

**THE GEOLOGY, LEASING AND  
PRODUCTION HISTORY OF THE  
SUNNYSIDE URANIUM-VANADIUM  
MINE, APACHE COUNTY, ARIZONA**

by

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## INTRODUCTION

The Sunnyside 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 mine, on Sunnyside Mesa, is located in a very remote area of the western Carrizo Mountains.

During 1943 nearly 500 tons of vanadium ore was produced. In 1955, 28 tons of uranium-vanadium ore was produced as the result of cleanup mining in the abandoned mine. This report is intended to supplement the information on the mine reported by Scarborough [1981, p. 129].

## LOCATION AND LAND STATUS

The Sunnyside mine is located on the east rim of Sunnyside Mesa which is nine miles southeast of the settlement of Immanuel Mission in the western Carrizo Mountains (Figure 1). The mine is located approximately 600 feet southeast of U.S. Mineral Monument No. 3 which is marked as 6514T on the Kinusta Mesa 1:24,000-scale quadrangle [U.S. Geological Survey, 1982]. The latitude of the mine is 36° 44' 35" N and the longitude is 109° 16' W38" W. The mine was accessible by unimproved dirt trails that head southeast from Immanuel Mission, up the valley of Walker Creek for about eight miles and then easterly up the valley of White Rock Wash approximately five miles to Sunnyside Mesa. The mine is approximately 100 feet above the valley floor on the east side of the mesa.

The Sunnyside mine is located within the Navajo Indian Reservation. On the Reservation, all prospecting, exploration and mining is controlled by the Navajo Tribal Council and the Bureau of Indian Affairs, U.S. Department of the Interior.

## 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. 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 Arizona Geological Survey Library.

## GEOLOGIC SETTING

The uranium-vanadium ore bodies at the Sunnyside mine occur in the Salt Wash Member of the Upper Jurassic Morrison Formation. In the western Carrizo Mountains, the Salt Wash Member is 180 to 220 feet thick. It is composed of gray, fine- to very fine-grained, well rounded, quartz sandstone with interbedded lenses in beds of reddish-brown and greenish-gray mudstone and siltstone. Between 5% and 15% of the total thickness of the member consists of mudstone and siltstone beds. Huffman and others [1980] have subdivided the Salt Wash Member in the Carrizo Mountains into three stratigraphic units based on depositional environments. The lowermost unit consists of an average of 30 feet of predominately overbank deposits and alternating thin mudstone and sandstone. It contains few channel sandstones. The middle stratigraphic unit is an average of 70 feet thick and is composed of channel-sandstone deposits, partially and completely abandoned channel-fill deposits, and overbank deposits. Approximately 80% of the sandstone in this unit is active channel fill. The upper unit is 120 feet 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].

The channel sandstone that contains the ore bodies at the Sunnyside mine is approximately 55 feet above the base of the Salt Wash, within the middle unit of the member. 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 ore bodies were formed by the selective impregnation of the sandstone and adsorption by the mudstone and fossil plant material. Ore bodies were commonly associated with detrital plant fragments in the sandstone. The ore bodies were roughly tabular in cross-section and irregular in plan. They ranged from several feet in width to a nearly thirty feet in length. Thicknesses at the Sunnyside mine ranged from a feather edge to up to three feet.

The deposits were originally called carnotite after the bright yellow mineral carnotite, a potassium uranium vanadate. Later work by Corey [1956, 1958] and S.R. Austin [written communication, 1967] have identified tyuyamunite, a calcium uranium vanadate, and meta-tyuyamunite as the only uranium minerals in the Carrizo deposits. The mineralogy of the Martin mine in Saytah Wash was studied by Corey [1956]. In this mine,

tyuyamunite was the only uranium mineral identified. The vanadium mineral montrosite was present as were pascolite and volborthite [Corey, 1956]. Calcite was the major cementing agent. Pyrite, limonite, hematite and gypsum were also present in the ore at the Martin mine.

The beds of the Salt Wash on Sunnyside Mesa dip five degrees to the west due to the Carrizo intrusive three miles east of the mesa.

## EARLY LEASING FOR RADIUM

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 western 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 years, these deposits were mined for radium and yielded some byproduct uranium and vanadium. This activity led to prospecting and the discovery of similar deposits in the Carrizo Mountains.

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 (Figure 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, Radium Ores Company, John F. Wade, president, located 28 claims in the northern and western Carrizo Mountains (Figure 1). Details of the location and size of the claims are given in Table 1. Another of Wade's companies, Carriso Uranium Company located 41 claims in the vicinity of the Arizona - New Mexico state line Milepost 16, in the eastern Carrizo Mountains (Figure 1).

In November, 1920 Radium Ores Company produced 40,000 pounds of ore valued at \$1,600. A transportation charge of \$1,200 left the value at only \$400 [GSA, 1981]. It is possible that this material was shipped to the Standard Chemical Company's ore-buying station near Naturita, Colorado, which was buying carnotite ores for their radium content in the 1910s and 1920s. The November, 1920 shipment represented the first production of carnotite ore from the Carrizo Mountains. According to Wade [personal communication, 1955] this shipment came from mineralized exposures along Saytah Wash. This shipment was apparently made in trespass, as Radium Ore Company's lease did not become effective until December 23, 1922 [GSA, 1981]. At that time, Radium Ores paid their first year's rental of \$142.50 for the 570.016 acres held under lease [GSA, 1981].

Radium Ores apparently never canceled their lease and by 1931, some \$3,990.00 in back rent was due [DeVoto and Huber, 1982]. The Federal government apparently settled with the bonding company in 1932 for \$500.00 [DeVoto and Huber, 1982].

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. A vanadium market never developed, as there was little demand for domestic vanadium because of imports from Peru.

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 regulation 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 5, 1940, effective May, 1940, John F. Wade, Thomas F. Curran, and H. R. Redington (d.b.a. Wade, Curran and Co.) leased 42.32 acres in the Carrizo Mountains. This lease, I-149-IND-4225, covered the Sunnyside Lode Claim of 20.66 acres on Sunnyside Mesa and the Syracuse Lode Claim of 20.66 acres in the eastern Carrizo Mountains (Figure 1). The claims were described by U.S. Mineral Survey Nos. 3700 and 3857. The lease was for a period of five years. These two claims covered ground that John Wade's companies had previously leased in the 1920s.

When the United States entered World War II, the demand for vanadium by the steel industry increased significantly. Due to the uncertainty of foreign supplies and the need for vanadium, and other strategic materials, the Federal government had formed Metals Reserve Company in December 1941. This agency was part of the Reconstruction Finance Corporation. The Metals Reserve vanadium program stimulated renewed interest in the carnotite deposits in the Carrizo Mountains with increased ore prices and by establishing buying stations. At Monticello, Utah and Durango, Colorado, Metals Reserve had mills to process vanadium ore.

The two claims comprising Lease I-149-IND-4425 were inactive until the Metals Reserve program was in place. Ore shipments from the lease began in July, 1942 and continued through October, 1943. Total production from the lease was 966.30 tons of ore containing 84,417.95 pounds  $V_2O_5$ , and averaging 4.37%  $V_2O_5$  (Table 2). Ore mined from the two claims was trucked to Farmington, New Mexico. Here it was transferred to rail cars to be shipped on the narrow gage railroad to the Metals Reserve mill at Durango, Colorado, operated by U.S. Vanadium Corporation.

Shipments from the two claims were not kept separate, but John Wade [oral communication, 1955] stated the Syracuse was the first to be mined as it was more accessible than the Sunnyside. When Duncan and Stokes [1942, p. 25] examined the Sunnyside mine in November, 1942, they noted that the mine was idle and a few tons of ore were stockpiled. The mine workings consisted of a short adit and an open cut.

Harshbarger [1946, p. 25] reported that the records of the Metals Reserve Company indicated that from May through October, 1943 the Sunnyside mine produced 475 tons of ore containing 24,395 pounds  $V_2O_5$  and averaging 2.57%  $V_2O_5$ . Figure 2 is a map of the Sunnyside mine as mapped by Harshbarger and Smyth on August

28, 1945 [Harshbarger, 1946, fig. 25]. At that time, Harshbarger [1946, p. 41] described the Sunnyside mine as follows:

“North-south elongated ore body of gray, calcareous, vanadiferous sandstone and varied amounts of disseminated carnotite concentrated around mineralized trees and vegetal trash. Lenticular, irregular ore seams usually near or along small shale or carbonaceous shaly sandstone seams. Greatest thickness and best grade of ore near portals.”

Lease I-149-IND-4225 was due to expire on May 9, 1945, but was apparently canceled earlier [DeVoto and Huber, 1982].

## URANIUM MINING

In 1948, the newly created U.S. Atomic Energy Commission (AEC) began a well publicized program to acquire uranium for national defense. In order to cope with a large number of individual Navajos who wished to prospect, the Interior Department and the Navajo Tribal Council developed new regulations in 1949 that allowed individual Navajos to prospect. If a discovery was made, the ground would be held by a tribal mining permit. In 1951, additional regulations allowed non-Navajos to prospect on the Reservation, but only Navajos could obtain a mining permit. Permits could be assigned to an individual or company to explore and mine. Permits were issued for two years and could be renewed. Both the Tribe and the permittee received royalties.

On November 16, 1954, H.D. Thomas was issued Navajo Tribal Mining Permit No. 218. This permit included 40 acres on Sunnyside Mesa and 147.2 acres on Eurida Mesa (Figure 1). On August 2, 1956, the mining rights to the permit were assigned to Frontier Mining Company of Farmington, New Mexico.

In September, 1955, Jack H. Leonard of the Frontier Mining Company, told the author [personal communication, 1955] that the company had “acquired the Sunnyside mine through John Wade, who had retained his lease since the days of Curran Brothers and Wade.” This was not a true statement since the earlier lease of Wade, Curran and Company was canceled prior to 1945 [DeVoto and Huber, 1982].

During August through October 1955, Frontier Mining Company shipped a total of 27.69 tons of ore averaging 0.16 percent  $U_3O_8$  and 3.14 percent  $V_2O_5$  to the mill at Shiprock, New Mexico operated by Kerr-McGee Oil Industries, Inc. (Table 3). Records of the Navajo Tribal Mining Department, at Window Rock, Arizona indicate the assignment of Mining Permit No. 218 was canceled by Frontier on August 2, 1956. There is no record of any ore being produced from the Eurida Mesa parcel of the permit.

When the author examined the Sunnyside mine in June 1962, it appeared that the 28 tons had come from clean up mining, mainly from mine pillars. No drill holes were observed behind the mine workings.



## SUMMARY

Although originally leased for radium mining in the 1920s, the remote location of the mineralized exposure on Sunnyside Mesa hindered its development. In 1943, as the result of the Metals Reserve Company's vanadium program, 475 tons of vanadium ore were produced. Uranium in the ore was secretly recovered at the Durango mill for the Manhattan Project [Chenoweth, 1997]. During the uranium boom, created by AEC programs, 28 tons of uranium-vanadium ore were produced in 1955 as the result of clean up mining at the abandoned mine.

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Table 1. Claims included in Radium Ores Company carnotite lease

<i>NAMES</i>	<i>ACRES</i>	<i>LOCATION</i>
Sunnyside	20.661	Sunnyside Mesa
Eurida Nos. 1,2,3,5	103.305	Eurida Mesa
Eurida No. 4	20.661	Eurida Mesa
Preston, Preston No. 1, Stormy Day	61.983	Saytah Wash
Preston Nos. 2,3,4,5,	82.644	Saytah Wash
Say Tah, Martin	41.322	Saytah Wash
Martin Nos. 2-13	230.440	Saytah Wash
	570.016	Total Acres

Source: GSA (1981)

See Figure 1 for locations.

Table 2. Vanadium ore production, Lease I-149-IND-4225, Syracuse and Sunnyside claims, Apache County, Arizona

<i>YEAR</i>	<i>QUARTER</i>	<i>TONS OF ORE</i>	<i>POUNDS V<sub>2</sub>O<sub>5</sub></i>	<i>% V<sub>2</sub>O<sub>5</sub></i>	<i>VALUE</i>
1942	3rd	94.14	26,332.68	13.99	8,273.85
1942	4th	151.64	17,741.89	5.85	8,541.73
1943	1st	194.85	12,542.07	3.22	5,676.56
1943	2nd	211.29	13,639.32	3.23	6,429.46
1943	3rd	291.82	12,930.49	2.22	6,175.99
1943	4th	22.56	1,231.50	2.73	565.49
<b>TOTAL</b>		966.30	84,417.95	4.37	\$35,663.08

Royalty paid to the Navajo Tribe - \$5,442.55

Source: GSA [1981]

Table 3. Uranium-vanadium ore production, Sunnyside Mine, Apache County, Arizona

<i>YEAR</i>	<i>QTR</i>	<i>OPERATOR</i>	<i>TONS OF ORE</i>	<i>POUNDS U<sub>3</sub>O<sub>8</sub></i>	<i>%U<sub>3</sub>O<sub>8</sub></i>	<i>POUNDS V<sub>2</sub>O<sub>5</sub></i>	<i>%V<sub>2</sub>O<sub>5</sub></i>
1955	3rd	Frontier Mining	16.37	50.60	0.15	986.11	3.01
1955	4th	Frontier Mining	11.32	40.75	0.18	751.65	3.32
<b>Total</b>			27.69	91.35	0.16	1,737.76	3.14

Source: Unpublished ore production records, U.S. Atomic Energy Commission, Grand Junction, Colorado

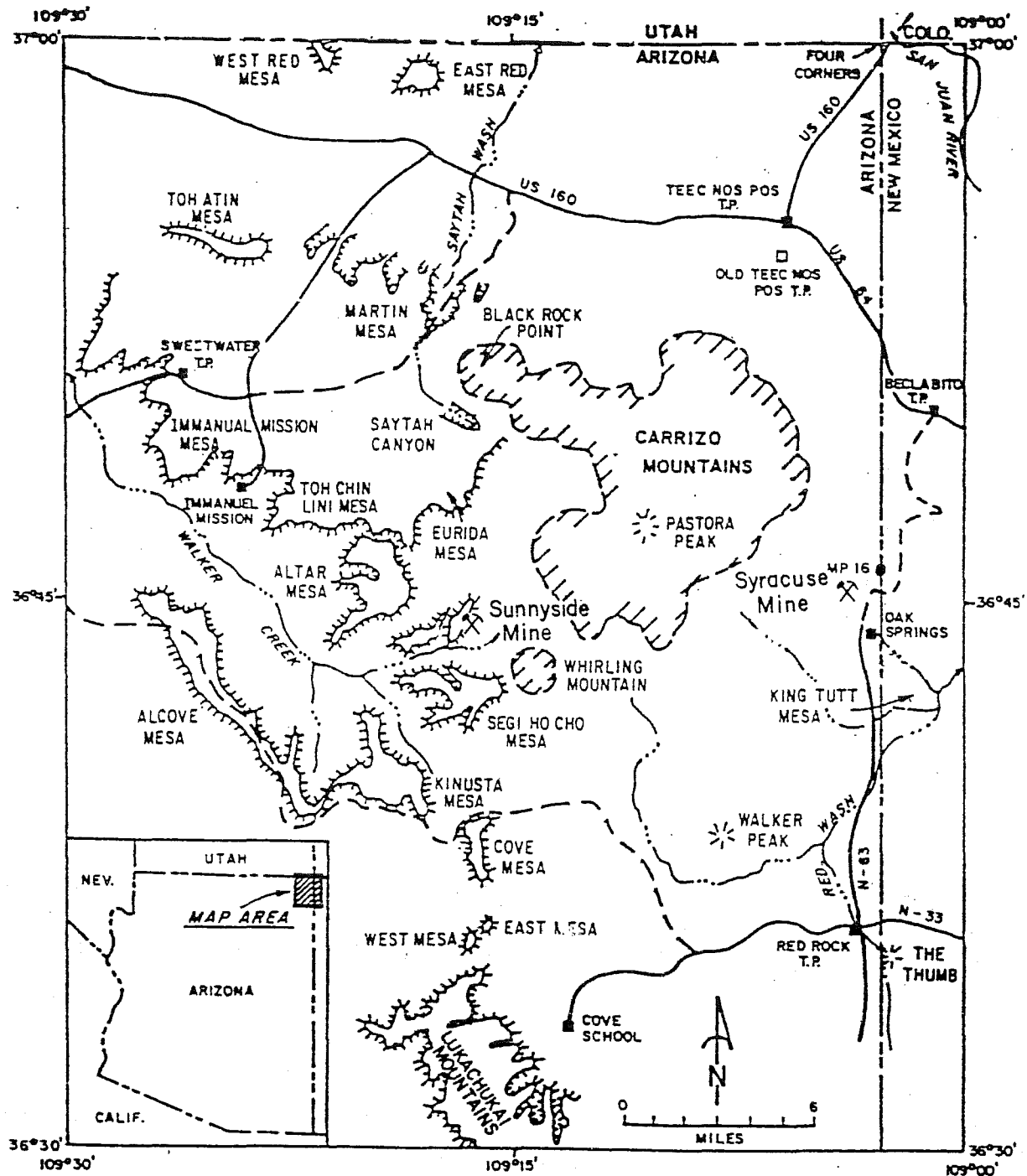


Figure 1. Index map of the Carrizo Mountains, Arizona-New Mexico showing the location of the Sunnyside and Syracuse mines.



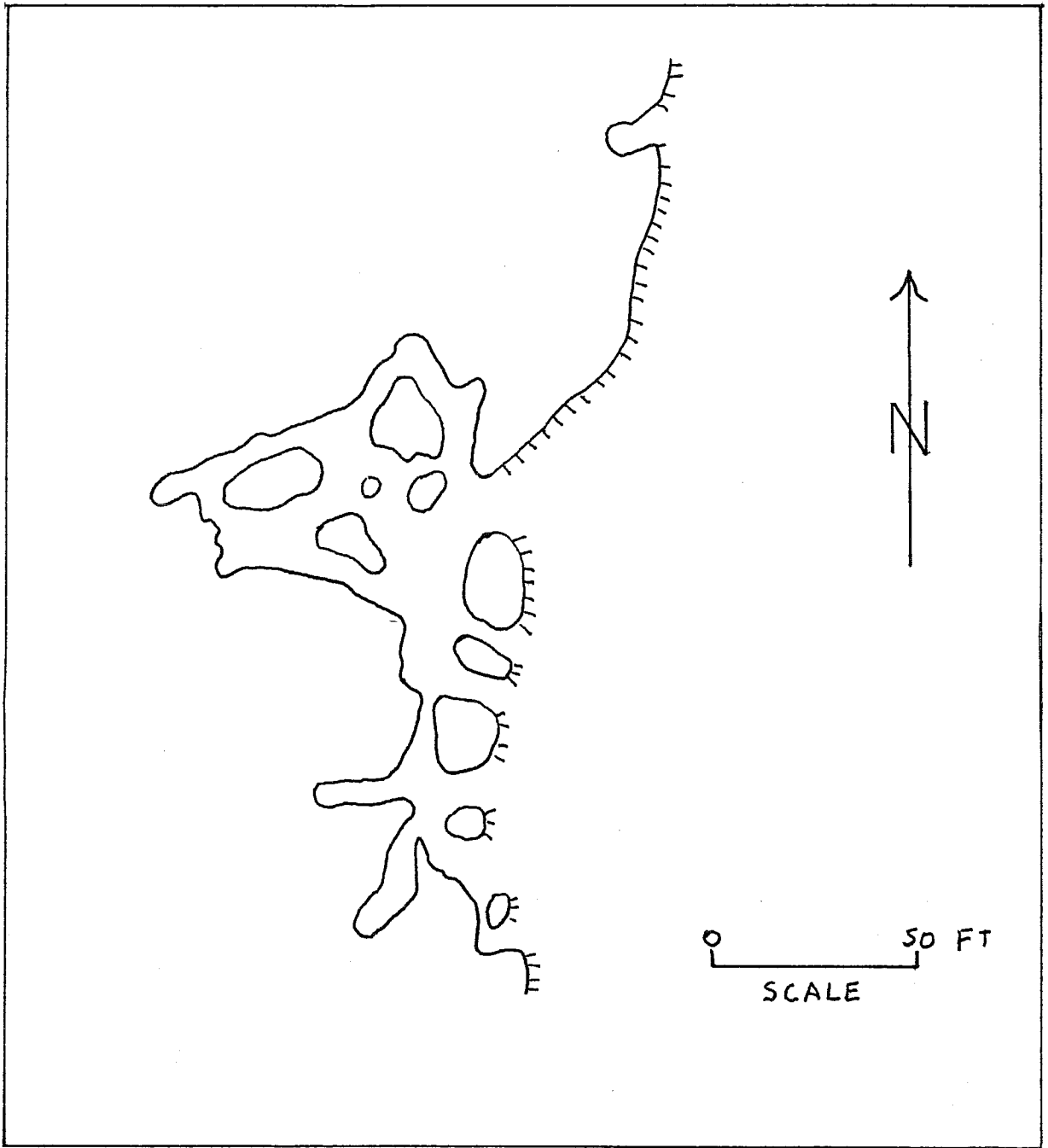


Figure 2. Map of the Sunnyside mine, August 28, 1945.  
From Harshbarger (1946, fig. 25).