# The Geology, Leasing, and Production History of the Rattlesnake No. 1/Shorty No. 1 Uranium-Vanadium Mine, Apache County, Arizona

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July, 2003

Arizona Geological Survey
**Contributed Report CR-03-D**

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*Interpretations and conclusions in this report are those of the consultant and do not necessarily coincide with those of the staff of the Arizona Geological Survey*

This report is preliminary and has not been edited or reviewed for conformity with Arizona Geological Survey standards.

# INTRODUCTION

The mineralized outcrops that would be developed into the Rattlesnake No. 1 uranium-vanadium mine were some of the earliest to be found on the north side of the Carrizo Mountains, Apache County, Arizona. This mine would later be known as the Shorty No. 1 mine. Uranium-vanadium minerals occurred in an isolated exposure of the Salt Wash Member of the Late Jurassic Morrison Formation at the edge of the Carrizo laccolith. Recent examination of the Bureau of Indian Affairs ore production royalty records indicate the mine produced over twice as much ore as previously reported [Scarborough, 1981, p. 126]. A map of the mine workings prepared by the author after mining ceased has been located and is included with this report.

# LOCATION

The Rattlesnake No. 1 mine was located on the west rim of the small canyon approximately 3 miles south, southwest of the old Teec Nos Pos Trading Post (Fig. 1). The mine was one half mile due west of the Holmes Dike, a prominent landmark in this area of the Carrizo Mountains. In the late 1960s, the trading post was relocated to near the junction of the nearly constructed U.S. Highways 160 and 64 (Fig. 1). These federal highways replaced the old unpaved Navajo Route 1 from Shiprock, New Mexico to Kayenta, Arizona.

The location of the uranium-vanadium deposits that were mined is shown on a map by Stokes [1951]. The small outcrop of Bluff Sandstone exposed in the canyon below the mine is shown on a geologic map of the Carrizo Mountains [Strobell, 1956] at 36θ52 '30" north latitude and 109θ07' 30" west longitude.

During the time the mine was active, it could be reached via a rough, dirt road that turned south off of Navajo Route 1 just west of the trading post. This road is shown on Strobell's [1956] map. On the latest topographic quadrangle [USGS, 1983] the last one half mile of the former road is shown as a trail.

## 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 (U.S. Energy Research and Development Administration and the U.S. Department of Energy). Information on 1944 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. The Grand Junction Area Office of the U.S. Department of Energy obtained a copy of the vanadium and uranium section of this report. A copy of the GSA report has been donated to the Arizona Geological Survey Library.

Copies of the ore production royalty records, prepared by the Conservation Division, U.S. Geological Survey for the Bureau of Indian Affairs [Allport, 1949, 1952, 1953], were located in the AEC records at the Department of Energy, as was a map of the mine workings.

## LAND STATUS

The Rattlesnake No. 1 mine is located within the Navajo Indian Reservation. On the Reservation all prospecting, leasing, and mining are controlled by the Navajo Tribal Council and the Bureau of Indian Affairs, U.S. Department of the Interior. During the 1940s mining companies obtained leases from the Secretary of the Interior to mine on the Navajo Reservation. Due to the uranium boom on the Colorado Plateau, the Tribal Council adopted Resolution CM-3-51 on March 22, 1951 authorizing the Advisory Committee to draft new mining regulations. New regulations pertaining to prospecting and mining were adopted on April 27, 1951 and were approved on September 19, 1951. The new regulations stated that all prospectors must have a permit. Mining permits and leases were to be issued by the Navajo Tribal Council and approved by the Bureau of Indian Affairs (BIA), U.S. Department of Interior. Only individual Navajos could obtain mining permits. Permit holders could assign the mining rights to another individual or a company; like the permits, these assignments had to be approved by the Tribal Council and the BIA. Any one company or individual could hold no more than 960 acres of tribal land. Both the permittee and the tribe would receive royalties from ore production.

# GEOLOGICAL SETTING

The Rattlesnake No. 1 mine is located in an isolated exposure of the Salt Wash Member of the Morrison Formation, of Late Jurassic Age, that outcrops on the north side of the Carrizo Mountains [Stokes, 1951, Strobell 1956]. In the western Carrizo Mountains, the Salt Wash is approximately 200 ft thick. It is composed pale gray to greenish-gray, fine-grained, well sorted sandstone with rounded to subrounded grains of predominately quartz which occur in lenses rarely obtaining a thickness of 20 ft. Five to eight percent of the total Salt Wash Member consists of thin beds of reddish-brown and greenish-gray mudstone and siltstone that are interbedded with the sandstone lenses.

Huffman and others [1981] have subdivided the Salt Wash Member in the Carrizo Mountains 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. Recent investigations of the Morrison Formation by Anderson and Lucas [1998] have determined that this lower unit should be included with the underlying Bluff Sandstone and not with the Morrison Formation.

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 deposited in generally eastward flowing fluvial system [Craig and others, 1955]. The channel sandstone that contain the ore bodies at the Rattlesnake No. 1 mine is approximately 30 to 40 ft above the base of the Salt Wash, within this middle unit of the member.

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 represents a prograding wet, alluvial fan [Huffman and others, 1980].

The uranium-vanadium ore bodies were formed by the selected impregnation of the sandstone and adsorption by the mudstone and fossil plant material. Detrital organic plant material, such as leaves, branches, limbs and small trunks are common in the ore-bearing sandstone. Most all of this material is carbonized. The larger ore bodies were commonly associated with the plant material. Ore thicknesses ranged from a featheredge to a maximum of two ft with an average of one and a half ft.

The ore deposits in the Carrizo Mountains were originally called carnotite after the bright yellow mineral carnotite, a potassium uranium vanadate. After studying dozens of samples, including work by Corey [1956, 1958], S. Ralph Austin, AEC petrologist, identified only tyuyamunite, a calcium uranium vanadate, and metatyuyamunite as the only uranium minerals in the Carrizo deposits [written communication, 1967].

In a study of the mineralogy and petrology of the Martin mine in Saytah Wash (Fig 1), Corey [1956] found tyuyamunite to be the only uranium mineral present. Vanadium was present in the tyuyamunite and in the mineral montrosite, an iron, vanadium oxide. Vanadium minerals pascolite and volborthaite were found as stains on surface outcrops at the Martin mine. Calcite was the major cementing agent of the ore. Pyrite, limonite, hematite and gypsum were also present in the ore at the Martin mine [Corey, 1956].

The beds of the Salt Wash member at the Rattlesnake No. 1 mine dip 11 degrees to the northeast. This deformation is due to an igneous sill of the Carrizo laccolith that is exposed south of the mine.

## PRODUCTION HISTORY

In the fall of 1943, Navajo prospectors located vanadium-bearing outcrops of the Salt Wash sandstone about three miles southwest of Teec Nos Pos Trading Post (Fig. 1). This is the old location, as the trading post is now located two miles to the north on U.S. Highway 160 (Fig. 1). In the 1940s, all mining leases were made as the result of competitive, sealed bids. Vanadium Corporation of America (VCA) asked the Office of Indian Affairs that a 13.50-acre tract be advertised on January 11, 1944. When the bids were opened on February 1, 1944, VCA was the only bidder with a bonus bid of $600.00. [GSA, 1981]. Lease I-149-IND-6342 was executed on February 8, 1944, effective April 1, 1944. VCA named the lease Rattlesnake No. 1. This lease had a 10 percent royalty to the Navajo Nation. The royalty was based on the value of the ore at mine.

Geologists with the Union Mines Development Corporation, P. Partridge and E. H. Eakland, Jr., examined the area on April 11, 1944. Union Mines was the geologic contractor to the Manhattan Engineer District, and was evaluating the uranium resources of the Salt Wash Member of the Morrison Formation, on the Colorado Plateau [Chenoweth 1988]. They made a reconnaissance map of the area (Fig. 2) and described the exposure as follows [Harshbarger, 1946 p. 42].

> "TNP-1: The largest outcrop of the group, 60 ft. long but partly covered with talus. Average thickness is about 2 ft. Exposed for depth of 20 ft. Ore occurs in steeply cross-bedded, light-brown, friable sandstone. 40 ft. To south there are 2

spots of similar ore, totaling 20 ft. in length with an average thickness of 1 ft. Estimated grade is 1% to 1.5% $V_2O_5$.

TNP-2: A 48-ft. outcrop with average thickness of 0.5 ft. A maximum thickness of 1.5 ft. Estimated grade about 1% $V_2O_5$.

TNP-3: a 12-ft. outcrop with an average thickness of 1 ft. Estimated grade about 2% to 3% $V_2O_5$. Working in development stage.

TNP-4: a 61-ft. outcrop on thin streaks having as average thickness of 0.2 to 0.3 ft. but with local swells to 0.8 ft. Estimated grade is about 1% $V_2O_5$."

During the summer of 1944, VCA mined 146 tons of ore containing 361 pounds $V_2O_5$ and averaging 0.12 percent $V_2O_5$ (Table 1). This ore was shipped to the company's mill at Naturita, Colorado. The value of this ore was $225.77 of which the Navajo Nation was due a royalty of $2.03 [GSA, 1981].

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 for uranium had developed, VCA began prospecting and mining on their vanadium leases in the Carrizo Mountains. Using company miners, VCA began shipments from the Teec Nos Pos lease in December 1948 and continued through June 1949 (Table 2). The ore was trucked initially to the company's mill at Naturita and later to the company's mill at Durango. In March 1950, Leo Redhouse, a Navajo contractor, commenced mining and made shipments through September 1950 and also in December 1950 (Table 2). Earl Saltwater, another contractor, began mining on the Teec Nos Pos lease in February 1951 and shipped ore through July 1951 (Table 2). Leo Redhouse resumed mining on the Teec Nos Pos lease in August 1951 and continued shipments into February 1952 when Earl Saltwater took over the mining. Saltwater's shipments continued through April. Redhouse made shipments in May and August 1952. Saltwater shipped ore in June and August through November 1952 and in March and in June 1953 (Table 2). The June 1953 shipment would be the last while VCA controlled the lease. On February 18, 1954, VCA applied to the Bureau of Indian Affairs to have Lease I-149-IND-6342 terminated. The lease was terminated on March 3, 1954.

Under the AEC program the Rattlesnake No. 1 lease produced 2,672.88 tons of ore containing 9,515.48 pounds $U_3O_8$ and 96,070 pounds $V_2O_5$ with average grades of 0.18 percent $U_3O_8$ and 1.80 percent $V_2O_5$ (Table 2). This is in contrast to the 962.53 tons averaging 0.17 percent $U_3O_8$ and 1.72 percent $V_2O_5$ shown in the AEC records and used by Scarborough [1981].

The author believes the early AEC records are confused due to the fact both Leo Redhouse and Earl Saltwater also mined at the VCA's Rattlesnake mines in the northwest Carrizo Mountains (Fig. 1). This was during the same time frame they worked at the Rattlesnake No. 1 mine. The ore production royalty sheets prepared by the U.S. Geological Survey, Conservation Division, acting as an agent for the Bureau of Indian Affairs, give detailed information on a monthly basis including the values of the ore and the royalty due the Navajo Nation [Allport, 1949, 1952, 1953]. These records are believed to be a correct source of information. The value of the ore mined during the 1948-1953 period was $48,666.35 of which the Navajos received $4,834.32 in royalties {Allport, 1949, 1952, 1953].

Upon learning that VCA had canceled their lease, Paul Shorty, a Navajo who had mined for VCA on King Tutt Mesa became interested in the area. On June 11, 1955 he was issued Navajo Tribal Mining Permit No. 309 which covered the same 13.50 acres as the former VCA lease. The mining rights to the permit were assigned to the Sylvania Mining and Milling Company of Denver, Colorado. The assignment was approved on July 21, 1955.

Sylvania proceeded to do some 6,000 ft. of exploration drilling in the vicinity of the old mine workings. Late in 1955 Sylvania began ore shipments to the mill at Shiprock, New Mexico, operated by Kerr-McGee Oil Industries, Inc. These shipments were identified as the Shorty No. 1 mine. Shipments continued through the spring of 1956 and the final shipments were made in late 1956. Sylvania shipped a total of 91.14 tons of ore that averaged 0.14 percent $U_3O_8$ and 1.50 percent $V_2O_5$ (Table 3). According to the author's old field notes, Deverick Drilling Company evaluated the mine during the final months of operation but apparently took no action.

The abandoned mine was mapped on September 9, 1960 by the author and Ray J. Holmquist, an AEC mining engineer. Figure 3 is a copy of this map, which was recently, located in the AEC records at the Department of Energy's Grand Junction office.

## SUMMARY

During the nine years that the Rattlesnake No. 1/ Shorty No. 1 mine was operating it produced a total of 2,910.02 tons of ore averaging 0.18 percent $U_3O_8$ and 1.70 percent $V_2O_5$ (Table 4). All of the uranium concentrate produced at the mills was purchased by the AEC. The vanadium concentrate produced at the Naturita and Durango mills was sold to the steel industry. Although the mill at Shiprock paid for vanadium, not all of it was recovered [Albrethsen and McGinley, 1982, p. A-15].

**Acknowledgment**. Stephen M Richard's review of an earlier version of the report, for the Arizona Geological Survey, is greatfully acknowledged.

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## FIGURES

Figure 1. Index map of the Carrizo Mountains, Arizona-New Mexico showing the location of the Rattlesnake No. 1/Shorty No. 1 uranium-vanadium mine.

Figure 2. Sketch map of the uranium-vanadium occurrences south of Teec Nos Pos [Harshbarger, 1946, figure 48].

Figure 3. Map of the Rattlesnake No. 1/Shorty No. 1 mine. Mapped by W.L. Chenoweth and R.J. Holmquist, September 9, 1960.

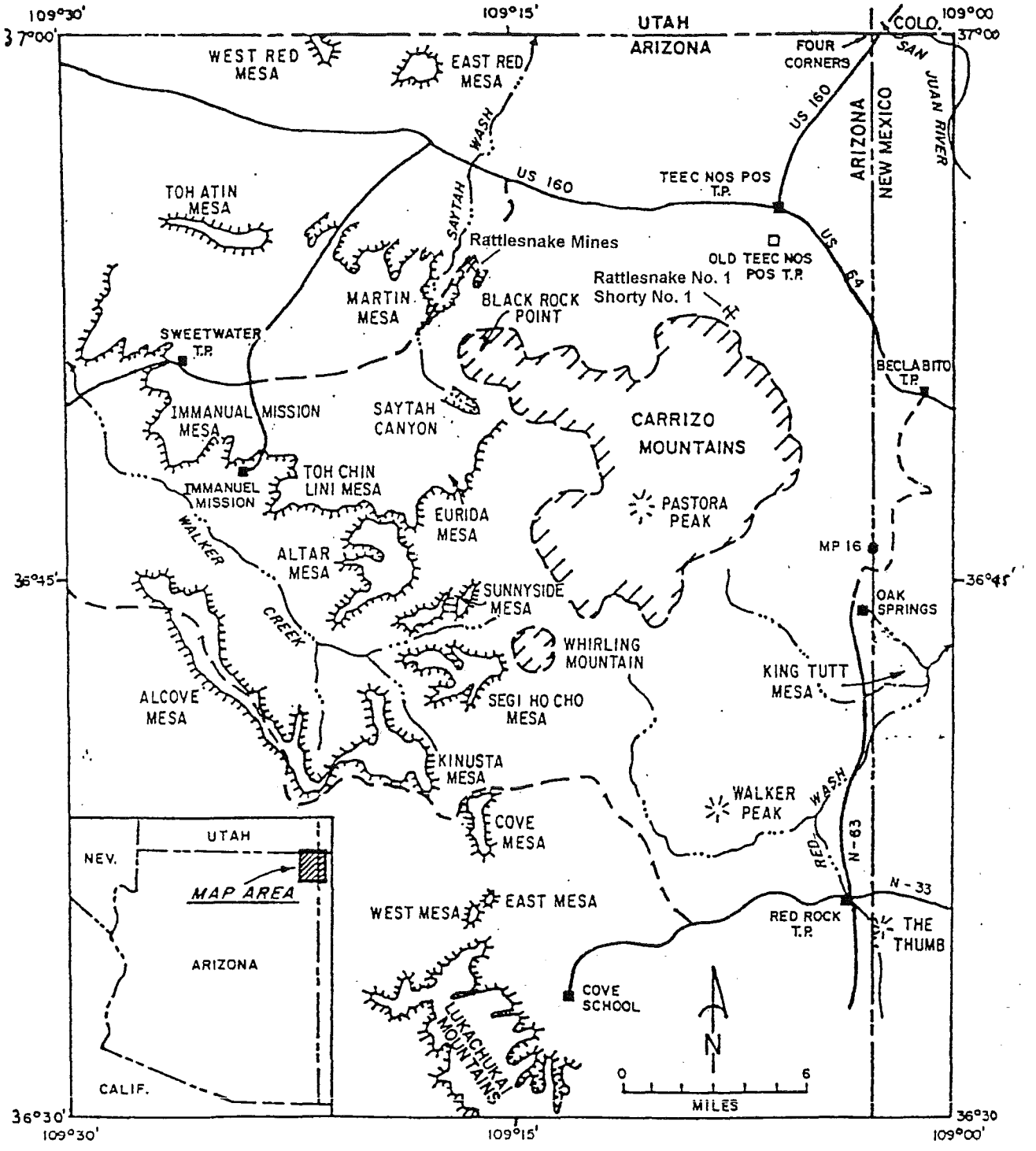


Figure 1. Index map of the Carrizo Mountains, Arizona-New Mexico showing the location of the Rattlesnake No. 1/Shorty No. 1 uranium-vanadium mine.

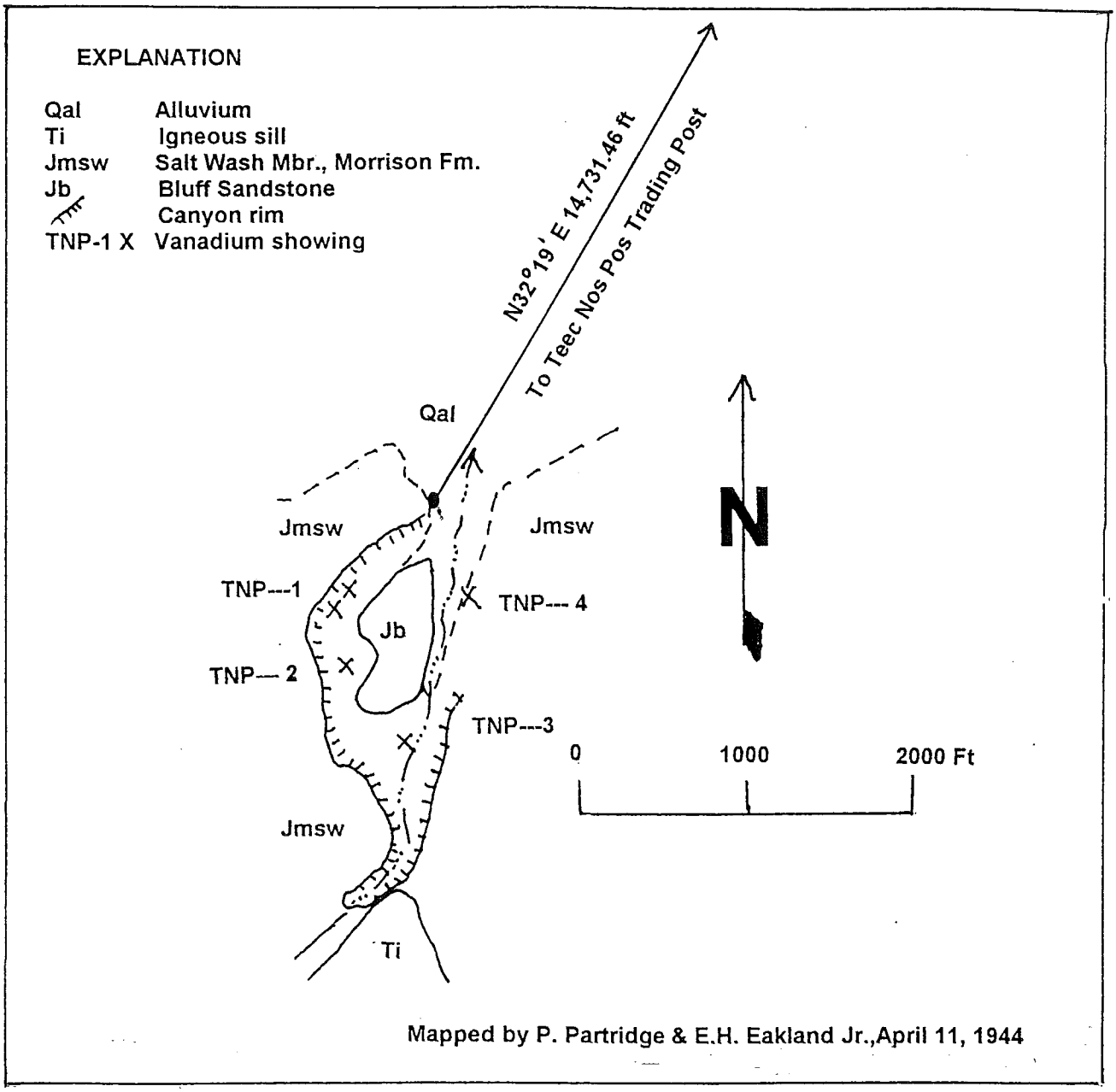


Figure 2. Sketch map of the uranium-vanadium occurrences south of Teec Nos Pos [Harshbarger, 1946, figure 48].

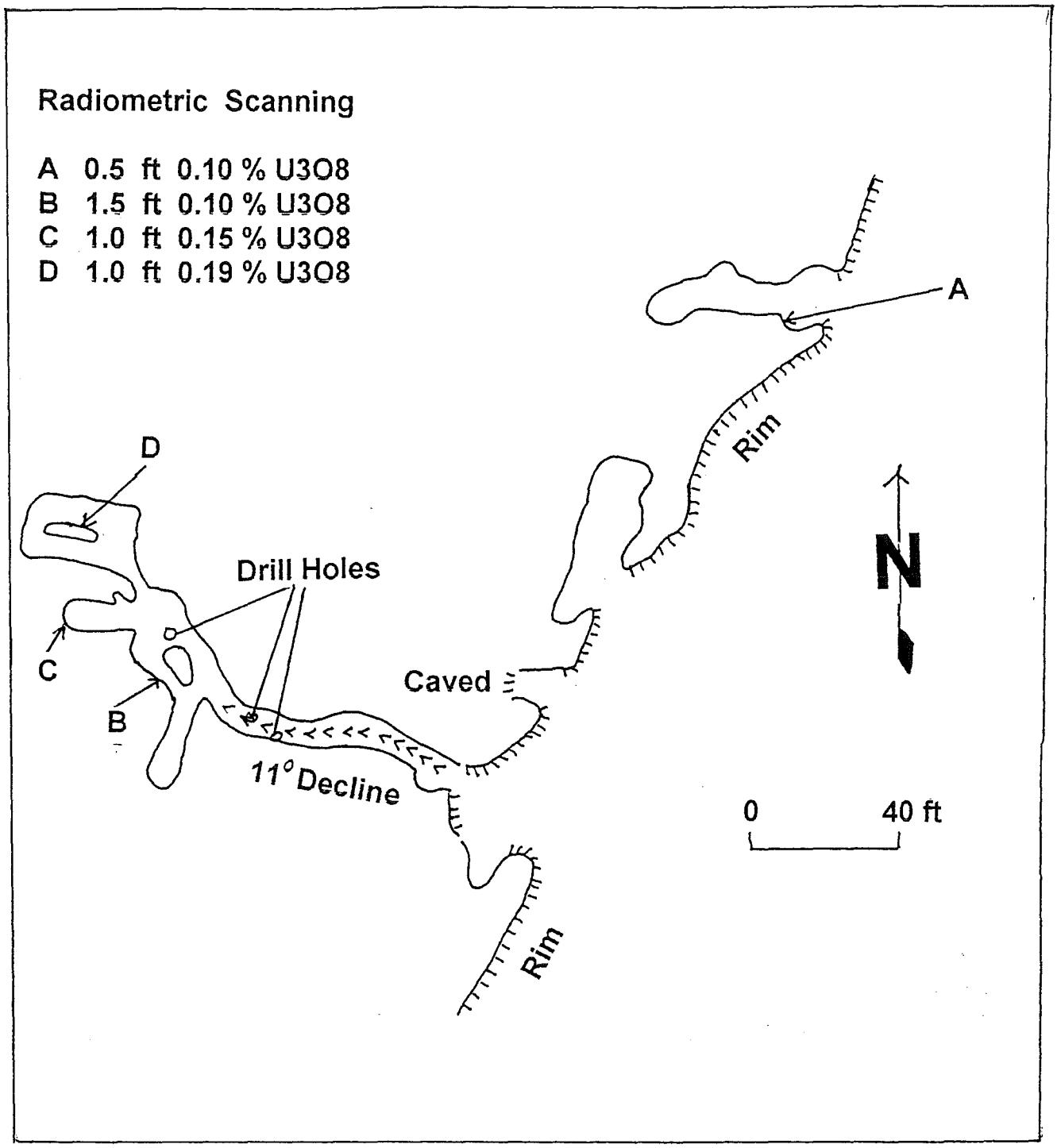


Figure 3. Map of the Rattlesnake No. 1/Shorty No. 1 mine. Mapped by W.L. Chenoweth and R.J. Holmquist, September 9, 1960.

**Table 1. Early vanadium ore production, Rattlesnake No. 1 mine, Apache County, Arizona**

| YEAR | QUARTER | OPERATOR | TONS OF ORE | POUNDS $V_2O_5$ | % $V_2O_5$ |
|---|---|---|---|---|---|
| 1944 | 2, 3 | VCA | 146 | 361 | 0.12 |
| | | | | | |

Source: GSA (1981)

**Table 2. Uranium-vanadium ore production, Rattlesnake No. 1 mine, Apache, County, Arizona**

| YEAR | QUARTER | OPERATOR | TONS OF ORE | POUNDS $U_3O_8$ | % $U_3O_8$ | POUNDS $V_2O_5$ | % $V_2O_5$ |
|---|---|---|---|---|---|---|---|
| 1948 | 4 | VCA | 27.16 | 64.90 | 0.15 | 783 | 1.36 |
| 1949 | 1 | VCA | 362.79 | 1,405.00 | 0.19 | 12,453 | 1.72 |
| 1949 | 2 | VCA | 542.14 | 1,594.00 | 0.15 | 17,904 | 1.65 |
| 1950 | 1 | Leo Redhouse | 12.56 | 88.18 | 0.35 | 745 | 2.97 |
| 1950 | 2 | Leo Redhouse | 154.03 | 513.60 | 0.17 | 6,620 | 2.15 |
| 1950 | 3 | Leo Redhouse | 152.78 | 565.26 | 0.18 | 6,458 | 2.11 |
| 1950 | 4 | Leo Redhouse | 60.62 | 186.57 | 0.15 | 2,161 | 1.78 |
| 1951 | 1 | Earl Saltwater | 142.09 | 466.70 | 0.16 | 4,925 | 1.73 |
| 1951 | 2 | Earl Saltwater | 286.30 | 965.80 | 0.17 | 11,157 | 1.95 |
| 1951 | 3 | Earl Saltwater | 85.49 | 225.81 | 0.13 | 2,961 | 1.73 |
| 1951 | 3 | Leo Redhouse | 206.64 | 824.30 | 0.20 | 7,161 | 1.73 |
| 1951 | 4 | Leo Redhouse | 115.27 | 559.02 | 0.24 | 5,319 | 2.31 |
| 1952 | 1 | Leo Redhouse | 54.38 | 155.57 | 0.14 | 2,093 | 1.92 |
| 1952 | 1 | Earl Saltwater | 126.46 | 434.48 | 0.17 | 4,449 | 1.76 |
| 1952 | 2 | Earl Saltwater | 45.74 | 165.09 | 0.18 | 1,484 | 1.62 |
| 1952 | 2 | Leo Redhouse | 49.77 | 167.02 | 0.17 | 1,709 | 1.72 |
| 1952 | 3 | Leo Redhouse | 6.06 | 8.49 | 0.07 | 180 | 1.48 |
| 1952 | 3, 4 | Earl Saltwater | 113.61 | 541.86 | 0.24 | 3,664 | 1.61 |
| 1953 | 1 | Earl Saltwater | 101.82 | 461.66 | 0.23 | 2,987 | 1.47 |
| 1953 | 2 | Earl Saltwater | 27.17 | 122.17 | 0.22 | 857 | 1.58 |
| Total | | | 2,672.88 | 9,515.48 | 0.18 | 96,070 | 1.80 |

1/ Production by quarters not separated.
Source: Allport (1949, 1952, 1953)

**Table 3. Uranium-Vanadium ore production, Shorty No. 1 mine Apache County, Arizona**

| YEAR | QUARTER | OPERATOR | TONS OF ORE | POUNDS $U_3O_8$ | % $U_3O_8$ | POUNDS $V_2O_5$ | %$V_2O_5$ |
|---|---|---|---|---|---|---|---|
| 1955 | 4 | Sylvania | 8.26 | 23.12 | 0.14 | 184.92 | 1.12 |
| 1956 | 1 | Sylvania | 43.66 | 121.14 | 0.14 | 1,197.46 | 1.37 |
| 1956 | 2 | Sylvania | 8.53 | 46.06 | 0.27 | 366.75 | 2.15 |
| 1956 | 4 | Sylvania | 30.69 | 94.80 | 0.15 | 992.00 | 1.62 |
| Total | | | 91.14 | 252.12 | 0.14 | 2,741.13 | 1.50 |

Source: AEC Unpublished ore production records.

**Table 4. Summary ore production Rattlesnake No. 1/ Shorty No. 1 mine, Apache County Arizona**

| YEARS | TONS OF ORE | POUNDS $U_3O_8$ | % $U_3O_8$ | POUNDS $V_2O_5$ | % $V_2O_5$ |
|---|---|---|---|---|---|
| 1944 | 146.00 | -- | -- | 361.00 | 0.12 |
| 1948-1953 | 2,672.88 | 9,515.48 | 0.18 | 96,070.00 | 1.80 |
| 1955-1956 | 91.14 | 252.12 | 0.14 | 2,741.13 | 1.50 |
| | | | | | |
| Total | 2,910.02 | 9,767.60 | 0.18 | 99,172.13 | 1.70 |