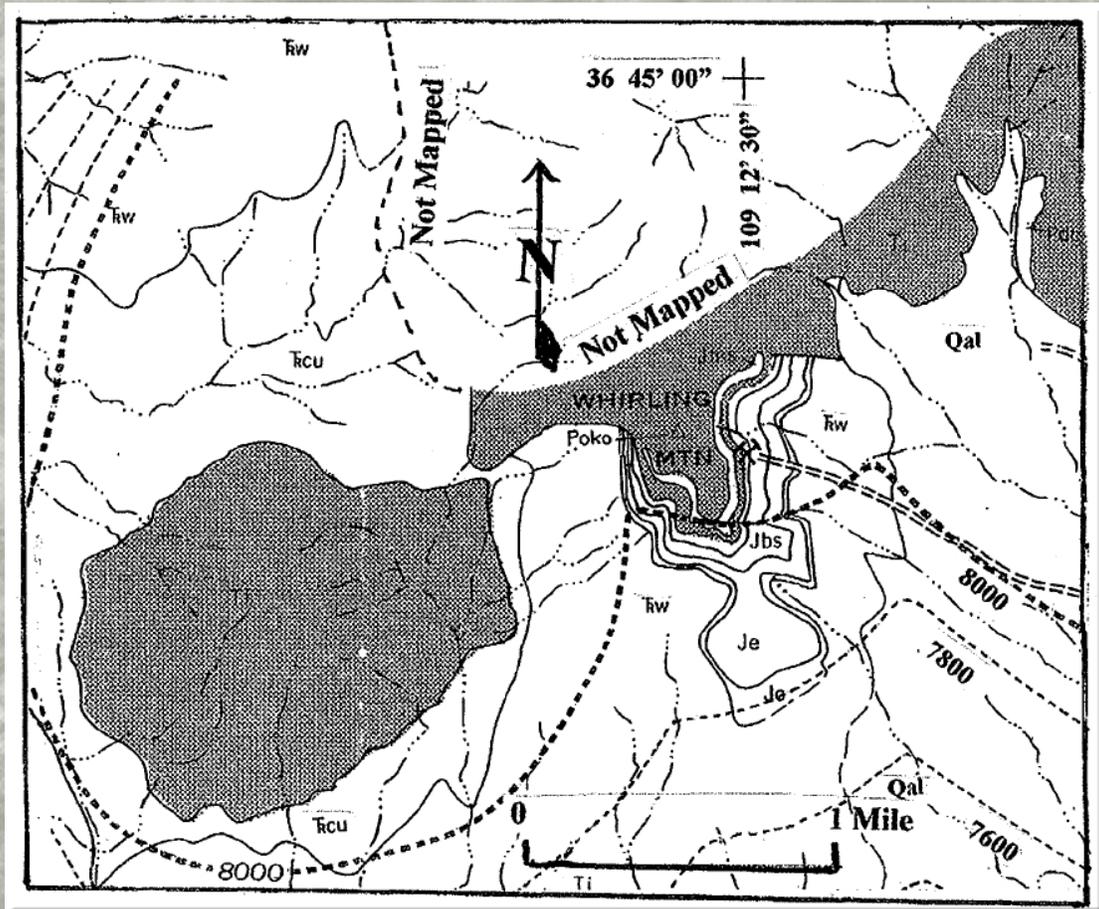


## CONTRIBUTED REPORT CR-11-K

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Whirling Mountain location map.

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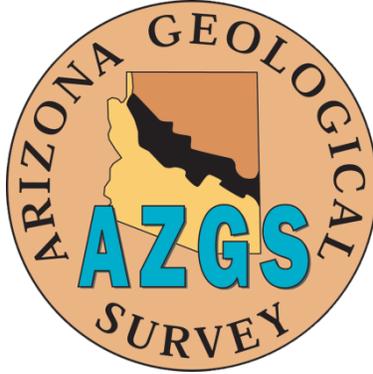
ARIZONA GEOLOGICAL SURVEY

Arizona Geological Survey Contributed Report CR-11-K

The Geology and Production History of the Tohe Thlany Begay  
(Whirling Mountain) Uranium-Vanadium Mine,  
Apache County, Arizona

September 2011

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## **INTRODUCTION**

The Tohe Thlany Begay mine, also known as the Whirling Mountain mine, was developed on an isolated exposure of uranium-vanadium minerals that were located on the south flank of the Carrizo Mountain laccolith, Apache County, Arizona. The host rock was the Salt Wash Member of the Morrison Formation of Late Jurassic age. Due to its isolated location, it was one of the few mineralized exposures in the Salt Wash in the Carrizo Mountains not located and mapped by field parties of the Union Mines Development Corporation in the 1940s [Harbarger, 1946]. Union Mines was a geologic contractor investigating the uranium resources of the Morrison Formation on the Colorado Plateau for the Manhattan Engineer District.

## **LOCATION AND LAND STATUS**

The Tohe Thlany Begay mine was located on the east side of a point of the Carrizo Mountains known as Whirling Mountain at an elevation of 8,190 feet. The mine is shown on the Boiling Over Well topographic quadrangle [USGS, 1982] at 36° 43' 45" north latitude and 109° 12' 31" west longitude. When the mine was operating it would be reached by a series of unimproved dirt roads originating from the Red Rock – Oak Spring road (Figure 1).

The mine was within the Navajo Reservation. Mining permits were issued by the Navajo Tribal Council and approved by the Bureau of Indian Affairs (BIA), U.S. Department of the Interior. Mining permits could be obtained by individual Navajos only. 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. Permits were issued for a 2-year period and could be renewed for an additional 2 years. No more than 960 acres of tribal land could be

held by any one company or individual. Both the permittee and the tribe received royalties for ore production. Based on the mine value of the ore, the tribe received between 10% and 20% royalties and the permittee between 2% and 5% royalties.

In addition to mining permits, the tribe issued drilling and exploration permits. These permits were good for 120 days and were not renewable.

### **SOURCES OF INFORMATION**

Much of the information presented in the 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). Some historical data [U.S. Atomic Energy Commission, 1960] was located at the National Archives, Rocky Mountain Region, Denver, Colorado.

### **GEOLOGICAL SETTING**

The uranium-vanadium deposits at the Tohe Thlany Begay mine occurred in the Salt Wash Member of the Morrison Formation of Late Jurassic age. In the southern Carrizo Mountains it is approximately 200 feet thick. It is composed of pale gray to greenish-gray, fine-grained, well sorted sandstone with rounded to subrounded grains of predominately quartz. The sandstone forms lenses that are rarely up to 20 ft thick. Interbedded with sandstone lenses are thin beds of reddish-brown and greenish-gray mudstone and siltstone, that form only five to eight percent of the total Salt Wash.

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 feet 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. 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 subdivisions of Huffman and others are used in the report.

The middle stratigraphic units is an average of 70 feet 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 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 uranium-vanadium orebodies 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 orebodies were commonly associated with the plant material and range from several feet in width to over one hundred feet in length. Orebodies are at the Tohe Thlany Begay ranged from a feather-edge up to 2.0 ft thick.

The mine is in the lower Salt Wash, probably in the middle unit, directly below a

porphyritic diorite sill of the Carrizo laccolith (Figure 2).

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 nearby Martin mine in the northwestern Carrizo Mountains, 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 pascoite and volborthaite were found as stains on surface outcrops at the Martin mine. Calcite was the major cementing agent of the ore.

### **EXPLORATION AND PRODUCTION HISTORY**

An isolated exposure of uranium-vanadium minerals, high up in the southern Carrizo Mountains was located by Bennie Tohe in the summer of 1950. Tohe claimed the ground with an unnumbered Navajo Tribal Mining Permit. With the assistance of the Vanadium Corporation of America (VCA) he improved the road to the area and in December 1950 and January 1951 he shipped a total of 86.07 tons of ore averaging 0.13 percent  $U_3O_8$  and 2.34 percent  $V_2O_5$  to the VCA mill at Durango, Colorado (Table 1). The source of the ore was identified as the Whirling Mountain mine.

Due to the uranium boom being experienced on the Navajo Indian Reservation, the Navajo Tribal Council began issuing numbered mining permits in 1952. Also issued were new regulations regarding the assignment of mining permits, etc. On April 26, 1962, Mining Permit No. 7 was issued to Bennie Tohe, Willie Clazzie Thlany, and Berlin Begay. This permit covered

640 acres on the east side of Whirling Mountain (See appendix). The mining rights to the ground were assigned to Carl R. Chelf, of Austin, Texas, on May 6, 1962. The assignment was approved on September 16, 1952. On March 1, 1953, Mr. Chelf made an initial ore shipment to the AEC ore-buying station at Shiprock, New Mexico. Shipments continued through August 1953. The shipments were identified as the Tohe Thlany Begay mine. Chelf shipped a total of 155.50 tons of ore that averaged 0.16 percent  $U_3O_8$  and 2.84 percent  $V_2O_5$  (Table 1).

In June 1953 the AEC drilled seven holes behind the workings, all were barren (Table 2). This drilling was done under the Cove Mesa No. 4 contract. The contractor for this wagon drill project was the Oliver Brothers, Norwood, Colorado. Immediately after Chelf's last shipment, the Texas Mining Company did additional drilling without finding any ore. Carl Chelf cancelled his assignment on September 16, 1953. Mining Permit No. 7 expired for the lack of activity on April 26, 1954.

On August 3, 1955, Navajo Tribal Mining Permit No. 335 was issued to Berlin Begay, Willie Clazzie Thlany and Sam Foster. This permit covered the same 640 acres as Mining Permit 7. In September and October 1955, Sam Foster made two small shipments to the mill at Shiprock, New Mexico operated by Kerr-McGee Oil Industries, Inc. These shipments, identified as the Carrizo No. 7 mine, totaled 11.75 tons of ore that averaged 0.10 percent  $U_3O_8$  and 2.00 percent  $V_2O_5$  (Table 1).

Sam Foster relinquished his interest (213.35 acres) in Mining Permit 335 on October 2, 1956. The permit was then assigned to the Mud Mesa Mining Company, Cortez, Colorado from February 11, 1956 until February 11, 1958. Mud mesa made no shipments.

When the mine was last examined by AEC geologists on August 31, 1960, the workings consisted of a rim cut 300 ft long, 30 ft wide and 20 ft deep, one adit with 135 ft of

workings and one small dog hole near the adit. Thin streaks of uranium-vanadium minerals were noted in the face of the rim cut [Grundy and Tipton, 1960].

### **SUMMARY**

The uranium recovered from the Tohe Thlany Begay ores at the Durango, Colorado and Shiprock New Mexico mills was sold to the AEC. At the Durango mill, the vanadium that was produced was sold to the steel industry. Excess vanadium concentrate was sold to the AEC. At Shiprock, vanadium was paid for but not all of it was recovered [Albrethsen and McGinley, 1982].

### **Acknowledgement:**

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

Jeffrey G. Tack, S.M. Stoller Corp., contractor at the Department of Energy's Grand Junction office, provided information on how to obtain historical data on the Tohe Thlany Begay mine from the National Archives, Rocky Mountain Region, Denver, Colorado.

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U.S. Geological Survey, 1982, Boiling Over Well quadrangle, Arizona, 7 ½ minute series (topographic), provisional, scale 1:24,000.

## APPENDIX

Legal description of Navajo Tribal Mining Permits No. 7 and No. 335.

Beginning at a rock monument which bears N.25° 50"W, 3,013.8 feet to U.S.G.S. station POKA, latitude 36° 44' 00.945", longitude 109° 12' 43.060", thence west 10 feet to corner No. 1: thence north 10,560 feet corner No. 2: thence west 2,640 feet to corner No. 1: thence east 10 feet to the rock monument and point of beginning. Containing 640 acres more or less.

Source: U.S. Atomic Energy Commission [1960].

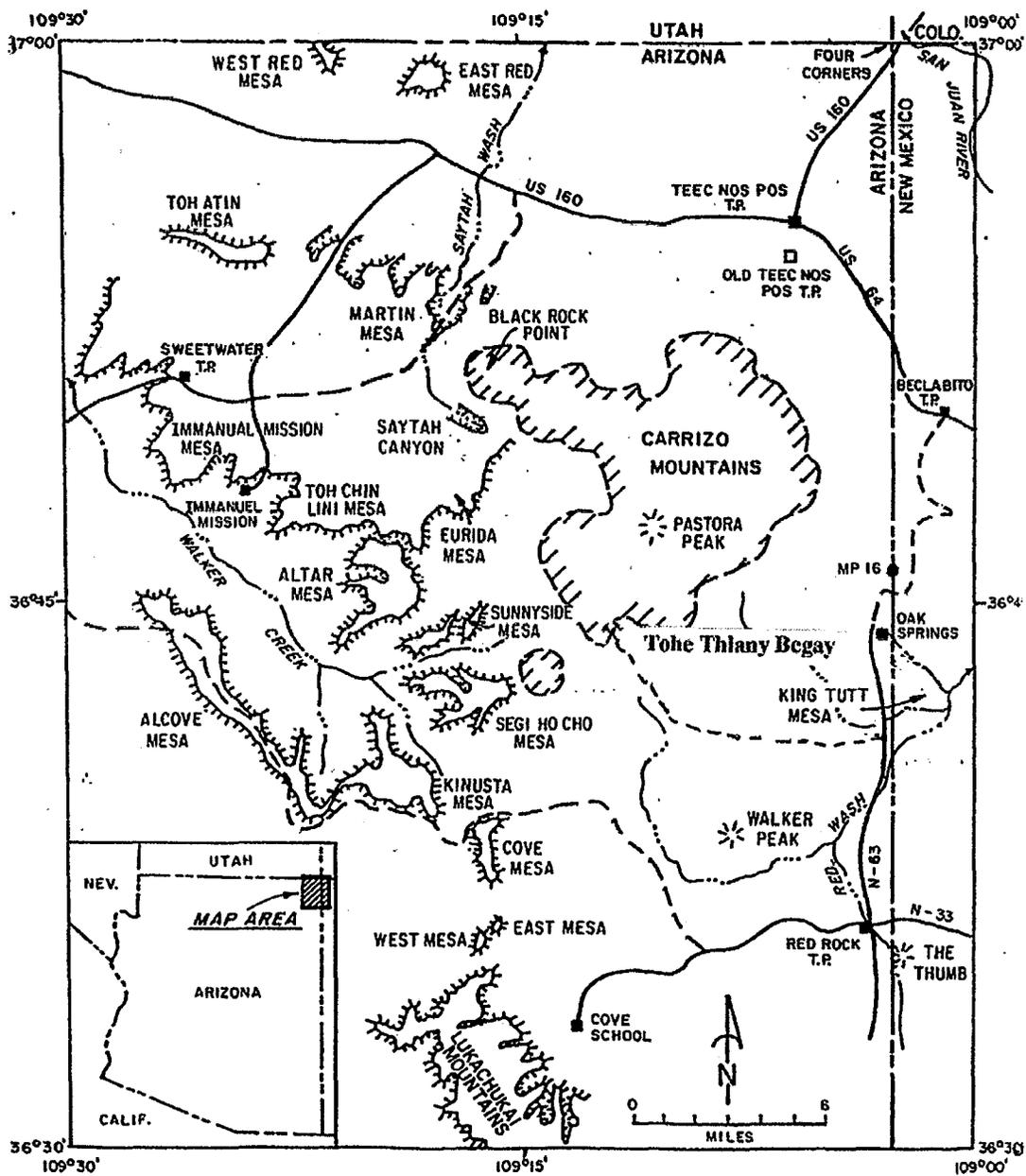


Figure 1. Index map of the Carrizo Mountains, Apache County, Arizona and San Juan County, New Mexico showing the location of the Tohe Thlany Begay uranium-vanadium mine.

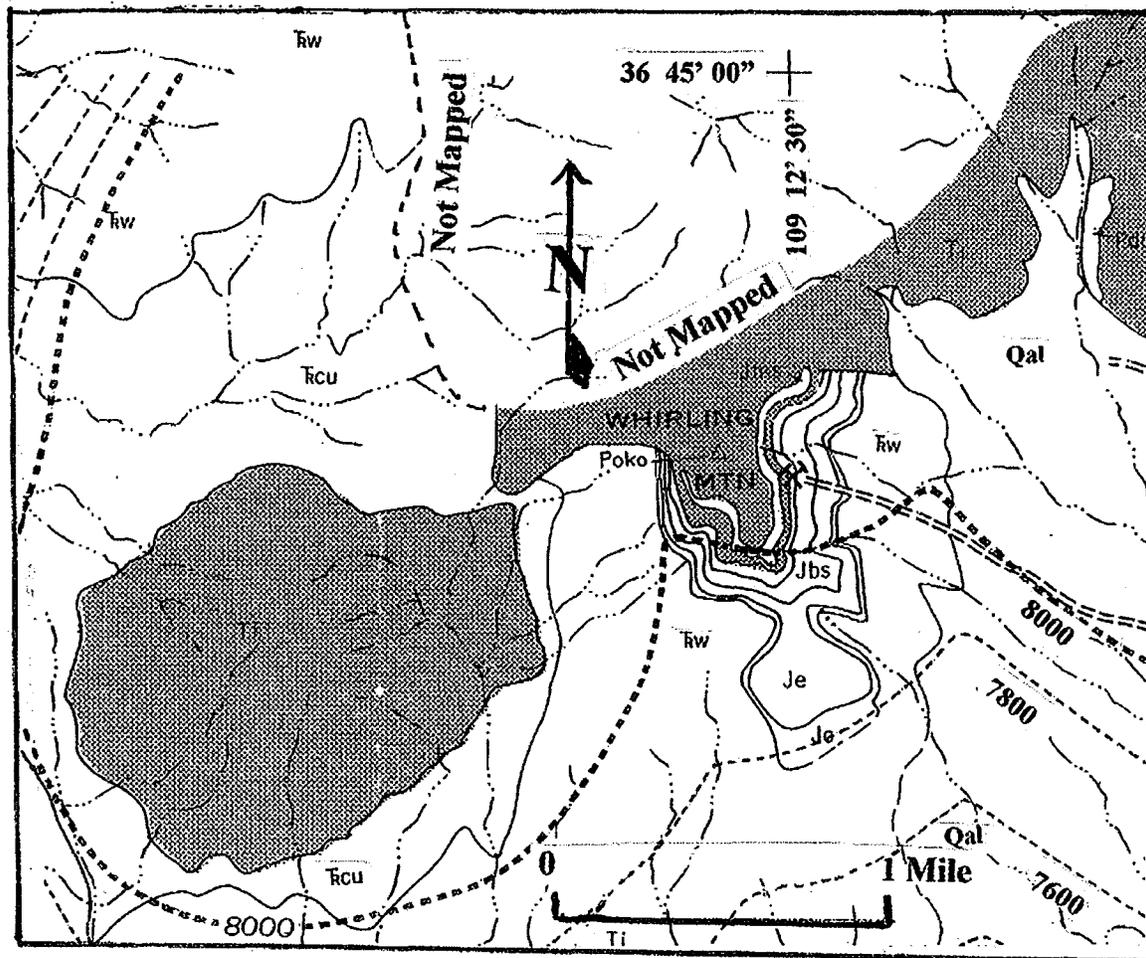


Figure 2. Geologic map of the Whirling Mountain area [Strobell, 1956]. Geologic symbols; Pdc, DeChelly Sandstone; Trcu, Chinle Formation, upper member; Trw, Wingate Sandstone; Jc, Camel Formation; Je Entrada Sandstone; Jbs, Bluff Sandstone and Summerville Formation undifferentiated; Jms, Salt Wash Member, Morrison Formation; Qal, Alluvium and pediment gravel; Ti, Diorite porphyry. Structure contours on base of the Morrison Formation.

**Table 1. Uranium-vanadium ore production Tohe Thlany Begay mine, Aapache County, Arizona.**

| YEAR  | QUARTER | OPERATOR    | TONS<br>OF ORE | POUNDS<br>U <sub>3</sub> O <sub>8</sub> | %<br>U <sub>3</sub> O <sub>8</sub> | POUNDS<br>V <sub>2</sub> O <sub>5</sub> | %<br>V <sub>2</sub> O <sub>5</sub> |
|-------|---------|-------------|----------------|---|------------------------------------|---|------------------------------------|
| 1950  | 4       | Bennie Tohe | 20.54          | 60.76                                   | 0.15                               | 1,045.00                                | 2.54                               |
| 1951  | 1       | Bennie Tohe | 65.48          | 162.39                                  | 0.12                               | 2,985.00                                | 2.28                               |
| 1953  | 2       | Carl Chelf  | 133.25         | 420.04                                  | 0.16                               | 7,339.26                                | 2.75                               |
| 1953  | 3       | Carl Chelf  | 22.25          | 90.17                                   | 0.20                               | 1,508.47                                | 3.39                               |
| 1955  | 3       | Sam Foster  | 6.03           | 12.06                                   | 0.10                               | 221.87                                  | 1.84                               |
| 1955  | 4       | Sam Foster  | 5.73           | 12.59                                   | 0.11                               | 248.31                                  | 2.17                               |
| Total |         |             | 253.33         | 758.01                                  | 0.15                               | 13,347.91                               | 2.63                               |

Source: AEC Unpublished ore production records.