, an estimated density of 1.5 tons per cubic yard, and an average grade of 1 ppm gold (0.043 oz/yd^3). The total gold thus represented is about 8 short tons.

The rest of the deposits of the Ancho-Jicarilla mining district that contain detectable gold (detectable in samples weighing 50 pounds or more) cover an area of at least 5 square miles (shown mostly as unit To on pl. 1) to an average depth of 15 feet. Assuming a density of 1.5 tons per cubic yard and a grade of 0.1 ppm gold (0.004 oz/yd^3), which is believed to be realistic, these deposits represent a total low-grade gold resource of about 10 short tons. This low-grade resource and the 8 short tons of higher grade resource and reserve inferred for Rico, Ancho, and Little Nugget Gulches indicate that the placer deposits of the Ancho-Jicarilla mining district may contain the largest gold resource in the State.

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