THE GEOLOGY AND GOLD DEPOSITS OF SELECTED AREAS OF THE JICARILLA DISTRICT, LINCOLN COUNTY, NEW MEXICO

By

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Submitted in Partial Fulfillment of
the Requirements for the Degree of
Master of Science in Geology

New Mexico Institute of Mining and Technology

Socorro, New Mexico

1986

ABSTRACT

The Jicarilla District is located on the eastern piedmont slopes of the Jicarilla Mountains in west-central Lincoln County, New Mexico. The district is known mainly for low-grade gold placer deposits and minor amounts of lode gold.

The Jicarilla Mountains are an exposed laccolith-stock of intermediate composition intruded into Paleozoic and Mesozoic sedimentary rocks during the Oligocene-Miocene. Geomorphic processes have removed several thousand feet of rock unroofing the intrusives and concentrating disseminated gold particles and weathered vein materials as auriferous gravels in the late Miocene to early Pliocene Ogallala (?) Formation and Holocene sediments.

An attempt to prospect two separate lease areas within the district was made by the Great Southwest Minerals and Mining Company during the summer of 1982. The results obtained were disappointing due to the limited exploration program completed. The company was unable to delineate economic gold reserves but further directed efforts could be successful.

ACKNOWLEDGEMENTS

I would like to thank Mr. Terry Cooper, President of the Great Southwest Minerals and Mining Company, for suggesting and sponsoring this project. Special thanks are due to Dr. Clay T. Smith for advice, the critical reading of this report and most of all his patience. I would also like to express grateful appreciation to my parents, Dr. Robert M. Baker and Mrs. Marguerite A. Baker, for their encouragement and support.

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INTRODUCTION

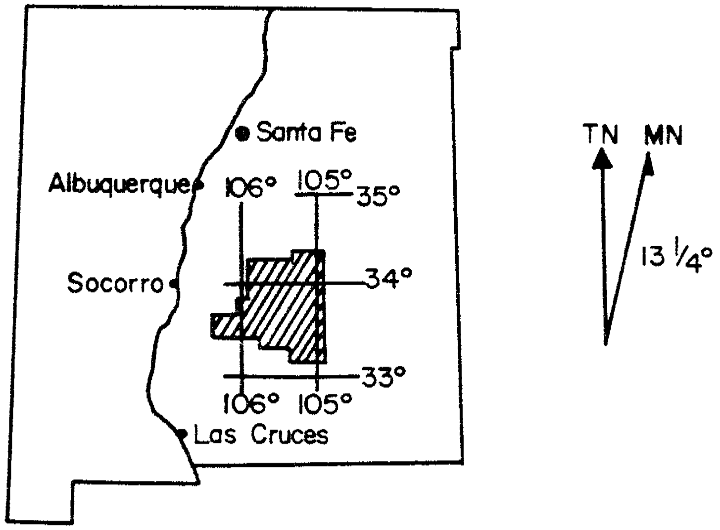
Purpose Of Study

The purpose of this study was to explore and develop the gold placer leases owned by Great Southwest Minerals & Mining Company in two separate plots near the village of Jicarilla, Lincoln County, New Mexico. The philosophy guiding this project was to obtain the maximum amount of information for a minimum expenditure and to determine if the available mineral reserves made the leases economically viable. The bulk of the information presented here was gathered from April 1982 to May 1983 during fieldwork, library research, laboratory study, and a limited drilling and trenching program.

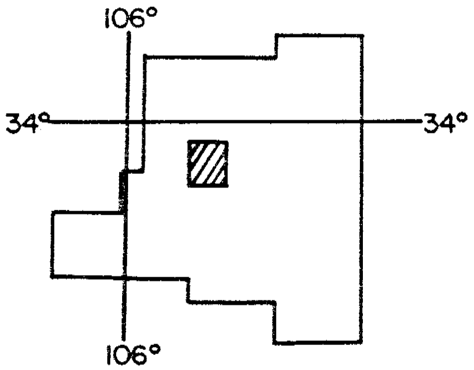
Location And Accessibility

The field area of this study is within T5S and R12E, 13½ miles northeast of Carrizozo, New Mexico, (see Figures 1 and 2). The lease areas lie at an average elevation of 6,700 feet in S3 and 7,000 feet in S13, roughly centered around the village of Jicarilla. These two sections represent separate life zones along the western piedmont slopes of the Jicarilla Mountains in an area of ephemeral drainage.

Roads leading to the area are paved to the villages of Ancho and White Oaks where they enter the Lincoln National Forest. The forest roads are gravel but are well maintained and good except during wet weather when they quickly become muddy and slick. There are many side roads leading off the main forest roads, (72, 72A, and 72B), which are poorly maintained but passable under dry conditions. Forest road 72 forms a large loop that connects with New Mexico State Route 54 via Ancho to the north and White Oaks and New Mexico State Route 349 to the south. In general most of the area is accessible by automobile and almost all of it is open to trucks and four-wheel drive vehicles. The higher elevations

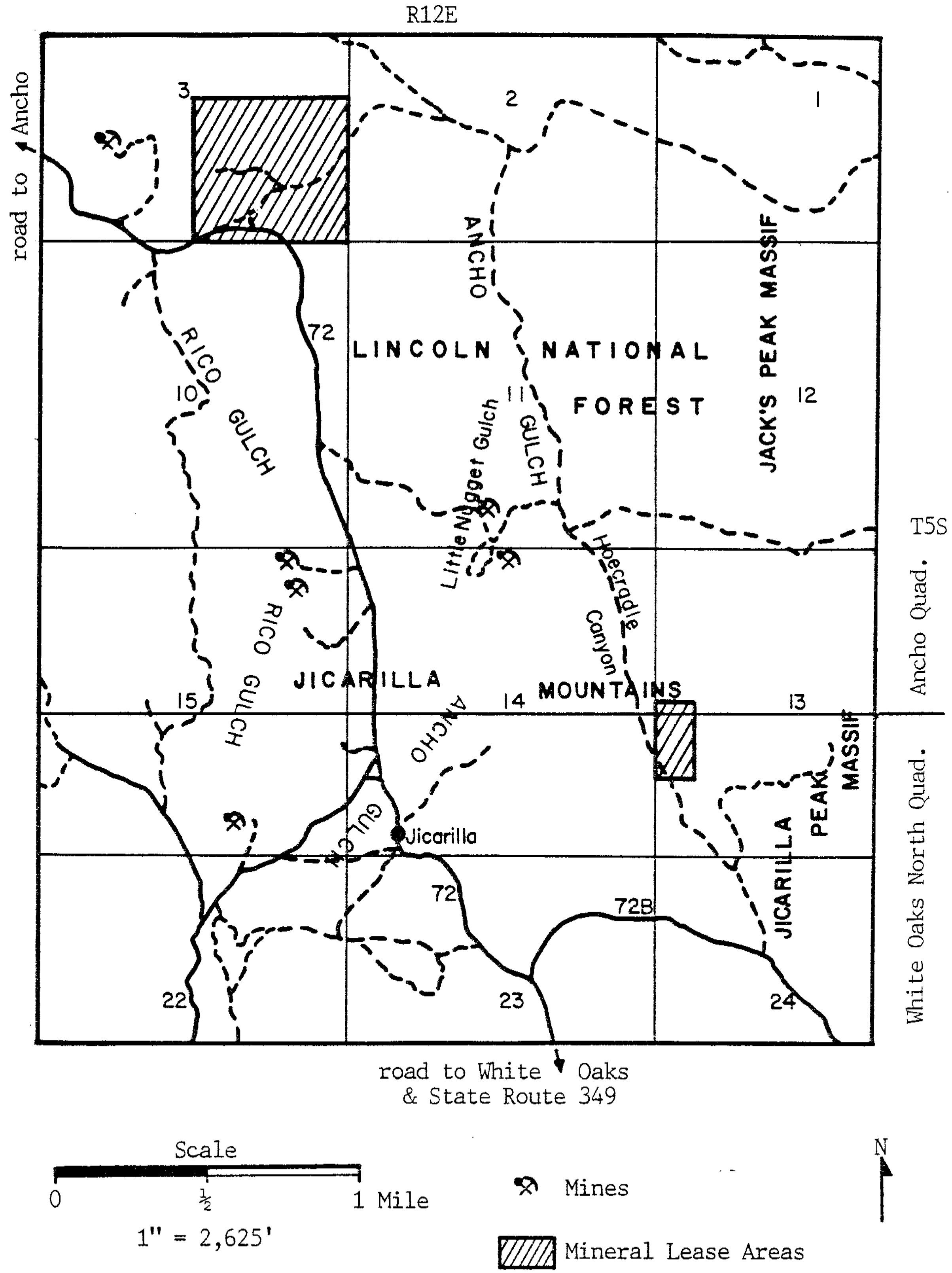


Index Map of New Mexico showing Lincoln County.



Index Map of Lincoln County showing Figure 2.

Figure 1. Index Maps, adapted from Griswold (1959).



Jicarilla Mountains in the Lincoln National Forest

Figure 2. Location of Great Southwest Minerals & Mining Co. lease areas, adapted from U.S.G.S., Ancho & White Oaks North Quads. (1973).

such as the Jicarilla Peaks are relatively inaccessible except on foot.

Previous Work

There is a long and broken history of mining in and around the Jicarilla District. Unfortunately very little published information regarding local mineralogy, ore concentrations and tonnages, and gold recovery exist. Jones (1904) briefly mentions the ore deposits of the district along with Lindgren, et al. (1910). Darton (1928a & b) looked at the area as part of a larger study and produced a reconnaissance map. Wells and Wootton (1932), Lasky and Wootton (1933) and Anderson (1957) also mention the Jicarilla District as part of larger studies. Griswold (1959) looked at the district in terms of mineral deposits, specifically gold and iron deposits; however he did little mapping.

Reconnaissance mapping was done by R.L. Harbor during the mid-1950'^{s}. Dane and Bachman (1958) and (1965) incorporated this work in their Preliminary Geologic Map of the Southeastern Part of New Mexico and Geologic Map of New Mexico respectively.

The New Mexico Geologic Society's 15th Field Conference Guidebook of the Ruidoso Country contains a wealth of material concerning the geology of the region. The first detailed geologic map and study covering the Jicarilla District was undertaken by George Ryberg as an unpublished Masters thesis done at the University of New Mexico in Albuquerque. Ryberg collaborated with Kenneth Segerstrom on "Geology and Placer-Gold Deposits of the Jicarilla Mountains, Lincoln County, New Mexico." This was published as U.S.G.S. Bulletin 1308 with text and a geologic map with cross-sections. Segerstrom and Ryberg (1974) has been a primary reference for this study and encouraged the management of the Great Southwest Minerals & Mining Company to prospect the Jicarilla District gold placers.

The presence of recoverable gold in the Jicarilla District is questionable and based on little detailed study. Although a fair amount of work has been done on the regional and local geology, the economic aspects of gold deposits in the district have been largely ignored. Reports of gold placer locations and concentrations from untrained and biased observers have been accepted and gained credence by repetition in the available literature. Careful exploration is necessary to displace myths and properly evaluate the true value of any property. Numerous small operations in the Jicarilla District seem ready to start production but hold back even with the high gold prices experienced from 1979 to the present. No company attempting gold recovery operations in the district has stayed in operation very long for any number of reasons.

Geography

The dominant topographic feature of the area is the Jicarilla Mountains which lie several miles to the east and south of the study area and have been extensively weathered. The topographic highs are Monument Peak (7,818' Ancho Peak (7,825'), Jicarilla Peak (7,688'), and Jacks Peak (7,553'). These peaks are interconnected by a series of saddles that are on average a thousand feet lower in elevation. The Jicarilla Mountains have an overall relief of approximately 2,000 feet and form the drainage divide separating the Pecos Slope from the northern end of the Tularosa Basin to the south and west (Ryberg 1968, p. 3). The Jicarilla Mountains trend north-south and are regarded as part of the Mescalero Arch (Kelley and Thompson 1964, p. 111

The lease areas are part of the intermontane basin fill that extends to the west of the Jicarilla Mountains. As defined by Gile, et al. (1981, p. 2 the S13 lease can be termed an upper piedmont slope and the S3 lease as a middle piedmont slope.

All drainage is ephemeral and the area has little or no groundwater flow. The climate is semi-arid with an average yearly precipitation that varies from 10 to 20 inches (Ryberg 1968, p. 5), and generally increases with altitude. July is the beginning of the rainy season which usually runs through to September. Afternoon thunderstorms of varying intensity can build up very quickly; pea-size hail occurred in mid-July during drilling on the S3 lease. Roads quickly become impassable if precipitation continues for any length of time.

Temperatures can exceed 100°F during the summer and often drop below 0°F during winter months. On the average temperatures are mild during the day becoming cooler at night.

Lower elevations, like S3, are characterized by various cacti, yucca, juniper, piñon, and grasses. These grade toward the higher elevations, as in S13, where scrub vegetation declines in favor of oak and ponderosa pine. All sections show a great abundance of wildlife including herds of deer and antelope, wild turkeys, rabbits, hawks, vultures, mice, squirrels, and many other species. Human habitation is sparse but appears to be on the increase as more homes and cabins are built. Local ranchers use the area as grazing land for cattle which coexist with wild herd animals.

Mining History

Smith and Dominian (1904, p. 799) state that Spanish miners worked the Jicarilla placers in the 1700'^{s} but fail to document their source. As a result of the Mexican-American War of 1846-1848 and the Treaty of Guadalupe Hidalgo (1848) the United States of America acquired New Mexico as a territory (Blum, et al. 1981, p. 287). The first documented reports of gold placer mining in the Jicarilla District date back to the 1850'^{s} (Jones 1904, p. 177). The construction of the Southern Pacific railroad through central New Mexico from 1879 to 1882 opened up the territory and encouraged mining operations. An attempt to locate the lode source rocks in the district was made in the 1880'^{s} with continued prospecting for gold placers (Ryberg 1968, p. 42).

In 1903 the American Placer Company operated a dredge west of Jicarilla village but the attempt failed (Jones 1904, p. 177). The Wisconsin Milling and Smelting Company built a mill capable of processing 50 short tons of ore per day in 1905-1906 (Lindgren, et al. 1910, p. 184). An insignificant amount of ore was processed before ending operations. The majority of ore processed in the district was done by individuals and any recovered gold was sold in small lots to merchants in Ancho, Jicarilla, and Carrizozo (U.S. Bur. of Mines, Minerals Yearbook 1934, p. 231 and 1936, p. 318 and Segerstrom and Ryberg 1974, p. 17).

From 1904 to World War I, prospecting was sporadic and total reported production was low, (see Table I). Lindgren, et al. (1910, p. 183), commented that "...the production from lodes and placers combined has been trifling..." for the Jicarilla District. Production remained low through to the Great Depression and estimated total placer production to 1931 was placed at $90,000 by Lasky and Wootton (1933, p. 77).

In an unpublished report written by Lester Millhouse (1975, p. 1) "...properties were developed primarily from the years 1922 to 1939 by numerous small high grade placer mine[s]". Specifically he is speaking of Warner Gulch and Ancho Gulch in the Jicarilla District. During the years of the Depression approximately 300 miners and some of their families were able to work the gold placers for a living (Segerstrom and Ryberg 1974, p. 17).

The main source of gold production was from the placers derived from the drainage off the central Jicarilla intrusive. The most productive placers have been in Rico Gulch, Ancho Gulch, and Warner Gulch (Ryberg 1968, p. 43). Wells and Wootton (1932, p. 13), valued total production from placers at that time to be around $145,000. Griswold (1959, p. 77)

Table I. Gold and Iron Production for the Jicarilla District, New Mexico, adapted from U.S. Geol. Survey (Mineral Resources of the U.S., 1905 and following), U.S. Bur. of Mines (Mineral Resources of the U.S., 1924 and following), U.S. Bur. of Mines (Minerals Yearbook, 1932 and following), and Kelley (1949).

Year	placer Au, fine oz.	number of operations	value in[1] dollars	lode Au, fine oz.	Fe production in long tons
1905[2]	small amts.	unknown	unknown	small amts.	....
1906	....	....	....	....	....
1907	small amts.	unknown	unknown	....	....
1908	816.00	several	16,320	....	....
1909	472.00	several	9,440	small amts.	....
1910	70.00	several	1,400	....	....
1911	78.80	several	1,629	....	....
1912	50.40	several	1,008	....	....
1913	51.35	several	1,027	....	....
1914	45.40	several	908	....	....
1915	65.40	several	1,308	....	....
1916	32.55	several	651	....	....
1917	small amts.	unknown	unknown	....	....
1918	....	....	....	....	493[3]
1919	....	....	....	....	597
1920	....	....	....	....	1,952
1921	....	....	....	....	248
1923	small amts.	unknown	unknown	....	....
[1924 to 1930, No Reported Production]					
1931	20.27	several	405	....	....
1932	128.24	several	2,565	....	....
1933-[4]	236.02	68	8,260	82.62[5]	....
1934	327.81	84	11,473	....	....
1935	309.09	63	10,818	....	....
1936	289.40	54	10,129	....	....
1937	184.20	47	6,477	....	....
1938	162.20	45	5,677	....	....
1939	203.00	55	7,105	....	....
1940	178.00	54	6,230	....	....
1941	178.00	19	6,230	....	....
1942	36.00	8	1,260	....	1,221[6]
1943	....	....	....	....	3,238
1944	....	....	....	....	....
1945	....	....	....	....	....
1946	1.00	1	35	....	....
1947	....	....	....	....	....
1948	1.33	1	47	....	....
[1949 to 1966, No Reported Production]					
1967	7.00	1	245	....	
1968	30.00	2	1,178	....	
[1969 to 1983, No Reported Production]					

Table I. (Continued)

(····, None Reported)

[1] As calculated from average yearly gold values.

[2] The U.S. Geol. Survey volumes prior to 1905 list only total gold production per state or territory.

[3] "...seemingly under the impetus of World War I, [iron] mining began in the Jicarilla District in 1918." (Kelley 1949, p. 15).

[4] In 1933 gold prices increased from $20 to $35 per oz.

[5] Gold value in dollars was calculated to be $2,892, 143 oz. of silver were also recovered. This represents the production of two lode mines.

[6] Increased demand for steel due to World War II, (Kelley 1949).

stated, "...the total value of gold production from the district is not known; a few hundred thousand dollars is a reasonable estimate." These amounts are much greater than those listed in Table I because the majority of the recovered gold was sold in small lots making accurate record taking nearly impossible.

Reported lode production was confined to the Lucky Strike Mine and another mine near the head of Ancho Gulch. Approximately 130 short tons of ore were processed yielding 82 ounces of gold in 1933, (U.S. Bur. of Mines, Minerals Yearbook 1934, p. 228 & 231 and Anderson 1957, p. 91).

The U.S. Bureau of Mines (Minerals Yearbook 1936, p. 318) reported that a power shovel was moved to the Ancho placer in 1935 but operated for only a short time. The 1930's and early 1940's were the times when the surface gravels were extensively churned by small scale rocking, sluicing, and drift mining. By 1943 gold mining in the Jicarilla District had ceased by government decree in favor of iron ore production associated with the war effort (Kelley 1949, p. 158 and Millhouse 1975, p. 1).

From 1943 to 1966 there is no reported gold production for the district except for minute amounts of placer gold listed for 1946 and 1948 (U.S. Bur. of Mines, Minerals Yearbook 1946, p. 1505 and 1948, p. 1574). The U.S. Bureau of Mines (Minerals Yearbook 1966, Vol. III, p. 554) reported exploration in the district for 1966. Production of several ounces was attributed to Lloyd Hoskins in 1967 and 30 ounces of gold were reported by the Jicarilla Mill and Mining Company in 1968, (U.S. Bur. of Mines, Minerals Yearbook 1967, Vol. III, p. 566 and 1968, Vol. III, p. 524). From 1968 to 1983 there was no reported production from the Jicarilla District. Many people have looked the district over, several pilot mills have been built and then soon dismantled. The heyday of the Jicarilla placers was from 1931 to 1942 when the near surface gravels were thoroughly worked. Any resurgence of gold production will depend on the discovery of new placers and/or lode deposits. Efforts have been made by E.M. Lynch, Lester Millhouse, Dr. G.U. Green, K. Segerstrom, G.E. Ryberg and others to identify and recover gold from the Jicarilla placers with very limited success. While the lack of water has often been cited in the literature as hindering operations some local water is available. The real problem would seem to be defining tangible gold reserves. If the deposits are economic, items such as water, labor, and machinery become engineering problems which can be solved.

Iron ore has been mined for brief periods of time in the Jicarilla District, (see Table I). The dominant mines were Jack No. 1 from 1918 to 1921, and the Magnetite and Jack No. 3 from 1942 to 1943. These mines produced both magnetite and hematite ores (Kelley 1949, p. 158-168).

Other deposits mined in the district include gypsum and shale. In 1902 the Rock Island Cement and Plaster Company built a plaster plant which operated for a few years (Jones 1904, p. 243). From 1910 to 1920 shale was mined to supply a brick plant in Ancho (Ryberg 1968, p. 43).

STRATIGRAPHY

General

Several hundred feet of sedimentary rocks and sediments ranging in age from Permian to Holocene are present in the Jicarilla District. The oldest strata exposed in and around the study area are from the Permian San Andres Formation. An unconformity separates the San Andres Formation from the Artesia Group which is also Permian in age. A disconformity separates the Paleozoic from the Triassic Santa Rosa Sandstone and the overlying Chinle Formation which together technically should be called the Dockum Formation in this area. The Chinle Formation is unconformably overlain by the Cretaceous Dakota Sandstone.

Tertiary sediments possibly equivalent to the upper Miocene and lower Pliocene Ogallala Formation and Holocene colluvium, fanglomerate, and alluvium mask many of the Paleozoic and Mesozoic rocks in the district.

Permian Rocks

San Andres Formation: The San Andres Formation was described by Lee and Girty (1909, p. 12-13), from an exposed section near Rhodes Pass in the northern San Andres Mountains, Socorro County, New Mexico. Needham and Bates (1943, p. 1664-1666), remeasured the San Andres and established Rhodes Canyon as the type locality. Their paper describes Permian type sections of central New Mexico in great detail.

In the Jicarilla area Ryberg (1968, p. 9) reports that the San Andres consists of a lower sandstone member, a middle limestone member, and an upper gypsum member. The contact with the sandstone member was not exposed in the study area. Most of the exposed San Andres Formation consists of weathered limestone with some gypsum. The limestone member is a light to dark grey, dominantly homogeneous and weathered limestone. It varies from thin- to thick-bedded and interbeds with gypsum near the top of the member.

The weathered limestone is typically light grey, fractured with white to tan calcite fillings and coatings. Differential weathering has locally produced vuggy textures and a rough craggy surface. This member crops out in a large part of the S13 lease and along the south edge of the S3 lease.

Artesia Group: The Artesia Group unconformably overlies the San Andres Formation and consists of beds of poorly resistant sandstone, siltstone and shale. The sandstone is orange red to red and light brown, fine- to coarse-grained, calcareous, and friable. The siltstone and shale beds are white to light brown, orange red and grey and are also calcareous. Small amounts of gypsum are present. The Artesia Group forms valleys with few outcrops in the Jicarilla District. The nearest exposures are to the northwest and west of the S3 lease.

The Artesia Group has been refered to as the Bernal Formation by Bachman (1953), as the Chalk Bluff Formation by Allen and Kottlowski (1958, p. 18) and Griswold (1959, p. 11), as the White Horse Group by Bates (1942, p. 42) and as the upper clastic member of the San Andres Formation by Wilpolt and Wanek (1951). Tait, et al. (1962, p. 504-517) investigated the problem and proposed the term Artesia Group. This would apply to all the beds above the San Andres Formation and below the Ochoan Series, (Ryberg 1968, p. 12). The subsurface section from Humble Oil and Refining Companys' Federal Bogle Well No. 1 was designated the reference section for New Mexico and west Texas (Tait, et al. 1962, p. 508 & 511). Ryberg (1968), Kelley (1971) and Segerstrom and Ryberg (1974) contain complete explanations of how the Artesia Group was named.

Triassic Rocks

Santa Rosa Sandstone: The Santa Rosa Sandstone unconformably overlies the Artesia Group. It consists mainly of red to brown, medium- to coarse-grained calcareous sandstone which locally is white to tan. The sandstone is cross-bedded in part and locally interbedded with red to brown calcareous shale and siltstone.

N.H. Darton (1922) named the Santa Rosa in 1919, however the U.S. Geological Survey Bulletin in which it appears was not published until 1922. The type locality is described as being, "...prominent in mesas in Guadalupe County and along the Pecos River at Santa Rosa...", (Darton 1922, p. 183).

The Santa Rosa Sandstone is up to 170 feet thick in the Jicarilla area (Ryberg 1968, p. 14). There are outcrops to the west of the S3 lease near Wilson Ranch. The contact between the Santa Rosa Sandstone and the Chinle Formation is conformable and gradational. Locally the Santa Rosa Sandstone is overlain by the Dakota Sandstone due to gravity gliding (Buddin 1963, p. 203-208) which forms an angular unconformity.

Chinle Formation: The Chinle Formation consists of sandy siltstones, mudstones, and shales that are a distinctive purple red to brown locally grading to grey and light green. The mudstones are soft, friable, thin-bedded and interbedded with thin lenses of sandstone and pebble conglomerate

The Chinle Formation was named and described by Gregory (1916, p. 79) with its type locality in the Chinle Valley of northeastern Arizona. Near the Jicarilla District the poorly resistant Chinle Formation is a valley former and Ryberg (1968, p. 15) has estimated that 200 feet of Chinle Formation is present. The formation crops out to the northwest of the S3 lease in T4S, R12E sections 33 and 34. At the top of the formation there is a marked angular unconformity between the Chinle and the Dakota Sandstone (Smith 1964, p. 94) and Cenozoic sediments (Segerstrom and Ryberg 1974, p. 8

The Santa Rosa Sandstone and the Chinle Formation are collectively called the Dockum Formation by Kottlowski (1963, p. 71), and the Dockum Group by Darton (1922, p. 183) and Lochman-Balk (1964, p. 58-59). The U.S.

Geological Survey has designated the Rio Grande as the arbitrary boundary between the Chinle Formation/Santa Rosa Sandstone and the Dockum Formation (Dr. J. MacMillian, New Mexico Institute of Mining and Technology, personal communication). I consider the local Triassic rocks in the Jicarilla area to be the Chinle Formation and the Santa Rosa Sandstone. This represents a time of continuous sedimentation during the late Triassic.

Cretaceous Rocks

Dakota Sandstone: The highly resistant Dakota Sandstone in the Jicarill area is a tan to light brown quartzose sandstone. It is medium- to coarse-grained and locally interbedded with light brown to grey siltstone and shale Meek and Hayden (1862, p. 419-420) first described the Dakota Sandstone and list the type locality as the "...hills back of the town of Dakota, Dakota County, Nebraska."

The sandstone forms a cap rock over the less resistant Triassic beds. The Dakota Sandstone crops out to the northwest of the S3 lease where it overlies with angular unconformity the Santa Rosa Sandstone and the Chinle Formation. About 1½ miles east of Ancho a partial section 140 feet thick was measured by Ryberg (1968, p. 15).

Tertiary Rocks

Ogallala (?) Formation: The Ogallala (?) Formation of late Miocene and early Pliocene age is a fanglomerate composed of moderately lithified alluvium ranging in size from clay to coarse-gravel. The predominantly unsorted and unstratified sediments are grey to yellow brown and white. These deposits vary but generally thicken away from the Jicarilla Mountains and can attain thicknesses of 50 to 100 feet. The Ogallala Formation is not differentiated from younger colluvial sediments that mantle hillslopes in the district which are poorly sorted slope debris and local stream gravels. In many ways the term colluvium applies as well as fanglomerate in describing these sediments.

In places a red brown soil has developed up to a foot thick. Both the fanglomerates and soils have large amounts of calcium carbonate. The fanglomerates consist of various sized clasts combined with a moderately lithified matrix of sand, silt, clay and heavy minerals. The clasts are predominantly monzonite lithic fragments in various stages of decomposition. Segerstrom and Ryberg (1968, p. 9) estimated the monzonite and allied intrusives accounted for 80% to 90% of the clasts and a similiar percentage of the matrix. The remaining clasts are chiefly limestone with some magnetite and sandstone fragments of various sizes.

The matrix consists of calcium carbonate, intrusive derived sand, silt, clay and a significant heavy mineral component. By far the majority of the heavy minerals are magnetite with lesser amounts of ilmenite and specular hematite. The magnetite varies in size from very fine-grained sand to cobbl sized float. Other heavy minerals include epidote, zircon, pyrite, apatite, hornblende, sphene, and gold. Gold placer grains are usually 10 microns or less in diameter (Segerstrom and Ryberg 1974, p. 9). Sample evaluation put the percentage of heavy minerals at 2% to 5% of the total matrix in the study area. The organic content of this formation is almost nil.

The Ogallala Formation was first named by Darton (1898, p. 741-742). The type section was established at the Feldt Ranch near Ogallala, Keith County, Nebraska by C.J. Hesse (1935, p. 79-111). The Ogallala Formation has been described in great detail by Bretz and Horberg (1949). They estimated the formation to be Pliocene in age and put forth the idea that the Ogallala extended into central New Mexico including the Jicarilla area. This has been supported by Budding (1963, p. 204) and Segerstrom and Ryberg (1974, p. 9) and more recent studies by Frye, et al. (1982). Current stratigraphic and paleontologic work in Texas and eastern New Mexico reviewed by Hawley (1984) indicates that the Ogallala Formation is late Miocene to early Pliocene in age (approximately 12 to 4 m.y. B.P.). My own field work also supports this view.

The Tertiary sediments overlie Permian and Mesozoic bedrock formations with an unconformity representing a significant interval of time. The Ogallala deposits roughly parallel the monzonite peaks and saddles to the east and south. The S3 lease is dominated by these sediments with thickness greater than 70 feet but averaging 50 feet. The Ogallala is locally auriferous and along with some Quaternary alluvial material have been the primary gold placer of the Jicarilla District.

Quaternary Deposits

Quaternary deposits in the Jicarilla area consist of alluvium, colluviu (talus and slope debris) as well as some soils. Post-Ogallala deposits of possible late Pliocene age are also included in this unit. Parts of the Ogallala Formation have been reworked along with other exposed formations to produce these sediments as valley fill and slope debris. Colluvium composed of various sized igneous clasts and weathering products has been deposited at the base of the monzonite peaks.

Lowering of the regional base level has caused down cutting into the Ogallala Formation and exposed older bedrock. Alluvium from reworked Ogallala sediments contains some second-cycle gold placers which have been extensively worked by miners.

Quaternary deposits are derived primarily from exposed monzonites and the Ogallala Formation. Other formations have contributed minor amounts of sediments. Quaternary deposits are typically thin but have extensive lateral expression in the Jicarilla area.

STRUCTURAL GEOLOGY

Regional Structure

The Mescalero Arch is the dominant structural feature of western Lincoln County, (see Figure 3). It is bordered on the west by the Claunch Sag and on the east by the Pecos Slope and roughly follows the buried Permian Pedernal topography (Kelley and Thompson 1964, p. 110). The eastern extension of the arch shows a fairly uniform dip of $\frac{1}{2}$° towards the Pecos Slope. The western side has a more variable and generally steeper dip where it either descends or is faulted into the Claunch Sag (Kelley and Thompson 1964, p. 111-113). The Claunch Sag is a southward extension of the Estancia Basin that plunges to the south at an average of 50 feet per mile into the Sierra Blanca Basin (Kelley and Thompson 1964, p. 111).

The Jicarilla Mountains and intrusives lie approximately halfway along the Lincoln County porphyry belt. This is a north-south arcuate zone that extends from Corona to Ruidoso with intrusive centers spaced along the complexly faulted Mescalero Arch (Segerstrom and Ryberg 1974, p. 14). The Capitan intrusive is the exception, trending along a roughly east-west axis where it offsets the southern crest of the Mescalero Arch approximately 15 miles eastward. This area is also the intersection of the Mescalero Arch and another major structural feature the Capitan Lineament. The Capitan Lineament is a roughly east-west zone of intrusives extending from west Texas to western New Mexico. The lineament is thought to represent a major hinge zone which could also be a fracture zone (Kelley and Thompson 1964, p. 120). The Lincoln County porphyry belt has been described as being, "...perhaps the greatest concentration of Tertiary intrusive centers in New Mexico." (Kelley and Thompson 1964, p. 114). At least ten Tertiary stocks and laccoliths were intruded in at least three separate stages of igneous activity (Schnake 1977, p. 4).

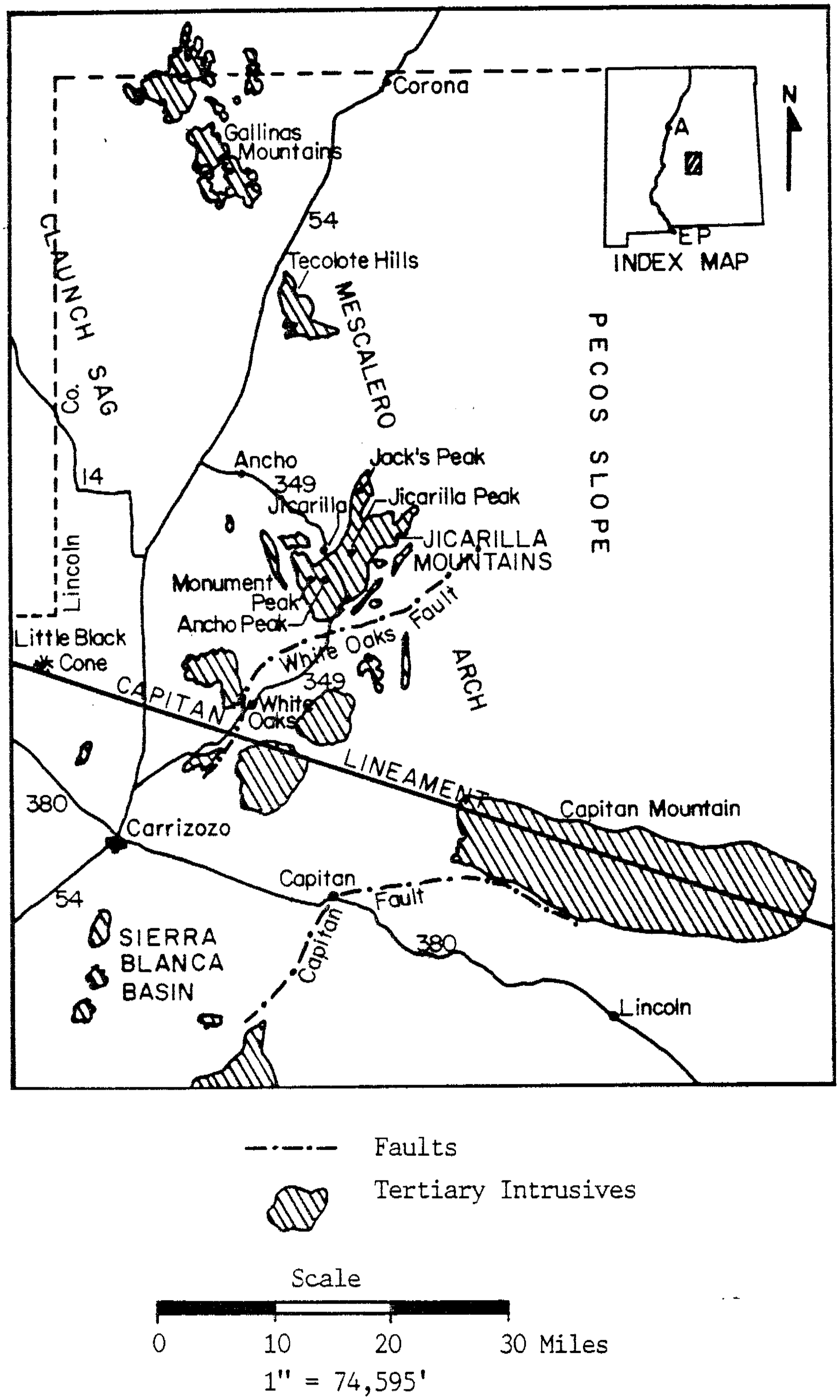


Figure 3. Map of central New Mexico illustrating regional structure and Tertiary intrusives, adapted from Kelley and Thompson (1964).

Major faults in the region are the White Oaks fault and the Capitan fault; both trend approximately east-west. The White Oaks fault forms the southern boundary of the Jicarilla Mountains-Lone Mountain cluster of intrusives. The fault is downthrown on the south with a maximum displacemen of several hundred feet reported near White Oaks (Kelley and Thompson 1964, p. 115). This movement is attributed to the emplacement of the Jicarilla-Lone Mountain intrusives and the subsidence of the Sierra Blanca Basin to the south. The Capitan fault follows the south edge of the Capitan intrusiv and is downthrown on the south. Movement along this fault is probably due to the emplacement of the Capitan intrusive and subsidence of the Sierra Blanca Basin (Ryberg 1968, p. 24).

Local Structure

Structurally and topographically the area is dominated by three massifs Monument Peak-Ancho Peak, Jicarilla Peak, and Jacks Peak (Segerstrom and Ryberg 1974, p. 14). These massifs bound the study area on the south and east respectively and represent a combination laccolith and stock that has been partially unroofed, (see Figure 3). This has exposed approximately 25 square miles of intermediate-monzonitic rock that make up the Jicarilla Mountains (Kelley and Thompson 1964, p. 114). The emplacement of the intrusives has generally arched surrounding pre-Tertiary formations upward.

The main body of the intrusive underlies the Monument Peak-Ancho Peak massif and is described as a laccolith approximately 25,000 feet across and 2,500 feet thick with accompanying sills varying from 2 to 500 feet thick (Segerstrom and Ryberg 1974, p. 14). The intrusives are usually concordant with the San Andres Formation except for a few dikes. Segerstrom and Ryberg (1974, p. 14) felt that exposures along the flanks of the Monument Peak-Ancho Peak massif indicated that approximately 2,500 feet of domed sills and interbedded sedimentary rocks had been eroded. Unroofing has left the center of the massif relatively flat while the sides dip steeply at 30° to 45°. Ryberg (1968) considers the Monument Peak-Ancho Peak massif and the Jicarilla Peak massif as a single body called the Jicarilla Pluton. He regards the northern part of the pluton as a laccolith with the central and southern area being a stock. This view is supported by field observati and several lines of reasoning summarized in Ryberg (1968, p. 31-32).

The Jacks Peak massif is a narrow and more elongate pluton. The contact with the San Andres Formation is obscured by colluvium but dips steeply away from the intrusive where exposed (Ryberg 1968, p. 30). The emplacement of the pluton has domed and altered the surrounding sedimentary rocks much more than in the Jicarilla Pluton. Segerstrom and Ryberg (1974, p. 14) were undecided whether to call the Jicarilla Peak and Jacks Peak massifs, stocks or laccoliths but did note doming and folded sills along the flanks of the intrusives.

Emplacement of the various intrusives has caused most of the folding observed in the area. The combination of sills and plutons has produced numerous domes and synclines in the surrounding San Andres Formation and other formations (Ryberg 1968, p. 34). Erosion has unroofed the intrusives and exposed arched and often altered sediments dipping away. Crowding by the intrusives has resulted in synclinal structures found on and near dome edges and as sedimentary wedges between the intrusives. Doubly plunging anticlines are present in the Jicarilla area (Budding 1964, p. 86).

Faulting is minor in the Jicarilla Mountains and due to structural adjustments after emplacement of the Tertiary intrusives. Major movement has occurred along the previously mentioned White Oaks fault and a fault east of the Jacks Peak massif. This normal fault can be attributed to the emplacement of the Jacks Peak intrusive and was estimated to have around 500 feet of displacement (Ryberg 1968, p. 33). Four minor faults border the Monument Peak-Ancho Peak massif on the north, south and southwest. The downthrown block of each is away from the intrusive with displacements varying from 100 feet to 370 feet (Segerstrom and Ryberg 1974, p. 14). Other minor faults consist mainly of high angle normal faults with less than 50 feet of displacement some of which have been intruded by mafic dikes (Ryberg 1968, p. 33).

In the Jicarilla Mountains the joints and dikes dip steeply and generally trend northeast although in the Jicarilla Peak and Jacks Peak area some trend to the north (Segerstrom and Ryberg 1974, p. 15). Near Ancho peak lode bearing veins generally have a northwest strike. Another set of joints that are subhorizontal were noted by Segerstrom and Ryberg (1974, p. 1 They interpreted the sequence of formation for the fractures as northwest, northeast, and subhorizontal on the basis of crosscutting relationships.

Anomalous structural phenomena in the form of gravity gliding have been reported in the area by Budding (1963 & 1964). The emplacement of Tertiary intrusives and the subsequent local doming of sedimentary rocks was accompanied by extensive uplift in the area (Budding 1963, p. 203). Erosional processes coupled with differences in the resistance of pre-Tertiary sedimentary rocks has led to the gravity gliding of large blocks of resistant Dakota Sandstone. Two blocks have moved downslope to the erosional surface of the Triassic Chinle Formation in the northern half of sections 3 and 4, T5S, R12E next to the S3 lease area (Segerstrom and Ryberg 1974, Plate I). A pre-late Miocene age is suggested for the gliding due to the presence of Ogallala gravel stringers partially covering blocks of Dakota Sandstone (Budding 1963, p. 206 and Frye, et al. 1982, p. 6). The gravity gliding structures in Ryberg's thesis area were estimated as being Oligocene or younger (Ryberg 1968, p. 40).

IGNEOUS ROCKS

General

Most of the leased land and nearby areas are underlain by intrusives which crop out locally. There are no extrusive rocks and the intrusives appear to be hypabyssal from textural and stratigraphic considerations. Segerstrom and Ryberg (1974, p. 10-11) divided the igneous rocks into two general categories of intermediate rocks varying in composition from diorite to monzonite to syenite, and mafic dikes composed of basalt. Ryberg (1968, p. 17) described the dominant intermediate rocks as latites and noted some areas of diorite and andesite along with scattered basalt dikes.

Intermediate Rocks

The typical intermediate intrusive found around and in the study area can be identified as monzonite. The following descriptions are from hand samples gathered from S13 and float from S3.

The monzonite varies from aphanitic to porphyritic, phenocrysts can comprise up to 50% of the rock or greater. Color ranges from light grey to buff with cream colored phenocrysts of plagioclase and lighter colored potassium feldspar in the groundmass. Other phenocrysts of biotite, hornblende, magnetite and chlorite are present and vary from black to occasionally dark green. The feldspar phenocrysts are euhedral to subhedral with some crystals exhibiting Carlsbad twining. Trace accessory minerals include small amounts of crystalline apatite and zircon needles. A typical modal analysis of monzonite is presented in Table II.

In some samples the plagioclase and potassium feldspar exhibit mild to moderate sericitization and kaolinitization. Much of the hornblende has been altered to chlorite especially in the intrusive float in the colluvium. All the monzonite examined had varying amounts of magnetite present. This is consistent with the observations made in Ryberg (1968)

Table II. Typical Modal Analysis of Monzonite

Plagioclase	35-40 %
Potassium Feldspar	40-35
Hornblende	13
Biotite	8
Magnetite	2
Quartz	< 2
	100 %

and Segerstrom and Ryberg (1974). Magnetite is ubiquitous in the colluvium and has been derived from the intrusives. It varies in size from fine filings of approximately 0.15 mm to cobble sized < 250.00 mm.

Contact Metasomatism

Magnetite is most common in and near areas where the intermediate igneous rocks have intruded the San Andres limestone. Here pyrometasomatic processes have produced magnetite skarns and accessory calc-alkaline silicates. The main regional magnetite deposits are found along the Lincoln County porphyry belt with notable deposits occurring on the Lone Mountain intrusive (Spahr 1983, p. 97). Butler (1964) and Schnake (1977) deal with the subject in detail. Local magnetite concentrations are found to the east and upslope of the lease areas along with variable concentrations in the local colluvium and alluvium.

Vein Mineralization

Some vein mineralization was reported by Segerstrom and Ryberg (1974, p. 19) consisting of fractures in the intermediate intrusive masses that have been filled with pyrite, quartz, gold and accessory sulfides. The mineralized areas display weak to moderate sericitization and silicification. Some veins have been worked for their gold content but the Jicarilla District is better known for placer gold (Griswold 1959, p. 99).

Basic Rocks

Scattered mafic dikes have been reported by Ryberg (1968, p. 21) and Segerstrom and Ryberg (1974, p. 10) as cutting Tertiary intrusives and some sedimentary rocks, including the San Andres Formation, Artesia Group, Santa Rosa Sandstone and Chinle Formation. Ryberg (1968, p. 22) raises the question of a possible association between these mafic intrusions and the basalt flows of the Little Black Peak area to the west. The dikes near the study area are of limited extent and appear to have intruded along minor faults and fractures as a late stage igneous event.

HISTORICAL GEOLOGY

The early Paleozoic of central New Mexico was a time of repeated erosion and non-deposition for the sedimentary platform called the New Mexico-Texas Arch by Eardley (1962, pls. 3-5). The study area was part of a larger region repeatedly uplifted epeirogenically and reduced to low relief.

During the Mississippian Period the Pedernal Arch began to develop along a roughly north-south axis. Ryberg (1968, p. 36) cites fieldwork to the north and southwest of the Jicarilla area as evidence that the region was part of the Pedernal positive area during the Mississippian and Pennsylvanian Periods. The Pedernal Mountains had developed by late Pennsylvanian times and attained maximum relief by the Wolfcampian of the lower Permian. The terrestrial Abo Formation redbeds of Wolfcampian-Leonardian age confirm the rapid uplift of the Pedernal Mountains and subsequent withdrawal of the Pennsylvanian seas. The Pedernal Mountains are also refered to as the Pedernal ridge by Darton (1922, p. 202 & 1928a, p. 279), the Pedernal landmass by Thompson (1942, p. 12) and the Pedernal axis by Read and Wood (1947, p. 225). The mountains trended along a north-south axis and were contemporaneous with similiar uplifts in northern New Mexico and southern Colorado (Kelley and Thompson 1964, p. 116-117 and Kelley 1971, p. 55).

The erosion of the Pedernal Mountains reached a stage of mature or late-mature development (Kelley and Thompson 1964, p. 117), followed by subsidence and burial during the Leonardian age of the upper lower Permian. The deposition of the Yeso Formation effectively covered large portions of the Pedernal erosion surface with very little contamination of the Yeso sediments. Alternating transgressive and regressive Permian seas are suggested by the sequence of sandstone, siltstone, limestone, and gypsum of the Yeso Formation mapped by Rawson (1957). His study area was to the north in and around the Tecolote Hills intrusive, (see Figure 3).

There are no outcrops of pre-Yeso Formation rocks in the Jicarilla area. Exposures of Precambrian rocks do protrude through the Yeso Formation as resistant outcrops in the Gallinas Mountains and as monadnocks in other areas of the region. This supports the view that Yeso sediments buried the Pedernal topography.

Through the early Permian slow and somewhat irregular subsidence and deposition continued with the deposition of the San Andres Formation. In th Jicarilla area the San Andres Formation is a sequence from base to top of sandstone, limestone and gypsum which implies that limited transgression and regression of the sea occurred (Smith 1964, p. 98). In other parts of New Mexico the sandstone member is a separate formation known as the Glorieta Sandstone (Needham and Bates 1942, p. 1664 and Lochman-Balk 1964, p. 59).

After the deposition of the gypsum member of the San Andres Formation the region was uplifted and remained above sea level for a considerable period of time (Smith 1964, p. 98). A karst erosional surface developed on the San Andres limestone marking a disconformity between this formation and the Artesia Formation. The Artesia Formation has been identified as being early to late Permian in age (Segerstrom and Ryberg 1974, p. 6) and the result of fluviatile and lacustrine conditions (Smith 1964, p. 98). During late Permian times the region was probably a landscape of wide low plains (Kelley and Thompson 1964, p. 117).

After deposition of the Artesia Formation a period of non-deposition and erosion persisted until the late Triassic. The Santa Rosa Sandstone represents a broad apron of river gravels and sands in a savannah-like environment (Smith 1964, p. 98). The late Triassic Chinle Formation overlies the Santa Rosa Sandstone and represents a continuation of the open plain environment. The finer sediments are a reflection of a substantially reduced elevation in the source area.

Post-Chinle sediments probably continued to be deposited through the Triassic. Erosion took over sometime in the Jurassic and continued to the early Cretaceous removing all sediments above the Chinle Formation (Ryberg 1968, p. 37).

By the late Cretaceous the basal sands of the Dakota Sandstone had been deposited. Subsidence continued and accelerated as the Dakota Sandstone was followed by the marine Mancos Shale which crops out to the south of the Jicarilla area. At the end of the Cretaceous the seas again receded. The whole region was remarkably stable through the Laramide orogeny (Smith 1964, p. 99).

South of the Jicarilla Mountains post-Mancos Shale formations such as the fluviatile Mesaverde Group and Cub Mountain Formation crop out. These sediments may have been present at one time in the Jicarilla area but erosion has removed any traces of them.

The first Tertiary tectonic movements in the Jicarilla area were probably minor warping along the Mescalero Arch (Ryberg 1968, p. 38). The emplacement of the Lincoln County porphyry belt in the mid-Tertiary was essentially contemporaneous although there were probably several stages of intrusion. This is suggested by similiarities in texture, composition and tectonic setting for the major intrusive centers (Ryberg 1968, p. 39). Various epochs have been put forward for the event but late Eocene to Oligocene seems to be the general consensus (Kelley and Thompson 1964, p. 120, Ryberg 1968, p. 39, and Segerstrom and Ryberg 1974, p. 13). A K/Ar analysis of biotite extracted from the Jicarilla monzonite was performed by R.F. Martin, H.H. Mehnert and V. Merritt of the U.S. Geological Survey and gave an age of 37.3 ±1.5 m.y. (Segerstrom and Ryberg 1974, p. 13).

The intrusion of laccoliths, stocks and dikes domed overlying sediments and triggered structural readjustments in the form of folds and faults. By the Miocene further flexing of the Mescalero Arch led to extensive uplift and continued erosion in the Jicarilla area (Ryberg 1968, p. 40). This renewed erosion led to the gravity gliding structures noted earlier and the exposure of some monzonite intrusives and the San Andres limestone (Budding 1963, p. 206).

During the late Miocene and early Pliocene it is thought that Ogallala Formation gravels and locally derived gold placers were deposited in the Jicarilla area when the local base level was higher than today (Segerstrom and Ryberg 1974, p. 15). Continued erosion after further uplift of the Jicarilla Mountains has enhanced the unroofing of Tertiary intrusives and removed or reworked large amounts of the consolidated Ogallala sediments. This has left only isolated stringers of Ogallala gravels scattered about the area. At present the processes of erosion continue to work in the Jicarilla area.

It should be noted that the Jicarilla area has been relatively stable over a long period of time showing a profound absence of orogenic movement. The emplacement of Tertiary intrusives has caused dilation of the crust as opposed to crumpling or shortening (Smith 1964, p. 99). The predominance of alkaline intrusives is another indication of a stable, non-orogenic block.

GEOMORPHOLOGY

Quaternary History And Landforms

By the end of the Pliocene continued uplift of the Jicarilla Mountains had changed the geomorphic setting from deposition to erosion. Superposed stream channels cut deep into the Ogallala fanglomerates through the Pleistocene. Ancho Gulch which previously has flowed to the north during Ogallala times began to flow to the west eroding the broad apron of fanglomerates and cutting into underlying Mesozoic and Permian formations (Segerstrom and Ryberg 1974, p. 15). Erosion of the Ogallala Formation has been so thorough that only scattered patches remain in the Jicarilla area.

The rate and progress of the erosional processes are dependent on, and change with, the climate. Pleistocene climatic patterns prior to the last full glacial interval are poorly documented except that it is generally recognized that the regional climate was arid to semi-arid throughout the Quaternary except in the highest mountain areas (Hawley, et al. 1976, p. 241 and Gile, et al. 1981, p. 19). The last full glacial event about 23,000 to 12,500 years B.P. was a time of lower temperatures and greater precipitation in the southern Basin and Range Province (Van Devender, et al. 1984, p. 344). During the cool-moist climatic interval glaciers were present along the northern flanks of Sierra Blanca Peak (Richmond 1963, p. 121), and numerous pluvial lakes formed in closed basins near present day Estancia and White Sands (Hawley, et al. 1976, p. 236). Recent work by Blagbrough (1984, p. 65) on former rock glaciers on the flanks of the Capitan Mountains indicates that the level of discontinuous permafrost and mean annual temperatures near freezing was approximately 8,000 feet during the last full glacial. During these times of enhanced stream erosion in the Jicarilla area Ancho Gulch and Rico Gulch were cut to bedrock in places up to 20 feet or greater below present sediment levels (Segerstrom and Ryberg 1974, p. 15). It is probable that all through the Pleistocene cool-moist glacial intervals with more winter precipitation alternated with short hot-dry interglacial intervals characterized by relatively high summer rain fall (Gile, et al. 1981, p. 19).

The erosion of interlayered Tertiary sills and pre-Tertiary sedimentary formations has exposed the core of the Jicarilla Mountains which is in a mature stage of development (Segerstrom and Ryberg 1974, p. 15). Weathering, stream action and mass wasting have removed an estimated 2,000 to 3,000 feet of rock of which approximately 10% still remains as local fanglomerate and colluvial deposits (Segerstrom and Ryberg 1974, p. 16). They further state that removal of the lighter components out of the area has left the remaining sediments with up to ten times the normal amounts of heavier fractions. The capacity of geomorphic processes to effectively sort large amounts of sediments and concentrate heavier substances like magnetite and gold over time are considerable. Denudation of the Jicarilla Mountains has continued to the present at decreasing rates of erosion.

By the Holocene (approximately 8,000 to 10,000 years B.P.), the local climate was hot-dry, with periods of intense summer rainstorms much like today (Segerstrom and Ryberg 1974, p. 3, Gile, et al. 1981, p. 20, and Van Devender, et al. 1984, p. 344 & 355). Alluviation was outpacing erosion thus filling stream channels and burying parts of the old erosion surface. The alluvium and colluvium consists of monzonite fragments, reworked Ogallala sediments and minor amounts of older sedimentary rocks. Continued reworking of older placers has further concentrated the heavy minerals as Holocene alluvial deposits in some places.

Physiographic Provinces

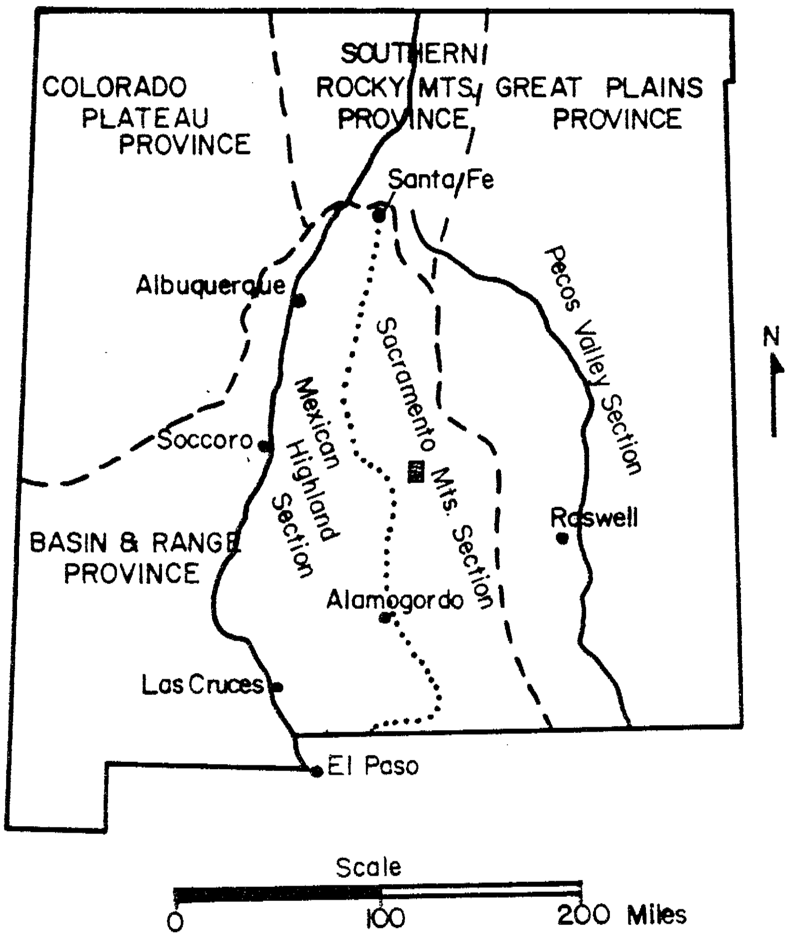
The Jicarilla area can be described as being in the Sacramento Mountains section of the Basin and Range Province based on the Fenneman (1931) physiographic classification system (Fenneman 1931, p. 393-395, Hunt 1974, p. 504-505, and Gile, et al. 1981, p. 16 & 18). The Sacramento section lies to the east of the Mexican Highland section and borders the Pecos Valley section of the Great Plains Province, (see Figure 4). Fenneman (1931, p. 393-395) and Gile, et al. (1981, p. 18) reported that the Sacramento Mountains section includes mature block mountains of gently tilted strata with block plateaus and bolsons as accompanying landforms.

The present study area landscape is on the piedmont slope of an intermontane basin (Gile, et al. 1981, p. 26-28) or a bolson (Tolman 1909, p. 139-141) depending on the classification system you chose (see Figure 5). The Jicarilla Mountains are the mountain uplands and sediment source for the piedmont slope or bajada that extends roughly to the west. The S13 and S3 leases lie on the upper and middle piedmont slopes respectively. The basin-floor component of the bolson landscape is located southwest of the study area in the northern Tularosa Basin near Carrizozo (see Figure 3).

For simplicity the classification system of Gile, et al. (1981) will be used for the rest of this report. It should be noted that the presence of bolsons in New Mexico was the source of considerable controversy in the early 1900's before the widespread drilling of water wells revealed the grea depth of sediment surrounding the topographic highs (Tolman 1909, p. 139-140

Weathering and mass wasting along with cloudburst flows of water and wind has produced the broad blanket of fanglomerates and colluviums that make up the piedmont slope in the Jicarilla area. The dominant constituents of the sediment are monzonite fragments, 75% to 80% by volume with smaller and roughly equal proportions of limestone and sandstone. Particle sizes range from clay and silt to boulder sized with the smaller sized particles dominating the mix of poorly sorted sediments.

Field data collected from bore holes indicates a very deep or possibly non-existant water table in the study area. This is not to say that the



▨	Approximate location of Figure 2.
----	Province boundaries
••••	Section boundaries

Figure 4. Map of New Mexico illustrating physiographic provinces and sections, adapted from Hunt (1974).

INTERMONTANE BASIN - BOLSON

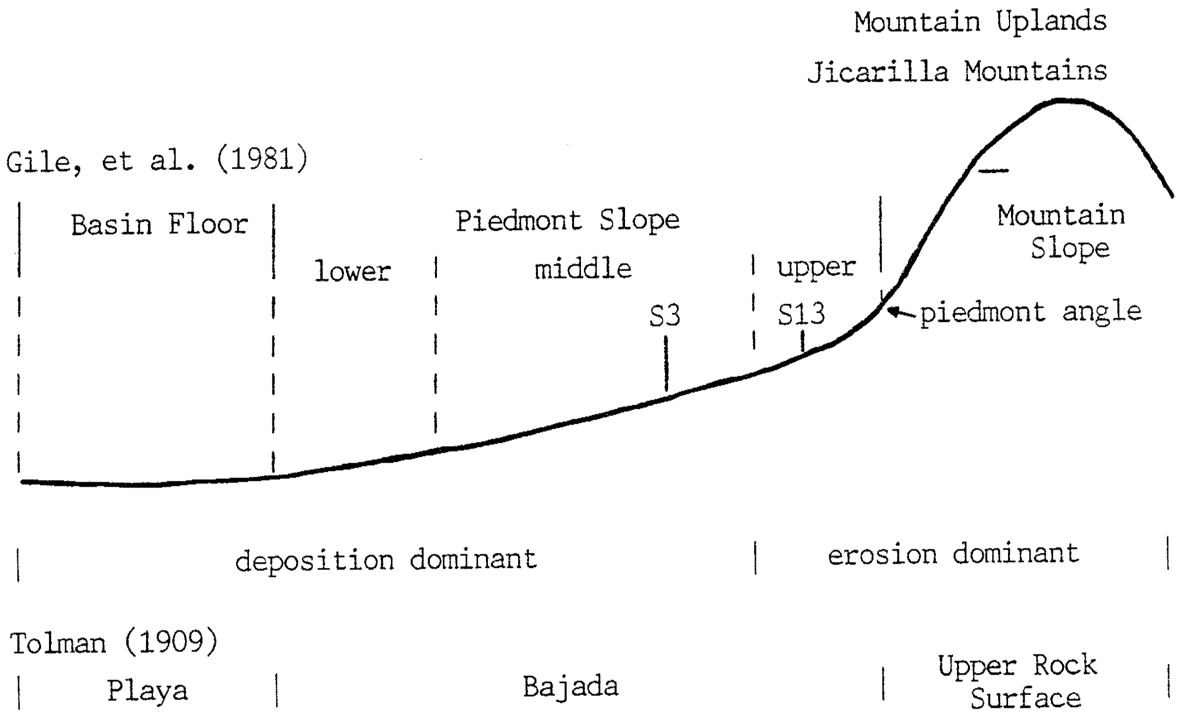


Figure 5. Intermontane Basin - Bolson cross section, adapted from Gile, et al. (1981) and Tolman (1909).

local sediment is dry but that it is not saturated or capable of producing water. There is some moisture available presumably held by the presence of large amounts of clay and silt. Lester Millhouse (1975, p. 1) reported that several water wells drilled from 112 to 143 feet in T5S, R12E, S26 in 1938 produced fifty gallons per minute. The mountain uplands and upper piedmont slopes of S26 receive a greater amount of yearly rainfall and suppo a larger biomass than sections on the middle and lower piedmont slopes. Water amounts and availability vary considerably in the Jicarilla area.

Source rocks and the relationship between area and altitude interacting with geomorphic and biologic regimes over time have produced the present landforms and placers of the Jicarilla District. As with other semi-arid environments change is slow as denudation of the landscape continues.

Origin Of The Jicarilla Placers

Placers are surfical mineral deposits formed by the mechanical concentration of mineral particles derived from the weathering of rock complexes, primary ore deposits, and older sediments. The dominant agent is fluvial but can also be marine, eolian, lacustrine, or glacial (Hails 1976, p. 213 and Hutchison 1983, p. 256). Important minerals found as placers are gold, platinum, cassiterite, columbite and tantalite, ilmenite, rutile, monazite, zircon, and alluvial gems (Griffith 1960, p. 1). Mining laws in the United States generally define placers as non-lode deposits consisting of clastics containing a valuable mineral that has accumulated as the result of weathering and mechanical concentration processes (Wells 1973, p. 3). The term placer is usually applied to deposits Tertiary or younger in age. Older deposits are regarded as fossil placers which usually have been lithified and subjected to various geologic processes.

Placer formation requires a source of material, weathering, fluvial processes, concentration, and preservation. Each of these will vary in extent and proportion depending on the individual deposit. A placer deposit is a temporary concentration of minerals that has been produced by dynamic geomorphic processes. It will exist and change with time as it interacts with changing geomorphic and tectonic regimes. Because of this, multi-cycle placers are common and can concentrate placer minerals effectively over long periods of time. This applies to all placers; however further discussion will center on the Jicarilla placers.

The gold placers of the Jicarilla District are genetically related to the Tertiary intrusives and vein deposits (Lindgren, et al. 1910, p. 184, and Segerstrom and Ryberg 1974, p. 19). The unroofing of the intrusives and the subsequent and continuing concentration of the heavy mineral component has produced auriferous placers in local Ogallala gravels and Holocene alluvial deposits.

The Jicarilla placers can be considered Bajada placers from a Spanish term for slope and gold placers typical of the Sonoran desert (Wells 1973, p. 121). They are the mineralized portions of alluvial fans formed under very arid conditions principally by cloudburst flows of water and the wind (Daily 1973, p. 17-152). The processes that form this type of placer differ greatly from those typical of a humid geomorphic environment where continuous flowing water predominates. Bajada placers are dry placers dependent on rock disintegration, heavy and intermittent rain storms, and eolian processes. Concentration of the heavier components is less efficient than wet placers and produces an erratic distribution of the placer mineral in the sediments as pay streaks.

During the late Pleistocene and early Quaternary cool-moist climatic intervals a different geomorphic regime was present in the Jicarilla area. It is possible that increased rainfall and fluvial action caused stream-type placer deposits to develop. The changes in climatic patterns through the Pleistocene would have buried some of the auriferous gravels and used the rest as source material for younger placers. The complex chain of events that produced the Jicarilla placers can accommodate several types of placers and areas of placer concentration.

The undocumented working of the Jicarilla placers has obscured their true extent and formation. This has complicated our understanding of the gold placers and efforts to determine if economic reserves are present.

RESEARCH AND EXPLORATION

General

The Jicarilla District is in a remote area of central New Mexico. A thorough search of the literature was conducted before going into the field and revealed the two primary references, Ryberg (1968), and Segerstrom and Ryberg (1974). The Guidebook of the Ruidoso Country edited by S.R. Ash and L.V. Davis (1964) contains a wealth of information on the regional geology of Lincoln County. Excellent U.S. Geological Survey 7.5 Minute topographic maps (1:24,000) along with the Segerstrom and Ryberg (1974) geologic map (1:31,680) made it possible to quickly check the company lease boundaries and get the company drilling program started.

Drilling Program

When this project began in the spring of 1982 an ambitious drilling program of approximately 200 holes was planned. We began with two drill rigs, a hydraulic auger and a mechanical auger which drilled 34 and 32 inch diameter bore holes respectively. By far the most effective rig was the hydraulic auger which unfortunately withdrew very early from the project. This left the mechanical auger that proved to be completely unreliable, drilling only a few holes of shallow depth. In mid-July 1982 an Ingersol-Rand hydraulic drilling rig owned by Ken Huey of Capitan, NM was contracted to air drill in the S3 lease area. This rig was able to drill six 6½ inch diameter bore holes to bedrock before allocated funds were exhausted. Several unsuccessful attempts to use the mechanical auger were made during the rest of the summer. By September 1982 all drilling efforts had ceased and the project was shut down, (see Appendix D).

The purpose of the drilling program was to identify where and at what depth economic concentrations of placer gold were located and the location of the bedrock-colluvium interface. The limited number of bore holes and shallow depths drilled did not allow realization of these goals.

Trenching And Surface Programs

By mid-May 1982 it was apparent that the proposed drilling program was lagging seriously behind schedule. In an effort to keep the project on track and people busy I proposed trenching and surface sampling programs. Various trenches (see Appendix B and Plate I) were dug and sampled in both lease areas in an attempt to delineate placer gold concentrations. Trenchin was at best a stopgap measure because only a very shallow interval of colluvium could be examined.

Surface sampling was an effort on my part to identify placer gold that could be processed by the company concentrator in S13. At first samples were taken for assay and the location recorded on the sample map. The uniformly poor results and cumulative cost of assaying caused me to modify the procedure. For the rest of the 1982 field season I covered the company lease areas hand panning spot samples by backpacking in water.

Aerial Photography

Aerial photographs were not consulted prior to the 1982 field season because the collection of aerial photographs on file at the New Mexico Bureau of Mines and Mineral Resources did not cover the Jicarilla District. Through the assistance of Joanne Osborne (New Mexico Bureau of Mines and Mineral Resources), index map number NM-302 was acquired in late 1982. With the index map aerial color photographs covering the company lease areas in stereo were purchased from the U.S. Department of Agriculture Forest Service. These photographs were taken in 1976 as part of a larger project. A thorough stereographic examination confirmed previous field work done on the ground. No new or unusual geologic structures were revealed by this inspection.

METHODOLOGY

Mapping

The primary source maps used in this project were the U.S. Geological Survey (1973) White Oaks North and Ancho 7.5 minute quadrangles. After comparing these maps with the claim boundaries of the lease areas I requested and received permission to use the facilities of the New Mexico Bureau of Mines and Mineral Resources Drafting section. Here I made enlargements from the primary source maps of the company lease areas to a scale of (1:3,060). Through the use of the overhead enlarger I was able to compare this map with the geologic maps produced by Ryberg (1968) and Segerstrom and Ryberg (1974). Later when aerial photographs were available I repeated the process as a test of map accuracy. The anticipated agreement between the various maps and photographs was gratifying.

A master map of the lease areas was inked on mylar and blueline copies made for field work. Field data, bore holes, geologic information and other pertinent information were entered on the blueline copies as they became available. This had the added benefit of allowing company maps to be easily updated and duplicated as necessary for reports and other company personnel.

The accuracy of the master map was checked in the field by starting with the available Bureau of Land Management section corner markers. This continued with compass traverses accompanied by careful tape measurements and pacing. The map was expanded by the addition of control points and the plotting of completed and staked bore holes. Closure between these map points was excellent and reflects the precision of the master map. The master map was continuously updated as new bore holes were staked and drilled, surface samples taken and trenches dug. The careful work done in the beginning greatly simplified and aided all field work. Compton (1962), "Manual Of Field Geology", was the primary reference applied to mapping, sampling and other field work.

It should be noted that when the lease areas were acquired by the Great Southwest Minerals and Mining Company it was thought that they consisted of 180 acres of claims. Careful calculations that were part of the master map verification process revealed that the company held claims totaling 167 acres.

Sampling

Because of the large diameter and shallow vertical extent of the auger bore holes they were accessible with the help of an extension ladder. The bore holes were measured, described, and channel samples taken for fire assay and petrographic examination. (see Appendices A & C). Channel samples of three to four pounds were taken in four foot intervals beginning at ground level and extending to TD (total depth). The intervals at TD often varied from the standard four feet to take up any left over footage. The samples were screened to break up any large fragments and then bagged with a tag identifying the bore hole and depth interval. Samples were submitted to the Socorro Assay Lab for fire assay and later returned for further petrographic study.

The initial procedure for collecting surface samples was the same as for bore hole wall samples. Three to four pounds of screened sample were bagged, labelled, entered on the master map and sent in for fire assay. At first all surface samples were fire assayed but the reported values were extremely low. In an effort to be more selective it was decided to hand pan surface samples first to determine if a fire assay was warranted.

The hand panning procedure was to weigh out a standard three ounces of sample, add that and a pint of water to the gold pan and work the sample through. The fire assay threshold was set at three gold grains or 'colors' per panned sample. Unfortunately all the surface samples panned showed no colors, consequently no bagged samples were taken. In this way the surface of the lease areas was covered quickly and efficiently.

Drilling locations were staked out for the Ingersol-Rand rig along the eastern edge of the S3 lease. Air drilled samples were taken via a PVC pipe return line that directed the dry cuttings over a sample splitter. From the surface to TD eight foot intervals were progressively drilled and sampled. Sampling consisted of separating an average of four to five pounds of cuttings from each interval that were then bagged, labelled and sealed. The bore hole was cleared with air before another eight foot interval was drilled and sampled. The TD interval usually varied from the standard eight feet to take up any left over footage or represented a smaller interval of sample. Air drilled samples were fire assayed and subjected to further petrographic study, (see Appendices A & C).

Six trenches were dug with the company backhoe in the lease areas. This was a temporary measure that would have been dispensed with if a viable drilling program existed. Trenches were staked and entered on the master map and my fieldbook. The backhoe operator was unable to dig the trenches very deep and often ignored the staked boundaries. This further limited the usefulness of trenching.

After each trench was excavated the position was checked on the master map and adjusted as necessary. The exposed trench face was examined and diagramed before sampling, (see Appendix B). Several sampling techniques were tried; channel and spot sampling, and later hand panning. The channel and spot samples were labelled and bagged then submitted for fire assay. The fire assay results showed very little gold so hand panning was used to examine some of the trenches. The procedures for trench sampling paralleled those for auger bore holes and surface sampling.

CONCLUSIONS AND RECOMMENDATIONS

Summary

This project was plagued by problems that ultimately led to its failure. When the project began in April 1982 the outlook was optimistic. The sponsoring company possessed two rigs, a concentrator, well paid personnel and registered gold placer claims. In retrospect the withdrawal of the hydraulic auger in late April was the most serious loss because it effectively ended the drilling program. This left us with a mechanical auger and concentrator that proved to be completely unreliable, (see Appendix D). This is not to say that homemade equipment cannot perform well but rather having the builders of the equipment available to keep it up and running is necessary. Case and point, the owner/operator of the mechanical auger could barely run his rig let alone maintain and repair it. Consequently the mechanical auger along with the concentrator spent most of the summer down for repairs and out of service.

It is a basic tenet of mining that exploration and reserve determinatio must precede production. Without a viable drilling program we were unable to define economic gold reserves on the company lease lands. Significant gold concentrations may exist in the lease areas as our exploration efforts only scratched the surface.

We started with a good plan of operation that suffered from poor execution. When the exploration program faltered the production crew running the concentrator became superfluous. The 'blind' processing of suspected gold placers cost the company considerable funds that could have been directed towards revitalizing the exploration program.

The drilling program was inadequate in terms of the number of bore holes and the total depth of the few holes drilled. The primary drilling target was the bedrock-colluvium interface but the only drilling rig to reach that interval was Ken Huey's Ingersol-Rand hydraulic rig. It became apparent by June 1982 that the mechanical auger and crew were not up to the task of drilling. At this junction the mechanical auger should have been dismissed and a two week notice given to the concentrator crew that operations would cease. The money saved by this action could have gone towards a revamped exploration program.

While hand panning surface samples, many shallow pits and an occasional deep pit were observed. After examining all the company lease areas and much of the surrounding ground it was apparent that the near surface gravels were thoroughly worked, probably in the 1930'^{s}. This view is supported by Griswold (1959, p. 77) and Segerstrom and Ryberg (1974, p. 17).

The exploration program was restricted to played out, near surface gold placers. It is entirely possible that new gold deposits exist within the company leases. Further investigations should look to new areas rather than duplicate previous efforts. Several theories of placer formation support the view that the concentration of gold placers is greatest at the buried bedrock-colluvium interface. This represents an erosion surface that has been buried by a shift in geomorphic regimes and processes. This is where any serious exploration effort should be directed.

Continuing Exploration

Efforts to find economic gold reserves in the company lease areas were disappointing due to the limited exploration program completed during the summer of 1982. The proper exploration of placer deposits can be cost effective and accurate with the application of available technology. A comprehensive exploration program is necessary with a range of options, goals and decision points. When the Great Southwest Minerals and Mining Company first approached the Jicarilla District drilling was limited to the 167 acres leased by the company. In this context the 'blind' drilling of this limited area made sense and was the course of action advocated and followed at that time. A serious effort to develop the Jicarilla placers should consider the entire district and claims held by other groups and individuals.

This proposed exploration program has three interdependent phases. Phase one involves geophysical prospecting primarily with seismic methods, phase two is a precision drilling program, while phase three requires evaluation of the drilling program with estimates of reserves and if applicable mining feasibility studies. Each phase has clear objectives with the methods of achieving them.

Phase One, Geophysical Prospecting: The objective of this phase is to use seismic profiling to develop a three dimensional map of the bedrock-colluvium surface. Identification of the buried topography and paleochannels would allow the targeting of bore holes to sample specific areas and depths.

Initially seismic shot lines should be run to profile sections 3 and 2, 10 and 11, and 15, 14, and 13 in T5S, R12E, (see Figure 2). This would cover the company lease areas and other areas that have been gold producers in the past. The technical advice and equipment necessary to handle a project of this scale can be purchased (or possibly rented) from a scientific supply house. I would estimate that a crew of 3 to 5 people could run the seismic shot lines in 15 to 20 working days with the information processed and maps drawn in a similiar time frame.

Another possibility is to offer the job to a professional geophysical company for bidding. This has the advantages of state of the art equipment in the hands of experienced people, faster execution of phase one, and computer processing and presentation of the data.

Other geophysical methods of prospecting like magnetic or electrical ground surveys have been considered. Their use is precluded by the sensitivity of these techniques and the scale of the project area (Dr. A.R. Sanford, New Mexico Institute of Mining and Technology, personal communication).

The conclusion of phase one is a decision point where several questions must be considered. Does the project proceed to phase two and if it does where do we drill and with what type of drilling rig?

Phase Two, Precision Drilling: The precision drilling program is directed at the areas defined by geophysical prospecting. Subsurface anomalies like buried paleochannels are prime drilling targets. If these locations lie outside of the company lease areas permission to drill must be obtained from the lease holder.

In terms of sampling and examination large diameter bore holes produced by a hydraulic auger or similiar drilling rig are preferred. As a second choice a reverse circulation, air drilling rig could be used. The gathered drill cuttings would be examined, hand panned, labelled and bagged, and selected samples sent in for spectral analysis and fire assay. Depending on the number of anomalies to be drilled and the type of drilling rig the field work should take 3 to 10 working days to complete. Another 10 to 14 days should be enough time for the completion of laboratory tests and analyses.

Phase Three, Evaluation and Feasibility Studies: With the data gathered from phases one and two the extent and value of placer gold can be determined. If insufficient reserves are present in this area phase one can be repeated in other areas of the district. If sufficient reserves are available mining feasibility studies and a mine plan to exploit these reserves will be prepared along with cost estimates.

The methods of mining gold placer deposits have lower operating and capital costs than other types of precious mineral operations. Spinoff technologies from hard rock mining and other industries are a big part of this cost efficiency. A successful placer operation requires proper exploration; reserves must be determined before they can be mined.

APPENDICES

A. Fire Assay Results

Key to Assay Sample Labels and Results

Section - Hole Number - (Depth Interval)
Section - SS: Surface Sample - Sample Number (remarks)
Section - X: Air Drilled - Hole Number (remarks)
trace = less than 0.002 troy oz/ton of gold

All fire assays were run for gold and silver by David A. Schwab, Socorro Assay Lab, Socorro, New Mexico. Samples can be compared with Plate I for sample location. Samples are listed in the order that they were submitted for analysis.

Sample	Gold in troy oz/ton
3-11-(0-4 feet)	0.002
3-11-(4-8 feet)	0.003
3-11-(8-10.5 feet, TD)	0.004
3-12-(0-4 feet)	trace
3-12-(4-8 feet)	trace
3-12-(8-12 feet)	trace
3-12-(12-14 feet, TD)	0.002
3-12½-(0-3 feet)	trace
3-12½-(3-7 feet)	0.002
3-12½-(7-11 feet, TD)	0.002
3-12½-(11 feet, TD)	0.002
3-13-(0-4 feet)	0.002
3-13-(4-7.5 feet, TD)	trace
3-13-(7.5 feet, TD)	0.002
13-2-(0-4 feet)	0.002
13-2-(4-8 feet)	0.003
13-2-(8-13 feet)	0.002
13-3-(0-4 feet)	0.005
13-3-(4-7 feet, TD)	0.002
13-7-(0-4 feet)	0.002
13-7-(4-8 feet)	trace
13-7-(8-12 feet)	trace
13-7-(12-16 feet, TD)	trace
13-8-(0-4 feet)	trace
13-8-(4-12 feet, TD)	0.002
3-SS-1 (at point L)	trace
3-SS-2 (at point R)	0.008

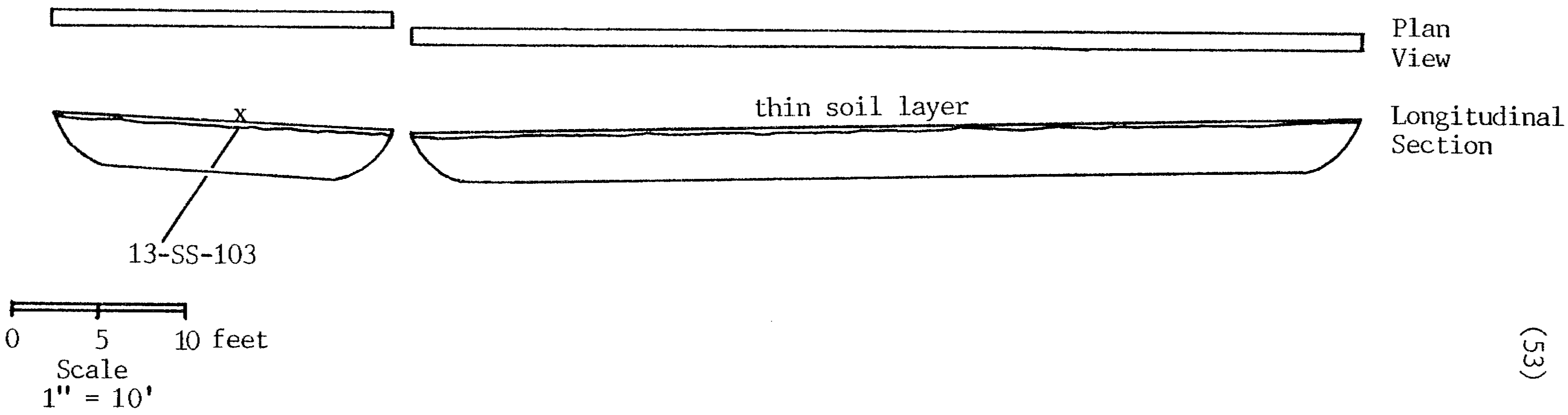
Sample	Gold in troy oz/ton
3-SS-3 (at point K)	trace
3-SS-4 (at point P)	trace
3-SS-5 (at point M	0.002
13-SS-101 (at point A')	0.003
13-SS-102 (at point Z)	trace
13-SS-103 (at trench 1)	0.002
13-SS-104 (concentrator waste)	0.002
3-SS-6 (at pit 2)	trace
13-SS-105 (10 ft. north of 13-3, trench 2)	trace
13-SS-105-4 (10 ft. N of 13-3, trench 2 @ 4 ft.)	trace
13-SS-106 (10 ft, east of 13-3, trench 2)	trace
13-SS-106-4 (10 ft. E of 13-3, trench 2 @ 4 ft.)	trace
13-SS-107 (10 ft. south of 13-3)	trace
13-SS-108 (10 ft. west of 13-3)	trace
3-X-1 (0-8 feet)	trace
3-X-1 (8-16 feet)	trace
3-X-1 (16-24 feet)	0.002
3-X-1 (24-32 feet)	0.002
3-X-1 (32-40 feet)	trace
3-X-1 (40-50 feet, TD)	trace
3-X-3 (0-8 feet)	trace
3-X-3 (8-16 feet)	trace
3-X-3 (16-24 feet)	0.007
3-X-3 (24-32 feet)	trace
3-X-3 (32-40 feet)	trace
3-X-3 (40-50 feet, TD)	0.002
3-X-4 (0-8 feet)	trace
3-X-4 (8-16 feet)	trace
3-X-4 (16-24 feet)	trace
3-X-4 (24-32 feet)	0.003
3-X-4 (32-40 feet)	trace
3-X-4 (40-48 feet)	trace
3-X-4 (48-56 feet)	trace
3-X-4 (56-64 feet)	trace
3-X-4 (64-72 feet)	trace
3-X-4 (72-80 feet)	trace
3-X-4 (80-85 feet, TD)	trace

Sample	Gold in troy oz/ton
3-X-5 (0-8 feet)	trace
3-X-5 (8-16 feet)	trace
3-X-5 (16-24 feet)	trace
3-X-5 (24-32 feet)	trace
3-X-5 (32-40 feet)	trace
3-X-5 (40-48 feet)	trace
3-X-5 (48-56 feet)	trace
3-X-5 (56-64 feet)	trace
3-X-5 (64-72 feet)	trace
3-X-5 (72-77 feet, TD)	trace
3-X-6 (0-8 feet)	trace
3-X-6 (8-16 feet)	0.002
3-X-6 (16-24 feet)	0.002
3-X-6 (24-32 feet)	0.003
3-X-6 (32-40 feet)	0.002
3-X-6 (40-48 feet)	0.002
3-X-6 (48-52 feet, TD)	trace
3-X-7 (0-8 feet)	0.002
3-X-7 (8-16 feet)	0.002
3-X-7 (16-24 feet)	trace
3-X-7 (24-32 feet)	trace
3-X-7 (32-40 feet)	trace
3-X-7 (40-48 feet)	0.002
3-X-7 (48-56 feet)	trace
3-X-7 (56-62 feet, TD)	0.002

B. Trench Cross-Sections

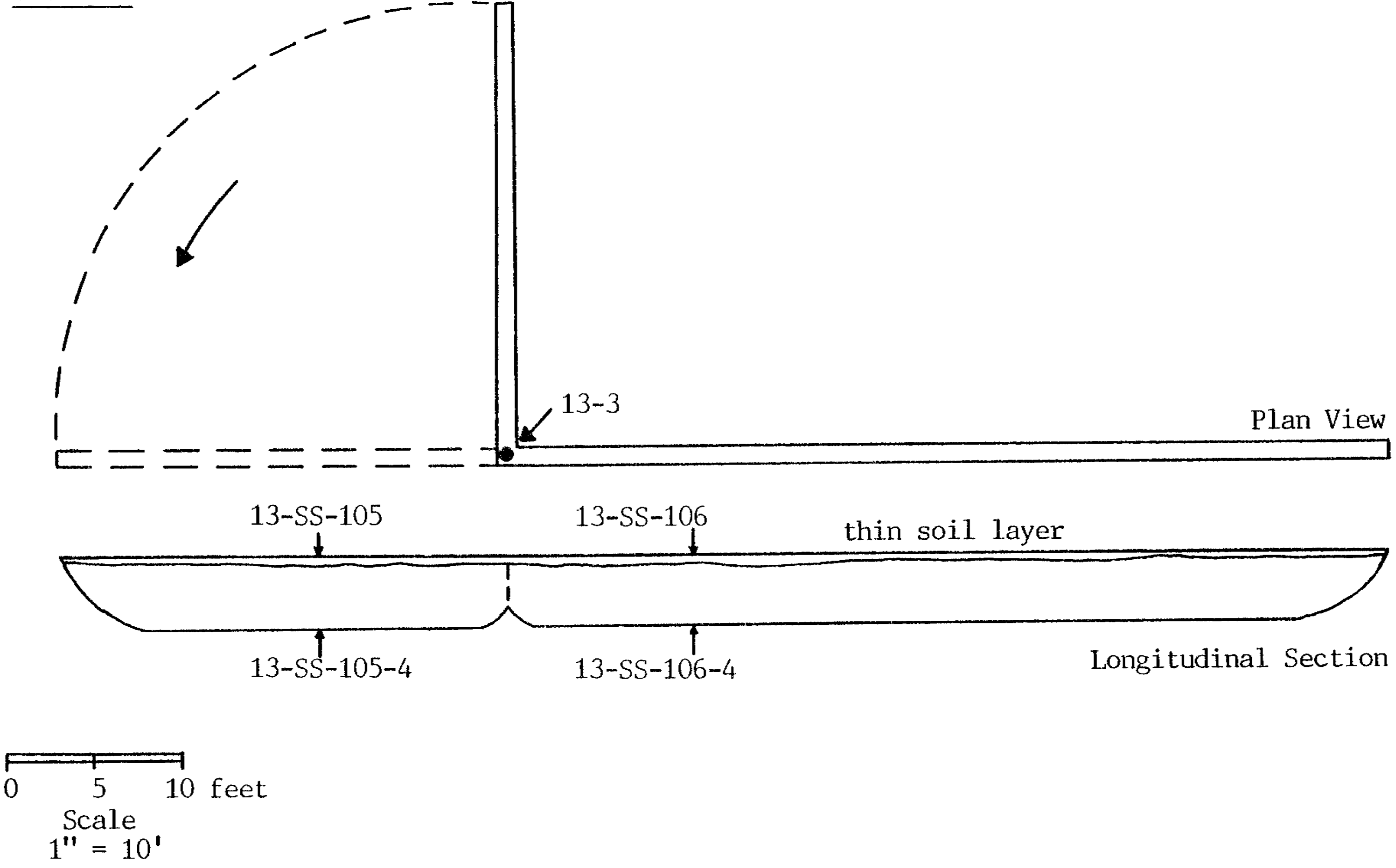
The six trench cross-sections are drawn to a common scale and list samples with other relevant information. Using the Munsell Soil Color Charts values for hue and value/chroma are given with descriptions of trench wall samples. Side wall channel samples were used for hand panning. All trench locations are diagrammed on Plate I.

Trench 1



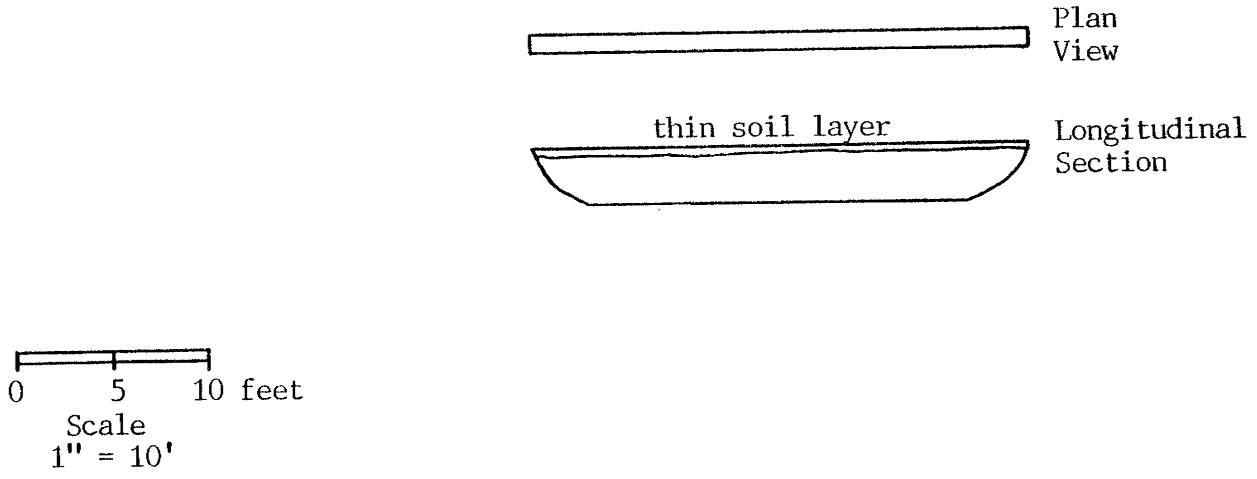
7.5YR 4/4, brown to dark brown, occasionally yellow brown, dominantly clay to silt occasionally sand to gravel, trace of sulfides, 3% to 4% magnetite, occasionally very fine white sediment, subangular to subrounded, occasionally cobble sized monzonite fragments and magnetite, occasionally calcium carbonate. Hand panning detected no gold.

Trench 2



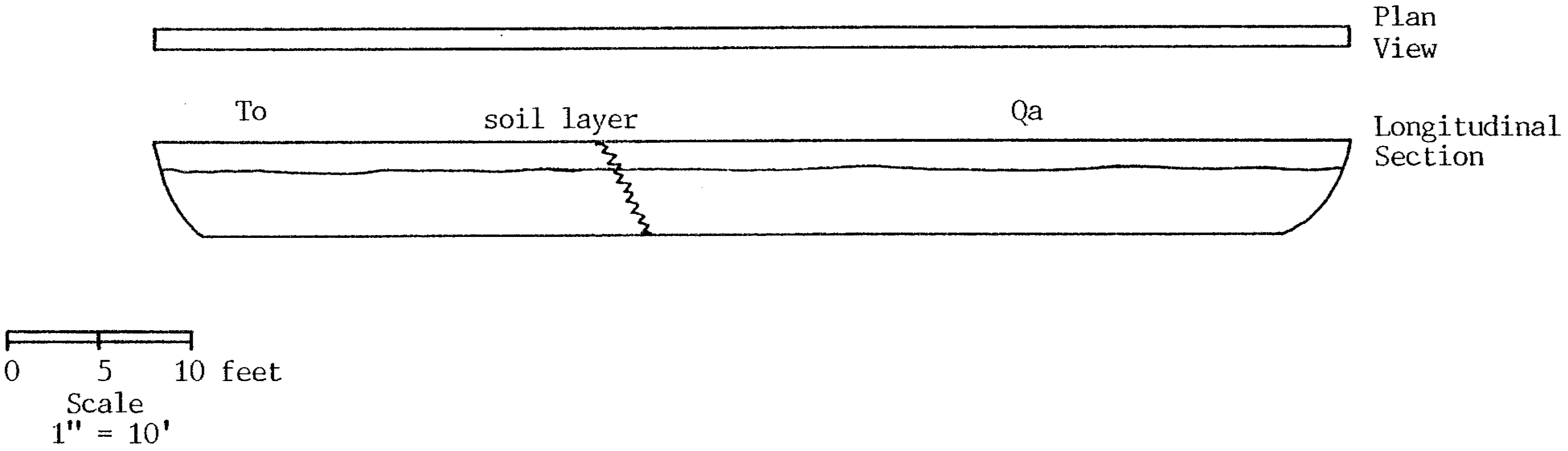
7.5YR 4/6, strong brown, occasionally dark brown to grey brown, dominantly clay to silt, occasionally sand to gravel, 2% to 4% magnetite, subangular to subrounded, occasionally monzonite fragments, occasionally calcium carbonate. Hand Panning detected no gold.

Trench 3



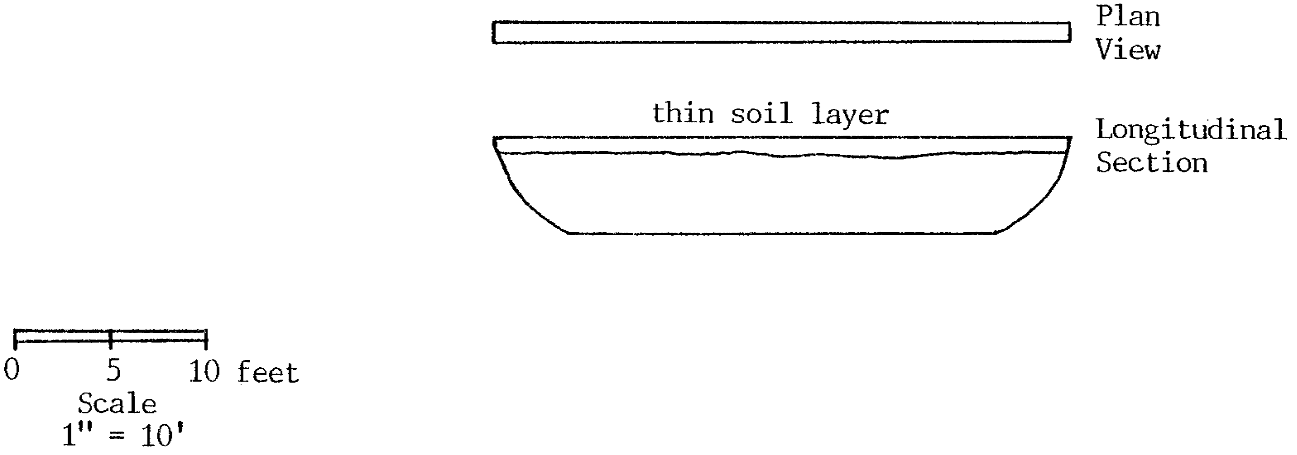
7.5YR 4/4, brown to dark brown, dominantly clay to silt, occasionally sand to gravel, trace galena, 4% magnetite, occasionally white calcium carbonate fragments and coatings, occasionally cobble sized monzonite. Hand panning detected no gold.

Trench 4



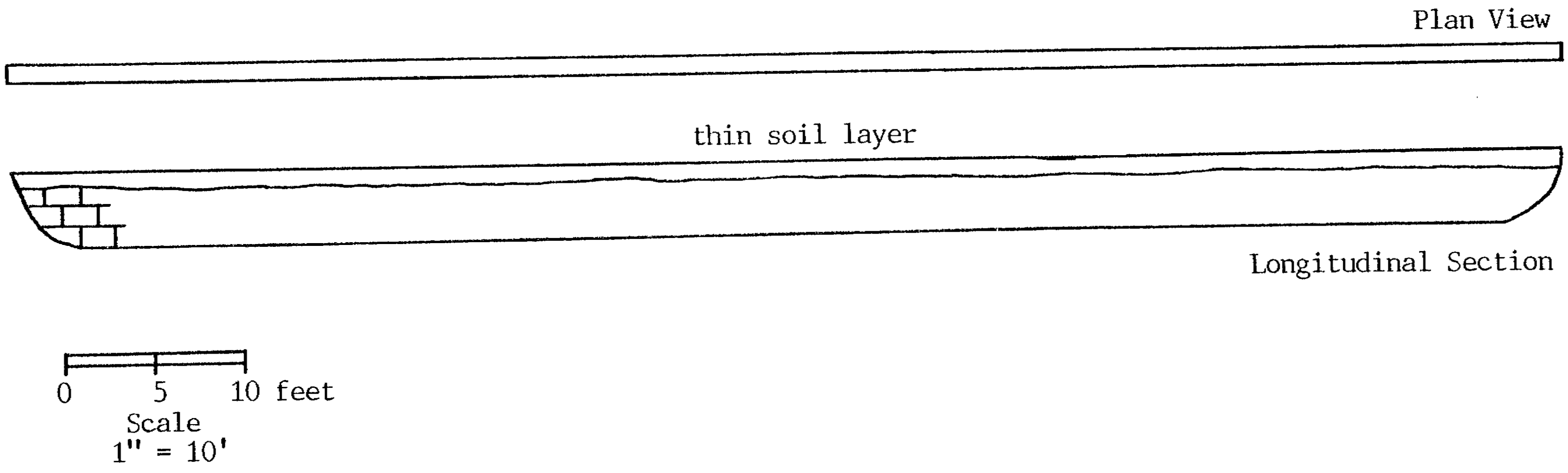
7.5YR 4/6, strong brown, medium to dark brown, clay to silt, occasionally sand to gravel 2% to 3% magnetite, subangular to subrounded, occasionally monzonite cobble, trace galena and mica flakes. To: sand/gravel > clay/silt. Qa: clay/silt > sand/gravel. Sporadic amounts of calcium carbonate present. Hand panning detected no gold.

Trench 5



7.5YR 4/6, strong brown, medium to dark brown, clay to silt, occasionally sand to gravel 3% to 4% magnetite, subangular to subrounded, monzonite sand to occasionally gravel sized, trace mica flakes and galena, varying amounts of calcium carbonate. Hand panning detected no gold.

Trench 6



7.5YR 4/6 strong brown, medium to dark brown mottled with white in part, coarse sand, silt and clay, occasionally gravel, 2% to 4% magnetite, monzonite grus, occasionally weathered light grey limestone, varying amounts of calcium carbonate. Hand panning detected no gold.

C. Bore Hole Sample Descriptions

All bore holes drilled as part of the exploration project completed during the summer of 1982 are listed. Using the Munsell Soil Color Charts values for hue and value/chroma are given with descriptions of bore hole samples. Some samples have been fire assayed, (see Appendix A) while the rest have been hand panned. All bore hole locations are listed on Plate I.

Hole # 3-9

(0-4 feet) 7.5YR 5/4, Medium brown to brown, dominantly clay to silt, occasionally sand to gravel, trace sulfides, 2-4% magnetite, scattered white monzonite fragments and calcium carbonate. No gold detected.

(4-8 feet) 7.5Yr 4/6, Strong brown-occasionally pink, dominantly clay to silt, occasionally sand to gravel, scattered white monzonite fragments and calcium carbonate, 2-3% magnetite, trace hematite and potassiu feldspar. No gold detected.

(8-12 feet) 7.5YR 5/6 and 4/4, Medium to dark brown-strong brown, dominantly clay to silt, occasionally sand to gravel, occasionally white monzonite fragments and calcium carbonate, 4% magnetite, trace sulfides. No gold detected.

(12-16 feet) 2.5YR 4/4 Reddish brown, dominantly clay to silt, occasionally sand, trace gravel, occasionally monzonite fragments and calcium carbonate, 4% magnetite. No gold detected.

(16-20 feet) 2.5YR 4/4 Same as above, (12-16 feet).

(20-22 feet, TD) 7.5YR 5/4, Brown dominantly clay to silt, occasionall sand to silt, scattered white monzonite fragments and calcium carbonate, 2% magnetite, trace sulfides. No gold detected.

Notes: At 3 and 4½ feet thin gravel and sand lenses, samples hand panne

Hole # 3-10

(0-4 feet) 7.5YR 4/4, Medium to dark brown, occasionally grey-brown, dominantly clay to silt, occasionally sand to gravel, scattered white monzonite and calcium carbonate, 2-4% magnetite, trace sulfides. No gold detected.

(4-8 feet) 7.5YR 4/4 Same as above, (0-4 feet).

(8-12 feet) 7.5YR 4/6, Strong brown to reddish brown, dominantly clay to silt, occasionally sand to gravel, scattered white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(12-16 feet) 7.5YR 5/8, Strong brown, same as above (8-12 feet).

(16-18½ feet, TD) 7.5YR 5/4, Brown, dominantly clay to silt, occasiona sand to trace gravel, occasionally monzonite fragments and calcium carbonate 2% magnetite, trace sulfides. No gold detected.

Notes: Gravels at TD, samples hand panned.

Hole # 3-11

(0-4 feet) 7.5YR 5/4 and 4/4, Brown to dark brown, dominantly clay to silt, occasionally sand to trace gravel, scattered white monzonite fragments and calcium carbonate, 3-4% magnetite, trace sulfides. No gold detected.

(4-8 feet) 7.5YR 4/6, Strong brown, same as above, (0-4 feet).

(8-10½ feet, TD) 7.5YR 5/6, Strong brown, dominantly clay to silt, occasionally sand to trace gravel, trace white monzonite fragments and calcium carbonate, 2% magnetite, trace sulfides. No gold detected.

Notes: Very slight traces of limestone and sandstone in sediment mix. Samples fire assayed.

Hole # 3-12

(0-4 feet) 7.5YR 4/4, Medium to dark brown, dominantly clay to silt, occasionally sand to trace gravel, occasionally white monzonite fragments and calcium carbonate, 2-4% magnetite, trace sulfides. No gold detected.

(4-8 feet) 7.5YR 4/6, Strong to dark brown, same as above, (0-4 feet).

(8-12 feet) 7.5YR 5/4, Brown to occasionally dark brown, dominantly clay to silt, occasionally sand,scattered white monzonite fragments in part and calcium carbonate, 4% magnetite, trace sulfides. No gold detected.

(12-14 feet, TD) 7.5YR 6/4, light brown to occasionally medium brown, dominantly clay to silt, occasionally sand to trace gravel, scattered white monzonite fragments and calcium carbonate, 3-4% magnetite, trace sulfides. No gold detected.

Notes: At 10 feet sand lense, samples fire assayed.

Hole # 3-12½

(0-3 feet) 7.5YR 4/4, Medium to dark brown, dominantly clay to silt, occasionally sand to trace gravel, scattered white monzonite fragments and calcium carbonate, 2-4% magnetite, trace sulfides. No gold detected.

(3-7 feet) 7.5YR 4/6, Strong to dark brown, same as above, (0-3 feet).

(7-11 feet, TD) 7.5YR 5/4, Brown to occasionally dark brown, dominantly clay to silt, occasionally sand to trace gravel, scattered white monzonite fragments and calcium carbonate, 4% magnetite, trace sulfides. No gold detected.

Notes: Some very large monzonite fragments, samples fire assayed.

Hole # 3-13

(0-4 feet) 7.5YR 4/4, Medium to dark brown, dominantly clay to silt, occasionally sand to trace gravel, scattered white monzonite fragments and calcium carbonate, 3-4% magnetite, trace sulfides. No gold detected.

(4-7½ feet, TD) 7.5YR 4/6, Strong to dark brown, dominantly clay to silt, occasionally sand to trace gravel, occasionally white monzonite fragments and calcium carbonate, 4% magnetite, trace sulfides. No gold detected.

Notes: Very slight traces of limestone and sandstone, samples fire assayed.

Hole # 3-14

(0-4 feet) 7.5YR 4/6, Strong brown, dominantly clay to silt occasional sand and gravel, scattered white monzonite fragments and calcium carbonate, 2-4% magnetite, trace sulfides. No gold detected.

(4-7½ feet, TD) 5YR 3/3, Dark reddish brown, occasionally light reddish brown, same as above, (0-4 feet).

Notes: At 7 feet calcium carbonate layer (caliche) and color change fror dark to light reddish brown with depth. Samples hand panned.

Hole # 3-X-1

(0-8 feet) 7.5YR 4/6, Strong brown, dominantly clay to silt with sand and gravel, scattered white monzonite fragments and calcium carbonate, 2-4% magnetite, occasionally sulfides. No gold detected.

(8-16 feet) 7.5YR 4/4, Brown to dark brown, dominantly clay to silt with sand and gravel, abundant scattered white monzonite fragments, occasionally calcium carbonate and sulfides, 2-4% magnetite, trace potassium feldspar. No gold detected.

(16-24 feet) 7.5YR 5/4 to 6/4, Light brown to brown, 2% magnetite, same as above, (8-16 feet).

(24-32 feet) 7.5YR 6/4, Light brown, dominantly clay to silt with sand to gravel, scattered white monzonite fragments, occasionally calcium carbonate, 2-3% magnetite, trace sulfides. No gold detected.

(32-40 feet) 7.5YR 6/4, Same as above, (24-32 feet).

(40-50 feet, TD) 7.5YR 6/4, Light brown, dominantly clay to silt, occasionally sand and gravel, abundant white monzonite fragments and calcium carbonate, 4% magnetite, trace galena, pyrite and limonite. No gold detected

Notes: Samples fire assayed.

Hole # 3-X-3

(0-8 feet) 7.5YR 4/6, Strong brown, dominantly clay to silt with sand and gravel, scattered white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(8-16 feet) 7.5YR 4/4, Brown to dark brown, dominantly clay to silt, occasionally sand and gravel, abundant white monzonite fragments, occasional calcium carbonate and sulfides, 2-4% magnetite. No gold detected.

(16-24 feet) 7.5YR 5/4 to 6/4, Light brown to brown, as above (8-16 fe

(24-32 feet) 7.5YR 6/4, Light brown, dominantly clay to silt with sand to gravel, scattered white monzonite fragments, occasionally calcium carbonate, 2-4% magnetite. No gold detected.

(32-40 feet) 7.5YR 6/4, Same as above, (24-32 feet).

(40-50 feet, TD) 7.5YR 6/4, Light brown, dominantly clay to silt, occasionally sand and gravel, abundant white monzonite fragments and calcium carbonate, 4% magnetite, trace galena and limonite. No gold detected.

Notes: Samples fire assayed.

Hole # 3-X-4

(0-8 feet) 7.5YR 4/2, Brown to dark brown, dominantly clay to silt with sand and gravel, occasionally white monzonite fragments and calcium carbonate, occasionally sulfides, 4% magnetite. No gold detected.

(8-16 feet) 7.5YR 5/4, Brown, same as above, (0-8 feet).

(16-24 feet) 7.5YR 6/4, Light brown, dominantly clay to silt with sand and gravel, scattered white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(24-32 feet) 7.5YR 6/4, Same as above, (16-24 feet), trace sulfides.

(32-40 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(40-48 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(48-56 feet) 7.5YR 6/4 to 5/4, Light brown to brown, as above (16-24 f

(56-64 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(64-72 feet) 7.5YR 6/4, Same as above, (16-24 feet), occasionally sand

(72-80 feet) 7.5YR 6/4 to 5/4, Light brown to brown, as above (16-24 f

(80-85 feet, TD) 7.5YR 6/4, Same as above, (16-24 feet).

Notes: Samples fire assayed.

Hole # 3-X-5

(0-8 feet) 7.5YR 4/2, Brown to dark brown, dominantly clay to silt with sand and gravel, occasionally white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(8-16 feet) 7.5YR 5/4, Brown, same as above, (0-8 feet).

(16-24 feet) 7.5YR 6/4, Light brown, dominantly clay to silt with sand and gravel, scattered white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(24-32 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(32-40 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(40-48 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(48-56 feet) 7.5YR 6/4 to 5/4, Light brown to brown, as above (16-24 f

(56-64 feet) 7.5YR 6/4, Same as above, (16-24 feet).

(64-72 feet) 7.5YR 6/4, Same as above, (16-24 feet), occasionally sand and trace gravel.

(72-77 feet, TD) 7.5YR 6/4, Same as above, (16-24 feet).

Notes: Samples fire assayed.

Hole # 3-X-6

(0-8 feet) 7.5YR 4/2, Brown to dark brown, clay to silt to sand and gravel, abundant white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(8-16 feet) 7.5YR 5/4, Brown, dominantly clay to silt with sand and gravel, occasionally white monzonite fragments and calcium carbonate, 3-4% magnetite, occasionally sulfides. No gold detected.

(16-24 feet) 7.5YR 6/4, Light brown, dominantly clay to silt with occasionally sand and gravel, scattered white monzonite fragments and calcium carbonate, 3% magnetite, trace limonite and sulfides. No gold dete

(24-32 feet) 7.5YR 6/4, Same as above, (16-24 feet), to very light br

(32-40 feet) 7.5YR 6/4, Same as above, (24-32 feet).

(40-48 feet) 7.5YR 6/4, Same as above, (24-32 feet).

(48-52 feet, TD) 7.5YR 6/4, Same as above, (24-32 feet).

Notes: At 50 feet clay layer, samples fire assayed.

Hole # 3-X-7

(0-8 feet) 7.5YR 5/4 to 4/2, Brown to dark brown, clay to silt and occasionally sand to gravel, abundant white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(8-16 feet) 7.5YR 6/4, Light brown, dominantly clay to silt with sand to gravel, occasionally white monzonite fragments and calcium carbonate, 3- magnetite, occasionally sulfides. No gold detected.

(16-24 feet) 7.5YR 6/4, Same as above, (8-16 feet).

(24-32 feet) 7.5YR 6/4, Same as above, (8-16 feet).

(32-40 feet) 7.5YR 6/4, Same as above, (8-16 feet).

(40-48 feet) 7.5YR 6/4, Light brown, dominantly clay to silt and occasionally sand and gravel, occasionally white monzonite fragments and calcium carbonate, 4% magnetite, occasionally sulfides. No gold detected.

(48-56 feet) 7.5YR 6/4, Same as above, (40-48 feet).

(56-62 feet, TD) 7.5YR 6/4, Same as above, (40-48 feet), abundant fin

Notes: Channel gravels at 37 feet, 43 feet and 52 feet, samples fire assayed.

Hole # 13-2

(0-4 feet) 7.5YR 5/4, Brown, clay, silt and sand, occasionally gravel abundant white monzonite fragments, scattered calcium carbonate, 4% magnetite, occasionally sulfides with trace galena, light grey weathered limestone in places. No gold detected.

(4-8 feet) 7.5YR 5/4, Same as above, (0-4 feet).

(8-13 feet, TD), 7.5YR 5/4, Same as above, (0-4 feet).

Notes: Gravel lenses at 2 feet and 4 feet, samples fire assayed.

Hole # 13-3

(0-4 feet) 7.5YR 4/6, Strong brown, dominantly clay to silt with sand to gravel, occasionally weathered light grey limestone, scattered white monzonite fragments with some calcium carbonate, 3-4% magnetite sulfides with trace galena. No gold detected.

(4-7 feet, TD) 7.5YR 4/4, Brown to dark brown, dominantly clay to silt with sand and trace gravel, occasionally white monzonite fragments and weathered light grey limestone, occasionally calcium carbonate, 4-5% magnetite, trace sulfides. No gold detected.

Notes: Sand and gravel lenses at 1½ feet and 4 feet, clay layer at TD, samples fire assayed.

Hole # 13-6

(0-4 feet) 7.5YR 4/4, Brown to dark brown, dominantly clay to silt, occasionally sand and gravel, occasionally white monzonite fragments and weathered light grey limestone, scattered white calcium carbonate, 4% magnetite, trace sulfides. No gold detected.

(4-8 feet) 7.5YR 5/4, Brown, dominantly clay to silt with sand, occasionally white monzonite fragments and weathered light grey limestone, white calcium carbonate in places, 4% magnetite, occasionally sulfides and trace limonite. No gold detected.

(8-12 feet) 10YR 5/8, Yellowish brown, dominantly clay to silt to fine-grained sand, scattered white monzonite fragments and weathered light grey limestone, abundant limonite, 2-3% magnetite, trace calcium carbonate. No gold detected.

(12-16 feet, TD) 10YR 6/6, Brownish yellow, clay to sand, abundant limonite and sulfides, scattered white monzonite fragments and calcium carbonate, 3-4% magnetite, trace limestone. No gold detected.

Notes: Samples hand panned.

Hole # 13-7

(0-4 feet) 7.5YR 4/4, Brown to dark brown, dominantly clay to silt with sand, scattered white monzonite fragments and calcium carbonate, 4% magnetite, trace sulfides and weathered limestone. No gold detected.

(4-8 feet) 7.5YR 5/4, Brown, dominantly clay to silt with sand, scattered white monzonite fragments, weathered light grey limestone in part, 3-4% magnetite, trace sulfides, limonite and calcium carbonate. No gold detected.

(8-12 feet) 10YR 5/8, Yellowish brown, dominantly clay to silt with sand, scattered white monzonite fragments and light grey weathered limeston 3-4% magnetite, trace calcium carbonate and limonite. No gold detected.

(12-16 feet, TD) 10YR 6/6, Brownish yellow, dominantly clay to very fine-grained sand, occasionally white monzonite fragments, occasionally limonite and sulfides, 3% magnetite, trace calcium carbonate. No gold detec

Notes: Samples fire assayed.

Hole # 13-8

(0-4 feet) 7.5YR 4/4, Brown to dark brown, dominantly clay to silt with sand and gravel, scattered white monzonite fragments and weathered light grey limestone, 3% magnetite, trace calcium carbonate. No gold detected.

(4-12 feet, TD) 10YR 5/6, Yellow brown, dominantly clay to silt to sand occasionally white monzonite fragments and light grey weathered limestone, 2% magnetite, traces limonite and hematite. No gold detected.

Notes: Samples fire assayed.

D. Brief Chronology

April 1982
- begin mapping, first holes staked
- first bore holes drilled in S13
- hydraulic auger leaves project

May 1982
- move mechanical auger to S3, very little drilling
- finish drafting and field checking master map
- finish ground reconnaissance and begin surface sampling
- concentrator usually down for repairs

June 1982
- no drilling with mechanical auger
- continue surface sampling, begin trenching
- concentrator typically down for repairs

July 1982
- no drilling with mechanical auger
- restake drill holes, bring in Ingersol-Rand hydraulic rig
- continue surface sampling and trenching
- mid-July, operation reorganized
- concentrator usually down for repairs

August 1982
- some drilling with mechanical auger
- operation reorganized again
- continue surface sampling and trenching
- more drill holes staked, others renumbered
- close down concentrator

September 1982
- very little drilling with mechanical auger
- last trench dug
- close down drilling operations
- close down field operations

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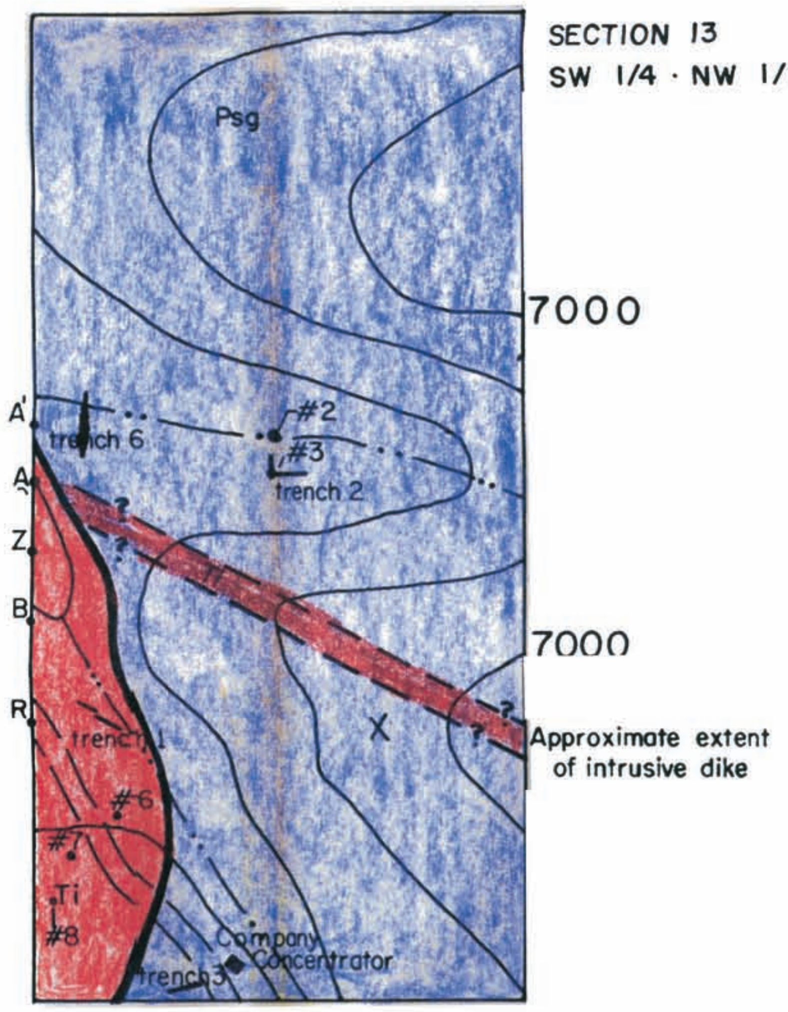
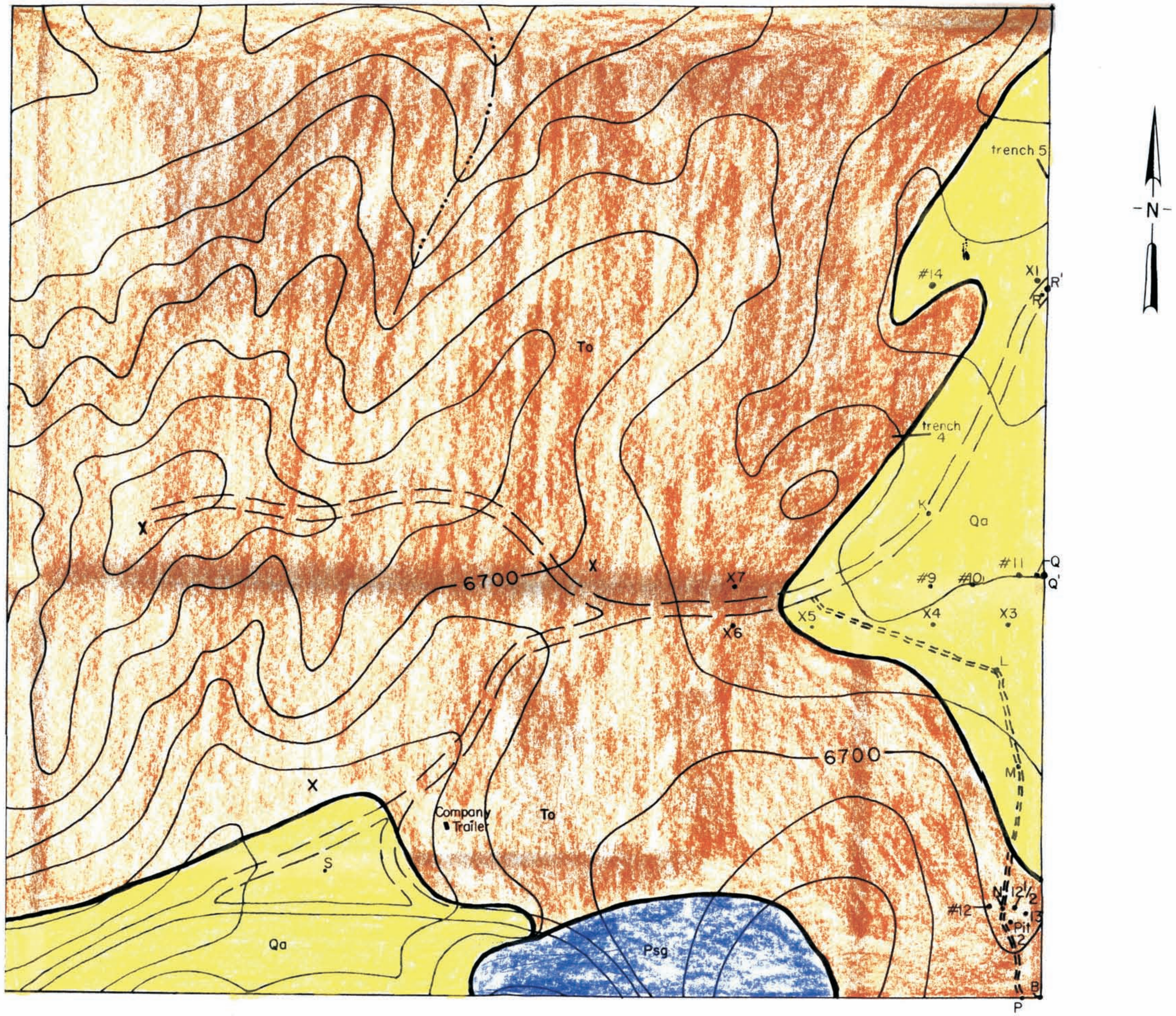
Date

PLATE I. MAP OF THE LEASE AREAS T5S R12E
LINCOLN CO., NEW MEXICO



SECTION 13
SW 1/4 · NW 1/2 · W 1/2



SCALE 1:3060

1/8 0 1/4 MILE

0 1000 2000 FEET

CONTOUR INTERVAL 20 FEET

Qa ALLUVIUM (Holocene)

To OGALLALA (?) FORMATION (Upper Miocene to Lower Pliocene)

Ti INTRUSIVE ROCKS (Oligocene to Eocene)

Psg SAN ANDRES LIMESTONE (Lower Permian)

D. BAKER 6/82