

**THE GEOLOGY, LEASING, AND PRODUCTION HISTORY
OF THE COTTONWOOD BUTTE (PLOT 8)
URANIUM-VANADIUM MINE,
SAN JUAN COUNTY, NEW MEXICO**

New Mexico Bureau of Mines and Mineral Resources

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INTRODUCTION

The Cottonwood Butte mine was developed on one of the initial discoveries of uranium-vanadium minerals in the Carrizo Mountains of northeastern Arizona and northwestern New Mexico. The host rock for the ore deposit is the Salt Wash Member of the Morrison Formation of Late Jurassic age.

The area was originally leased for the radium content of the ore, but no ore was mined from the outcrops. In 1942, the area was leased for vanadium mining. It wasn't until the early 1950s that the Cottonwood Butte mine produced uranium-vanadium ore.

This report is part of an ongoing study of the uranium deposits in New Mexico, especially the deposits in the eastern Carrizo Mountains, San Juan County.

Location

The Cottonwood Butte mine is located on Plot 8 of U.S. Department of the Interior's Lease No. I-149-IND-5905 in the eastern Carrizo Mountains, San Juan County, New Mexico (Fig. 1). This plot (claim) covers a small knoll a mile and three quarters northeast of the settlement of Oak Springs (Fig. 1). The mine received its name from a prominent butte north of the mine site. The mine is not shown on the Beclabito topographical quadrangle (U.S. Geological Survey, 1982) but is located at latitude 109° 02' 29"W, longitude 36° 46' 19" N. On this map the highest point on the plot is marked as 5885T.

The mine is accessible from the unimproved dirt road that heads north from Oak Springs to Beclabito.

The mine workings consist of a 40 ft long stripped area in front of a small underground mine with two pillars. Approximately 180 ft southeast of the adit are two rim cuts, 8 ft deep (Fig. 2). A small rim cut is on the north side of the knoll, approximately 200 ft northeast of the adit (Fig. 2). In the north central and central areas of the plot are two small open pits (Fig. 3).

Land Status

The Cottonwood Butte mine is located within the Navajo Indian Reservation. On the Reservation, all prospecting, leasing and mining is controlled by the Navajo Tribal Council and the Bureau of Indian Affairs, U.S. Department of the Interior. For Lease 1-149-IND-5905, the Tribe received a royalty of 10% of the mine-mouth value of the ore.

Previous Studies

Leasing and mining of the uranium deposits in the Carrizo Mountains for radium extraction has been described by Chenoweth (1989). Details of the vanadium production in the Carrizo's are also given by Chenoweth (1991). A report by McLemore and Chenoweth (1997) summarizes the uranium-vanadium production in the eastern Carrizo Mountains. Sources of Information

Most of the information presented in this report was obtained while the author was employed by the U.S. Atomic Energy Commission (AEC) and succeeding agencies: the U.S. Energy Research and Development Administration and the U.S. Department of Energy. Ore production royalty records, prepared by the U.S. Geological Survey (USGS),

Conservation Division, for the Bureau of Indian Affairs, were reviewed to obtain the names of the contract miners, the mines and the months they were operating. Information on the early vanadium ore production is contained in a detailed report prepared by the General Services Administration (GSA), Indian Trust Accounting Division for the Navajo Tribe. This document (GSA, 1981) was admitted as evidence in U.S. Claims Court, Navajo Tribe vs. United States, Docket Nos. 69 and 299 (copper, vanadium, uranium, sand, rock and gravel claims) held in Albuquerque, New Mexico, February 24-March 4, 1983. A copy of the vanadium and uranium section was obtained by the Grand Junction Area Office of the U.S. Department of Energy. Details of the mineral leasing regulations, applicable to the Navajo Indian Reservation, were taken from a report prepared by DeVoto and Huber (1982) for the U.S. Department of Justice, which was also admitted as evidence in the above case. Copies of both the GSA report and the DeVoto and Huber report have been donated to the Geosciences Information Center at the New Mexico Bureau of Mines and Mineral Resources. The maps of the mine workings (Fig. s 2, 3) was traced by the author in 1985 from the files of the Foote Mineral Company, successor to VCA, and the mine was last examined in May 1983.

GEOLOGIC SETTING

The uranium-vanadium orebodies at Cottonwood Butte occur in the Salt Wash Member of the Upper Jurassic Morrison Formation. In the Oak Springs - King Tutt Mesa area, the Salt Wash Member is approximately 220 feet thick. It is composed of light gray, fine - to very fine-grained, well rounded, quartz sandstone with interbedded lenses in beds of reddish-brown and greenish-gray mudstone and siltstone. The mudstone and siltstone

beds comprise between 5 to 45 percent of the total thickness of the member. Huffman and others (1980) have subdivided the Salt Wash Member in the Oak Springs - King Tutt Mesa area into three stratigraphic units based on depositional environments. The lowermost unit is an average of 30 ft thick and was considered by those authors to be predominantly overbank deposits of alternating thin mudstone and sandstone. It reportedly contains a few channel sandstones, however, the present author notes that this unit is lithologically distinct from the overlying ore-bearing unit. It, also, does not host any uranium-vanadium ore deposits.

The middle stratigraphic unit is an average of 70 ft thick and is composed of channel-sandstone deposits, partially and completely abandoned channel-fill deposits, and overbank deposits. It rests with sharp erosional contact on the lower unit. Approximately 80 percent of the sandstone in this unit is active channel fill in a generally eastward flowing fluvial system (Craig and others, 1955).

The upper unit is 120 ft thick. Most of the unit is composed of braided-stream deposits, and thin overbank deposits. Active channel-fill sandstone and conglomerates are also present. The sequence of stratigraphic units probably represent a prograding wet alluvial fan (Huffman and others, 1980). Prominent sandstones in the upper unit were mapped as the "middle" and "upper rims" by VCA (Fig. 3).

The channel sandstone that contains the orebodies at Cottonwood Butte is approximately 30 ft above the base of the Salt Wash, within the middle unit of the member. The outcrop of this channel sandstone was mapped as the "ore rim" by VCA (Figs. 2, 3).

Detrital organic plant material, such as leaves, branches, limbs and trunks are common in the ore-bearing channel. Most all of this material is carbonized.

The uranium-vanadium orebodies were formed by the selective impregnation of the sandstone and adsorption by the mudstone and fossil plant material. Orebodies were commonly associated with detrital plant fragments in the sandstone. The orebodies were roughly tabular in cross-section and irregular in plan. They ranged from several ft in width to a nearly hundred ft in length. Thicknesses at the Cottonwood Butte mine ranged from a feather edge to up to three ft.

The ore deposits in the Carrizo Mountains were originally called carnotite, because of their yellow color. Carnotite, a bright yellow mineral is a potassium uranium vanadate. Later work by Corey (1958) and S.R. Austin (written communication, 1967) found tyuyamunite, a calcium uranium vanadate, and meta-tyuyamunite as the only uranium minerals in the Carrizo deposits. The mineralogy of the nearby Nelson Point mine was studied by Corey (1958). In this mine, vanadium clay and montrosite were present. These minerals have been oxidized to form a number of secondary vanadium minerals that include sherwoodite, duttoniite (?), hewettite, methahewettite, rossite, metarossite, and hendersonite (Corey, 1958). Calcite is a common cement in ore. Pyrite, iron oxides, and gypsum may also be present.

The mine is located on the south flank of the east - plunging Syracuse Nose in the eastern Carrizo Mountains. This nose is probably due to an unexposed igneous sill of the Carrizo laccolith. Beds of the Salt Wash at the mine dip seven degrees to the southeast.

EARLY LEASING AND VANADIUM PRODUCTION

Radium The New Element

The discovery of radium by Marie and Pierre Curie in 1898 led to the realization that all uranium ores contained this new element. Experiments which showed that radium inhibited the growth of certain cancers so astonished the medical profession that an incentive to mine the uranium-bearing ores was created.

Shortly before 1910, metallurgical processes for relatively large-scale recoveries of radium from carnotite ores were perfected. The improved processes resulted in greatly increased demands for carnotite and in accelerated prospecting in southern Colorado. About one gram of radium is present in every 200 to 300 tons of ore containing 2.0 percent U_3O_8 .

Shortly after 1910, the carnotite deposits in southwestern Colorado and southeastern Utah became one of the principal world sources of radium (Tyler, 1930). For about 12 yrs, these deposits were mined for radium and yielded some byproduct uranium and vanadium. This activity lead to prospecting and the discovery of similar deposits in the Carrizo Mountains.

Early Prospecting

Outcrops containing uranium and vanadium minerals in the Carrizo Mountains were discovered by John F. Wade in about 1918 with the assistance of local Navajos (personal communication, 1955). Wade came from Farmington, New Mexico and operated the Sweetwater Trading Post in the western Carrizo Mountains (Fig. 1). Through business contacts and field trips. He had determined that the same rocks that contained the carnotite deposits of southwestern Colorado were present in the Carrizo Mountains. The

newly discovered deposits could not be mined because the Navajo Indian Reservation was then closed to prospecting and mining. A Congressional Act of June 30, 1919, opened the Navajo Reservation to prospecting and locating mining claims in the same manner as prescribed by the United States Mining Law of 1872. This Act allowed prospectors to enter the Reservation and stake a mining claim if their prospecting located promising mineral deposits. The locator of the claim then obtained a lease on this land under terms that included escalating advance royalties and rentals, and annual work commitments.

During the 1920s the Office of Indian Affairs (later changed to Bureau of Indian Affairs), U.S. Department of the Interior, issued four leases for metal mining in the Carrizo Mountains (GSA, 1981). Three of these were for carnotite mining. A fourth lease, located in the northeastern Carrizo Mountains is believed to have been for copper.

After the Navajo Indian Reservation was opened to prospecting and mining, John F. Wade, dba the Carriso Uranium Company, located 41 claims astride the Arizona - New Mexico state line in the vicinity of Milepost 16 (oral communication, 1955). The GSA (1981) could not locate the details of the Carriso Uranium Company's lease, except for the first year's rental \$44.36, on 177.45 acres was paid on May 19, 1922, and noted that no production was reported. This amount acreage would indicate that the Carrizo Uranium Company intended to retain only eight claims.

In April, 1921 the area was examined by W.H. Staver, a consulting mining engineer. Staver (1921) noted that the company's holding consisted of the South Butte, Bluebell, North Star, and Hilltop claim groups. The North Star Group was located astride the state line, with five claims in New Mexico and six claims in Arizona, and contained the only

development. Thirty-seven sacks of high-grade ore from these claims were stored at Beclabito Trading Post (Fig. 1). Staver estimated that a total of 2,900 tons of probable ore could be developed on the property. Although not developed, the mineralized exposures that would later be included in Plot 8 were no doubt claimed by Carriso Uranium Company. Butler and Allen (1921) mention that 500 ft of benching and 100 ft underground development had been done on the claims. Hess (1924) also visited the area of the Carriso Uranium Company's activities in 1921 and reported that no shipments had been made, and that the ore was richer in vanadium than in uranium.

By 1922 the radium industry in southwestern Colorado was beginning to decline as the carnotite ores were no longer competitive with the newly developed high-grade pitchblende ore in the Belgian Congo (now Congo). A vanadium market never developed, as there was little demand for domestic vanadium because of imports from Peru. The disposition of the stored ore at Beclabito was never mentioned in any of the early reports. However in 1926, Hess (1929) reported that the Utah Vanadium Company obtained some ore from the Carrizo Mountains and the ore was shipped to Denver for the production of fused vanadium oxide used by eastern ferroalloy manufacturers. Although there are no details on the size of this shipment, it represents the first vanadium production from the Carrizo Mountains. The shipment no doubt included the sacked ore observed by Staver at Beclabito, five year earlier.

On March 25, 1936, the Secretary of the Interior closed the Navajo Indian Reservation to claim location and prospecting for minerals until further authorization. In July 1936, an application to prospect was made to the Executive Committee of the Navajo

Tribal Council. The application asked the council to pass a resolution requesting the Secretary of the Interior to open the Navajo Indian Reservation for mining to the applicant. The resolution was rejected by the Executive Committee, which evidently did not want prospecting or mining on the Reservation at that time.

Leasing For Vanadium

By the mid-1930s the mines in the carnotite region of southwestern Colorado and southeastern Utah were being reopened for their vanadium content. At the same time, the Secretary of Interior was asked to open the Navajo Indian Reservation for prospecting and mining. The Navajo Indian Reservation was subsequently opened by a Congressional Act of May 11, 1938, but with new procedures. This Act gave the Tribal Council the authority to enter into leases for the Reservation land with approval of the Secretary of Interior. Prospectors no longer could enter the Reservation and stake a mining claim under regulation similar to those of the United States Mining Law. The new mining regulations contained escalating annual rentals, a base royalty of 10 percent (mine mouth value), bond requirements, acreage limitations, and a term of 10 years which could be extended by production.

On April 9, 1941, the Navajo Tribal Council requested the Secretary of the Interior to lease lands for mining purposed to the highest bidder. In order to take care of this situation, the mining leases were written for large areas and subsequently reduced in acreage at the end of the specified time period. The net effect of this type of lease was that a prospecting permit was issued to the highest bidder, who then had the right to lease

land within the permit area up to a maximum acreage. The maximum acreage a company could lease on the Reservation was 960 acres.

The East Reservation Lease

When the United States entered World War II, the demand for vanadium by the steel industry greatly increased. Due to the uncertainty of foreign supplies and the need for strategic materials, the Federal government formed Metals Reserve Company in December 1941. This agency was part of the Reconstruction Finance Corporation. The Metals Reserve vanadium program with increased ore prices, buying stations, etc., was the stimulus to renew interest in the carnotite deposits in the Carrizo Mountains. Metals Reserve's vanadium program was to acquire five million pounds V_2O_5 for the nation's strategic stockpile.

On May 29, 1942, in response to requests by several mining companies, the Office of Indian Affairs advertised an exploration lease sale for carnotite and related minerals in the eastern Carrizo Mountains. The area offered was described as follows:

“beginning at a point on the New Mexico-Arizona State Line which is approximately $8\frac{1}{3}$ miles south of the corner common to the states of Colorado, Utah, New Mexico, and Arizona; thence east 6 miles, thence south 12 miles; thence west 6 miles to the Arizona-New Mexico state line; thence west $3\frac{1}{2}$ miles; thence north 2 miles; thence east one mile; thence north

10 miles; thence east 2 ½ miles to the Arizona-New Mexico state line and in the point of beginning.”

The area contained approximately 104 sq mi. This was the second carnotite lease sale for Navajo lands held under the bidding procedures.

Bids were opened on June 15, 1942, at which time Vanadium Corporation of America (VCA) bid \$7,600, and John F. Wade and Thomas F.V. Curran, partner, bid \$7,550 (GSA, 1981, exhibit 31). As the bids were nearly equal, and since Wade and Curran offered to pay \$2,000 over and above the highest bid received, the General Superintendent of the Navajo Service requested that the Commissioner of Indian Affairs make the decision to award the lease. VCA was awarded the lease I-149-IND- 5705, which was executed on July 14, 1942, effective July 23, 1942, for a period of 10 yrs.

On September 2, 1943, the lease was reduced to a permanent operating lease and 12 plots totaling 436.79 acres were selected to be retained. Six of the plots (1-6) were on King Tutt Mesa, two on the plots (7, 10) were along the north side of the canyon of Oak Springs Wash and the remaining four plots (8, 9, 11, and 12) were in the vicinity of Milepost 16 on the New Mexico-Arizona State line. Each of the plots were named by VCA (Table 1). Lease I-149-IND-5705 was renamed as the “East Reservation Lease” by VCA. The mines on this lease were originally known as the Eastside mines, a name still used today in U.S. Geological Survey (USGS) reports. Plot 8, 20.66 acres, covered a small knoll south of Cottonwood Wash where uranium-vanadium minerals were exposed.

Vanadium Mining

Mining on the East Reservation Lease commenced in August 1942 on King Tutt Mesa. When the operations were examined by the USGS in November 1942, approximately 1,800 tons of ore with an average grade of 2.30 percent V_2O_5 had been produced (Duncan and Stokes, 1942, p. 26).

Mining continued through August 1944. Single shipments were recorded in February 1945 and in July 1947. Total vanadium production from Lease I-149-IND-5705 was 10,294.74 tons of ore containing 504,822.27 pounds V_2O_5 and averaging 2.47 percent V_2O_5 (Chenoweth, 1991). With the exception of the 1947 shipment, which was made to its mill at Naturita, Colorado, VCA shipped ore from this lease to the Monticello, Utah mill operated by VCA for the Metals Reserve Co. The Metals Reserve vanadium program ended in February 1944 when the strategic stockpile had been filled. At that time, mining all but ceased in the Four Corners area including the Carrizo Mountains. When Coleman examined the area in the summer of 1944 he did not record any evidence of mining on Plot 8 (Coleman, 1944, p. 14). Based on this examination, it is very possible that no ore was mined on Plot 8 during the vanadium era.

URANIUM MINING

The AEC Program

During 1947, the U.S. Atomic Energy Commission (AEC) began a procurement program on the Colorado Plateau to obtain uranium. The first domestic contract was signed with VCA on August 29, 1947, retroactive to May 20, 1947, to purchase uranium

concentrates from the company's mill in Naturita, Colorado. The AEC also contracted with VCA, effective October 8, 1948, to buy concentrates from the AEC-owned mill at Durango, Colorado, which VCA had leased with an option to buy (Albrethsen and McGinley, 1982).

Since a market had developed, VCA began prospecting and mining on their East Reservation Lease. In March 1948, shipments began from the lease, mainly from Plot 3 (Page Edwards, 1955, personal communication). Production in 1948 amounted to 1,302.62 tons averaging 0.29% U_3O_8 and 2.59% V_2O_5 (Table 2).

The reopening of the Durango mill in March 1949 resulted in a shorter haulage for the mines in the Carrizo Mountains and production from the East Reservation Lease increased to 4,331.62 tons (Table 2). It was not until early 1950 that VCA began to separate the shipments from the East Reservation Lease by the individual plots on mill receipts to the AEC. It is estimated that of the 6,757.90 tons mined in the 1948-1950 period (Table 2) only a few tons, if any, came from Plot 8.

In the spring of 1950, Alfred Nelson, a local Navajo who had previously mined vanadium for VCA, obtained a contract to mine Plot 8 for the company. Monthly shipments commenced in June 1950 and continued through March 1951. The ore was shipped to the VCA mill at Durango, Colorado for processing. When Mr. Nelson ceased mining, he had produced 141.44 tons of ore with an average grade of 0.25 percent U_3O_8 and 3.03 percent V_2O_5 (Table 3).

During the summer of 1953, the AEC drilled five core holes on Plot 8 as part of the East Carrizo No. 2 drilling project. None of the holes encountered uranium-vanadium minerals (Blagbrough and Brown, 1955, p. 16).

The mines on Plot 8 were idle until May 1954 when VCA company miners made a final shipment of 8.87 tons of ore averaging 0.19 percent U_3O_8 and 2.19 percent V_2O_5 (Table 3).

Summary

A total of 250.31 tons of ore averaging 0.25 percent U_3O_8 and 3.00 percent V_2O_5 can be definitely credited to the mines on Plot 8. This probably represents the entire amount of ore that was produced from the property.

All of the uranium that was recovered from the ore at the Durango mill was sold to the AEC. The vanadium concentrates were purchased by the steel industry.

Acknowledgments

Virginia T. McLemore of the New Mexico Bureau of Mines and Mineral Resources reviewed an earlier version of this report, and her comments are appreciated.

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Legal Description Of Plot 8, Lease No. I-149-IND-5905

"Beginning at Corner 1, which bears S. 68° 59'S., 1,982.59 feet to the Witness Corner of Milepost 16 on the New Mexico-Arizona State Line, thence S. 84° 27'E., 1,500 feet to Corner No. 2, thence N. 5° 33'E., 600 feet to Corner No. 3 thence N. 84° 27'W., 1,500 feet to Corner No. 4, thence S. 5° 33'W., 600 to Corner No. 1 the point of beginning. Containing 20.66 acres more or less."

From the files of the Navajo Tribal Mining Department, Window Rock Arizona.

Table 1.

Location, Name and Size of Plots, East Reservation Lease

Number	Plot Name	Acres	Location
1	Red Wash Point	3.53	S.E. King Tutt Mesa
2	King Tutt Point	9.14	S.W. King Tutt Mesa
3	Shadyside	145.13	Central King Tutt Mesa
4	Williams Point	8.62	N. Central King Tutt Mesa
5	Fissure	1.57	N. Central King Tutt Mesa
6	Franks Point	6.23	N.W. King Tutt Mesa
7	Lower Oak Creek	205.39	Oak Creek Canyon
8	Cottonwood Butte	20.66	N. Of MP-16
9	Lone Star	6.20	E. of MP-16
10	Oak Springs	5.53	S.E. of Oak Springs
11	White Cap	20.66	S.W. of MP-16
12	Syracuse	4.13	W. of MP-16
Total		436.79	

All were located in San Juan County, New Mexico except numbers 10, 11, and 12 in Apache County, Arizona.

Source: Unpublished data, U.S. Atomic Energy Commission, Grand Junction, Colorado office.

Table 2. Uranium - vanadium ore production only identified as being shipped from the East Reservation Lease, New Mexico - Arizona

YEAR	SHIPPER	TONS OF ORE	POUNDS U_3O_8	% U_3O_8	POUNDS V_2O_5	% V_2O_5
1948	VCA	1,302.62	7,613.87	0.29	67,396.00	2.59
1949	VCA	4,331.62	15,090.72	0.17	174,222.00	2.01
1950	VCA	1,123.44	7,081.30	0.31	69,895.00	3.11
TOTALS		6,757.68	29,785.89	0.22	311,503.00	2.30

Source: Unpublished AEC ore production records.

Majority of ore shipped from Plot 3, also includes minor production from Plots 1,2,4,6,7,9,11, and 12.

Table 3. Uranium-vanadium ore identified as being produced from Plot 8. Cottonwood Butte, San Juan County, New Mexico

YEAR	QTR	SHIPPER	TONS OF ORE	POUNDS OF U_3O_8	% U_3O_8	POUNDS OF V_2O_5	% V_2O_5
1950	2nd	Alfred Nelson	21.23	92.88	0.22	1,241.00	2.92
1950	3rd	Alfred Nelson	92.54	340.49	0.19	5001.00	2.70
1950	4th	Alfred Nelson	70.55	484.46	0.34	4,624.00	3.28
1951	1st	Alfred Nelson	57.12	293.10	0.26	3,759.00	2.20
1954	2nd	VCA	8.87	33.69	0.19	388.00	2.19
TOTALS			250.31	1,244.62	0.25	15,013.00	3.00

Source: Unpublished AEC ore production records.

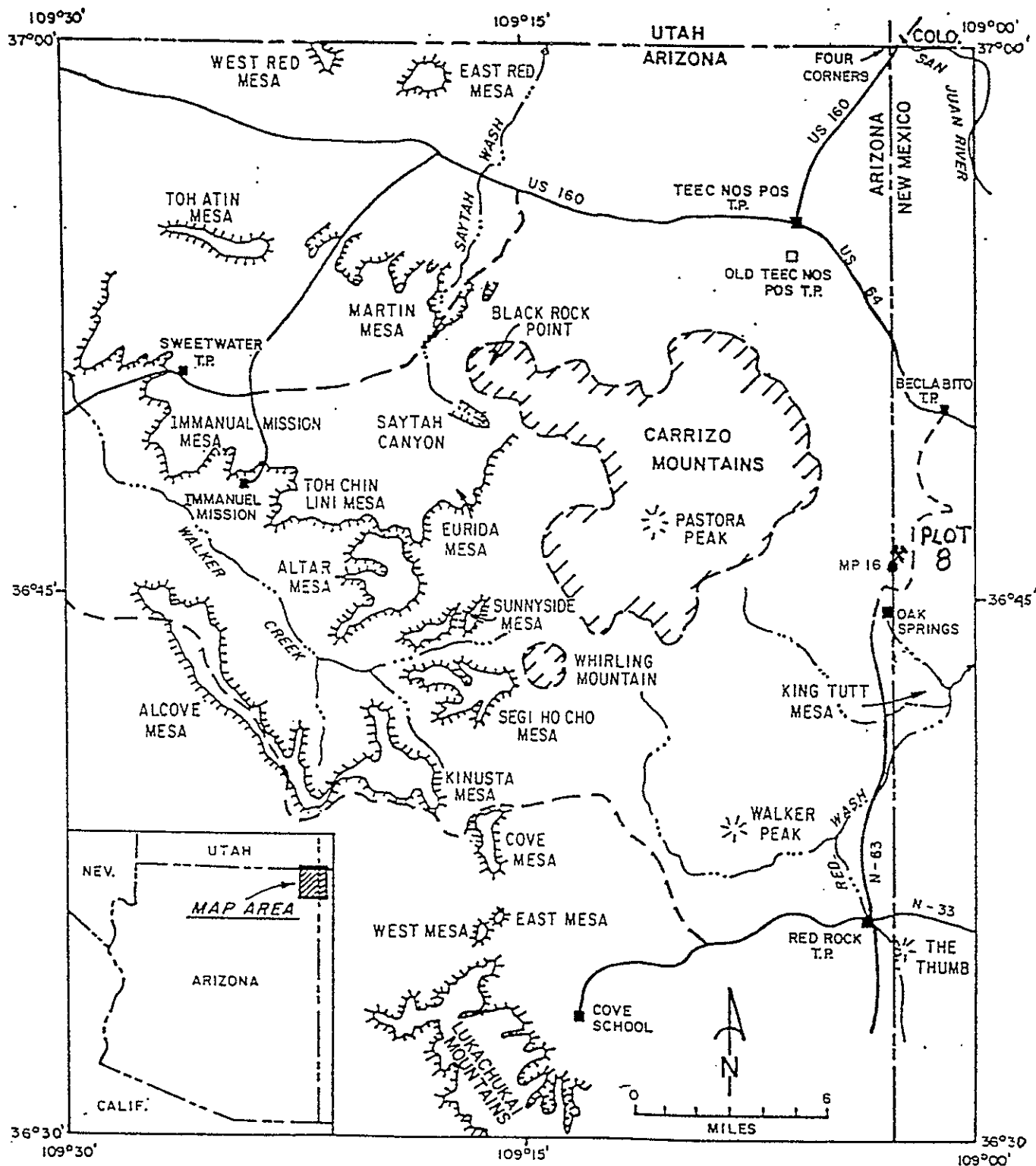


Figure 1. Index map of the Carrizo Mountains, Arizona-New Mexico showing the location of Plot 8.

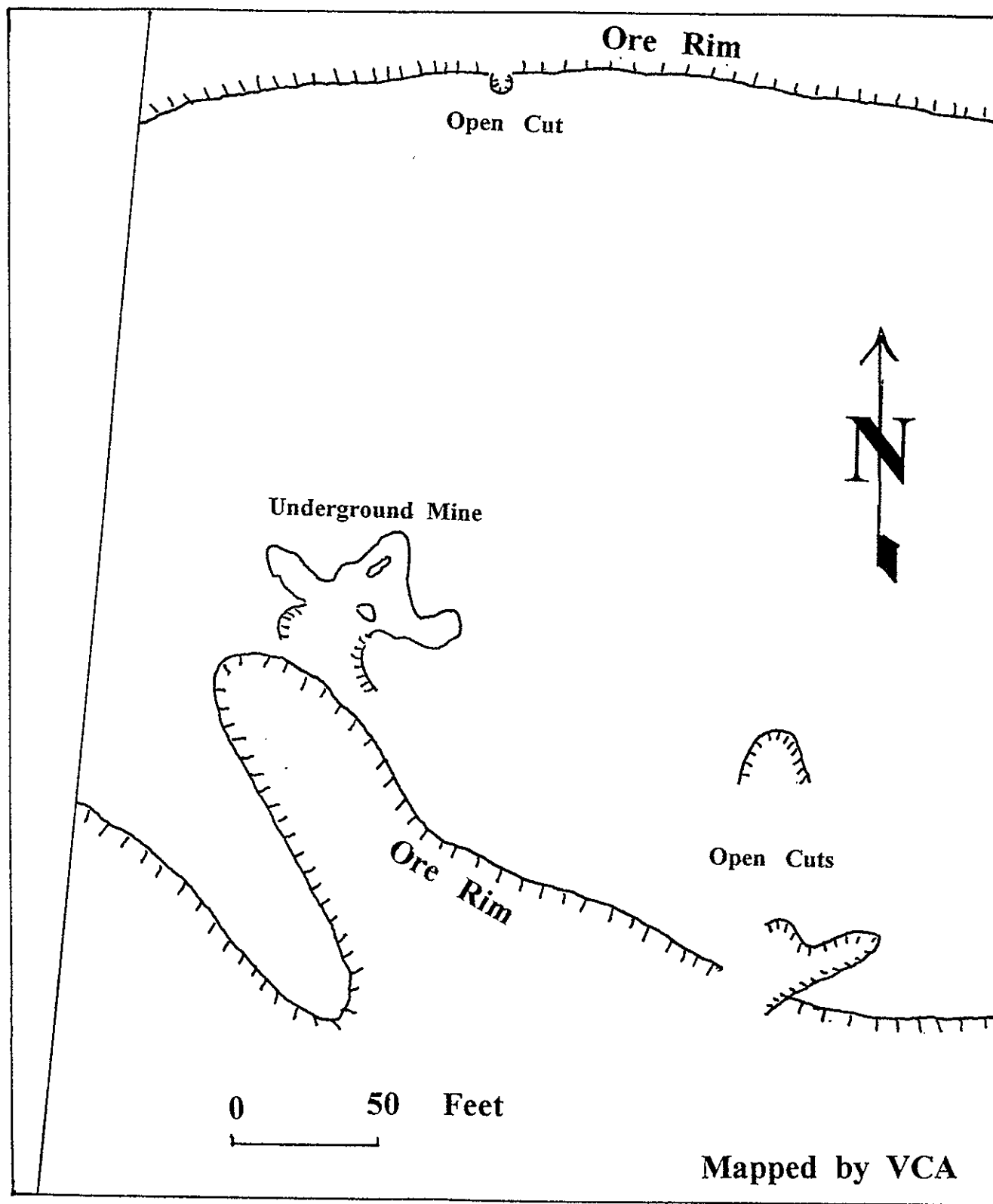


Figure 2. Plan map of the principal mine workings, Plot 8, East Reservation Lease, San Juan County, New Mexico

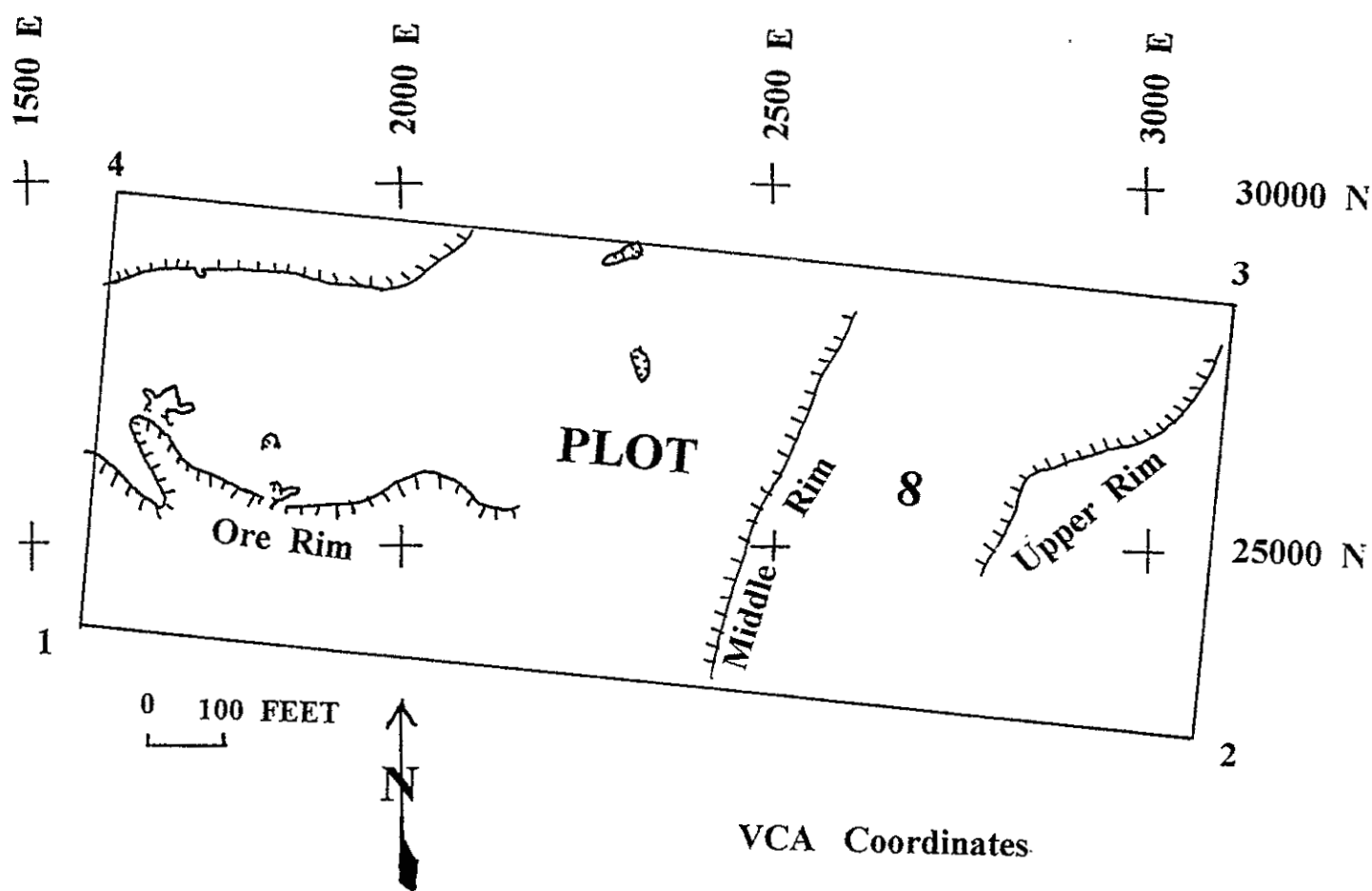


Figure 3. Plan map of the Cottonwood Butte uranium-vanadium mine, Plot 8, East Reservation Lease, San Juan County, New Mexico.