# THE GEOLOGY AND PRODUCTION HISTORY OF THE BLUESTONE NO. 1 URANIUM-VANADIUM MINE, GARNET RIDGE, APACHE COUNTY, ARIZONA, WITH NOTES ON THE U.S. ATOMIC ENERGY COMMISSION'S DRILLING PROJECT

by
William L. Chenoweth
Consulting Geologist
Grand Junction, Colorado

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**Arizona Geological Survey**
416 W. Congress, Suite #100, Tucson, Arizona 85701

## INTRODUCTION

During the uranium boom of the mid-1950's some 53 tons of average grade uranium-vanadium ore was produced at the Bluestone No. 1 mine on Garnet Ridge in Apache County, Arizona. The host rock for the ore deposit was the Jurassic Navajo Sandstone where it was in contact with a serpentine rubble dike of Tertiary age. Recently a location map and lithologic logs of four core holes drilled in 1951-1952 by the U.S. Atomic Energy Commission (AEC) on the Bluestone No. 1 property were located in the files of the U.S. Department of Energy at Grand Junction, Colorado.

The purpose of this report is to briefly describe the geologic setting of this ore deposit, to provide production statistics, and to make available the lithologic logs of the early drilling. The information regarding the activities at the Bluestone No. 1 mine was obtained while W.L. Chenoweth was employed as a geologist by the AEC on the Navajo Indian Reservation.

## LOCATION AND LAND STATUS

The Bluestone No. 1 mine is on the northern end of Garnet Ridge, approximately 8 mi northeast of Dinnehotso[1], Arizona in Apache County (Fig. 1). The land is unsurveyed, and according to AEC records it is in T. 41 N., R. 23 E., sec. 19, SE 1/4. The following road log to the mine was written in 1960:

| Cumulative mileage | Miles | |
|---|---|---|
| 0.0 | | Dinnehotso school, proceed northeast on Route 1 (now US 160) |
| | 7.1 | |
| 7.1 | | Turn left onto a dirt trail |
| | 1.5 | |
| 8.6 | | Take left fork |
| | 0.4 | |
| 9.0 | | House on right (north) proceed straight ahead (west) |
| | 0.5 | |
| 9.5 | | Igneous pipe no. 2, take right fork |
| | 0.2 | |
| 9.7 | | Trench of Bluestone No. 1 mine |

The area is part of the Navajo Indian Reservation and is under the jurisdiction of the Navajo Tribal Council. Mining Permits (MP) are issued by the Navajo tribe and approved by the Bureau of Indian Affairs, U.S. Department of the Interior. Mining permits may only be obtained by individual Navajos, who may assign the mining rights to an individual company. Assignments are also approved by the Tribal Council and the Bureau of Indian Affairs. Mining permits are issued for two years, subject to renewal for an additional two years. The maximum amount of land an individual Navajo or company can hold is 960 acres. Drilling and exploration permits, issued for 120 days, are not renewable.

## GEOLOGIC SETTING

Garnet Ridge is named from pyrope garnet that occurs in Tertiary serpentine deposits that intrude rocks of Jurassic age on Comb Ridge. The serpentine deposits are mainly in pipes that are choked with

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[1] Two spellings exist for this word: Dennehotso and Dinnehotso. Many maps and texts, especially older ones, use the "i" spelling; however, the 1988 U.S. Geological Survey 7.5' Garnet Ridge quadrangle map uses the "e" spelling.

rock debris, which was derived from rocks ranging in age from Precambrian to Cretaceous. Malde and Thaden (1963, Plate 3) mapped four separate pipes on Garnet Ridge. Copper-uranium-vanadium mineralization is associated with a rubble dike at pipe no. 2 at the northeastern end of the ridge (Fig. 1).

The following description of the dike and mineralization is modified from Malde and Thaden (1963, p. 61). The rubble dike is approximately 150 ft long. It strikes N 75° W and dips 70° to the northeast. It is stained with iron oxide to a brownish-green color and contains veinlets of ankerite. The country rock adjacent to the dike is Navajo Sandstone of Jurassic age. It is more friable than typical Navajo Sandstone and contains small quantities of copper and uranium-vanadium minerals.

Three mineralized zones are roughly parallel to the dike walls and extend short distances into the country rock along fractures that intersect the dike. The copper minerals and the associated uranium-vanadium minerals occur in a vein that is exposed for nearly 700 ft. The zone closest to the dike is 1 to 3 in. wide and is bleached to a light buff color. The middle zone, which is up to 2 in. wide and is not always present, contains blue-green copper minerals. The outer zone is 1 to 2 ft wide and is stained with limonite. This zone grades into normal Navajo Sandstone.

Yellow uranium-vanadium minerals are sparsely disseminated in all three zones but are most abundant in the copper-bearing zone. Gruner and others (1954, p. 33) identified metatyuyamunite (?) from the property. M.E. Thompson of the USGS identified malachite, chrysocolla, volborthite and metatyuyamunite for Shoemaker (1956, p. 183). Shoemaker (1956, p. 183) also stated that the uranium-bearing sandstone contained trace amounts of silver, cobalt, nickel, lead, and thallium. Malde and Thaden (1963, p. 61) noted that tyuyamunite was the only uranium-bearing mineral identified. Shoemaker (1955, p. 63, 65) obtained an assay of 2.00 percent U in a selected sample, but noted that most uranium was of sub-ore grade (less than 0.10 percent $U_3O_8$). He also recorded that ore shipped to the mill was only obtained by careful hand sorting.

## PRODUCTION HISTORY

The copper-bearing vein was brought to the attention of AEC geologists in May 1951, who found it to be uraniferous (Chester and Cutter, 1951). The AEC drilled the vein in the winter of 1951-1952 with discouraging results. During this time, the property was controlled by Keith Francis under an unnumbered Navajo Tribal Mining Permit (Figure 2).

On July 15, 1954, Mining Permit No. 145 was approved to Keith Francis. This permit covered 55.2 acres, including the Bluestone No. 1 mine, and may have been the renewal of the earlier, unnumbered mining permit. The assignment of the mining rights to the Magor Mining Co. of Shiprock, New Mexico was approved on December 13, 1954.

Early in 1955, Magor drilled 3,500 ft and excavated a trench along the dike. During 1955, 44.64 tons of ore, averaging 0.21 percent $U_3O_8$ and 0.83 percent $V_2O_5$, were shipped to AEC's ore-buying station in Shiprock, New Mexico. In January 1956, a final 8.05-ton shipment was made. Total production from the Bluestone No. 1 mine was 52.69 tons of ore, which averaged 0.22 percent $U_3O_8$ and 0.82 percent $V_2O_5$ and contained 228.74 pounds $U_3O_8$ and 867.74 pounds $V_2O_5$ (Table 1).

When the mine was abandoned in early 1956, the workings consisted of a trench 150 ft long, 15 ft wide, and 20 ft deep. A 60-ft inclined shaft was sunk into the northeast-dipping dike at the northwestern end of the trench.

In April 1960, Texas-Zinc Minerals Corp. obtained a drilling permit for the area of the mine. The results of their drilling were reported to be negative, and the property has been inactive since that time.

## AEC DRILLING PROJECT

One of the earliest drilling projects carried out by the AEC on the Navajo Indian Reservation was on Keith Frances' claim on Garnet Ridge. Apparently a project report never was written, and there is only a brief reference to it in the literature (Malde and Thaden, 1963, p. 61)

During the winter of 1951-1952, the Grand Junction Exploration Branch of the AEC's Division of Raw Materials drilled four inclined diamond drill holes on Keith Frances' claim (Fig. 2). The drilling was done from a single station located approximately 150 ft northeast of the mineralization associated with the rubble dike and used a U.S. Bureau of Mines drilling rig. Total footage drilled was 769.80 ft of which 662.30 ft were cored. The only information located in 1990 were the lithologic logs. Neither the core nor information on analyses of the core could be located, but Malde and Thaden (1963, p. 61) mention that only weakly mineralized ground was penetrated. Spectrographic analysis, by the U.S. Geological Survey, of a portion of the drill cores from hole no. 1 are given in Figure 3.

## ACKNOWLEDGMENTS

Review of this report by Nancy Schmidt and Jon E. Spencer of the Arizona Geological Survey is gratefully acknowledged.

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TABLE 1

Uranium-vanadium ore production, Bluestone No. 1 mine, Garnet Ridge, Apache County, Arizona.

| Year | Tons of Ore | Pounds $U_3O_8$ | $\%U_3O_8$ | Pounds $V_2O_5$ | $\%V_2O_5$ |
|---|---|---|---|---|---|
| 1955 | 44.64 | 188.50 | 0.21 | 743.79 | 0.83 |
| 1956 | 8.05 | 40.24 | 0.25 | 123.95 | 0.77 |
| TOTALS | 52.69 | 228.74 | 0.22 | 867.74 | 0.82 |

All shipments were made by the Magor Mining Co. to the AEC's ore-buying station in Shiprock, New Mexico.

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

## APPENDIX

Description of Navajo Tribal Mining Permit No. 145, Bluestone No. 1 claim, issued to Keith Frances.

"Point of beginning is 7.1 miles from Dinnehotso in a northeasterly direction along the road to Mexican Water and 3 miles in a northwesterly direction from that point. Point of beginning is also the intersection of a line bearing N 72° 15' E to the Toe at the south end of Ute Mountain; and a line bearing S 23° 45' E to the north edge of Round Rock; and a line bearing S 57° 00' W to the highest point on Garnet Ridge. This point of beginning is to be known as the discovery monument; hence N 44° 30' E, 560 feet to corner no. 1; thence S 44° 15' E, 1203 feet to corner no. 2; thence 44° 30' W, 2000 feet to corner no. 3; thence N 44° 15' W, 1203 feet to corner no. 4; thence N 44° 30' E, 1440 feet to point of beginning. Above described claim contains 55.2 acres more or less. This claim to be known as Bluestone Claim No. 1."

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

Lithologic logs of the four diamond drill holes, Keith Francis claim, Garnet Ridge, Apache County, Arizona.

DRILL HOLE NO. 1

Direction S 81° 22' W
Inclined - 45°

| DESCRIPTION | DEPTH IN FEET |
|---|---|
| Plug bit, no core | 0-10.0 |
| Sandstone: yellowish-gray, crossbedded, very fine-grained, frosted, clean | 10.0-86.3 |
| Sandstone: pale, grayish-red | 86.3-87.1 |
| Sandstone: light brown | 87.1-88.6 |
| Sandstone: yellowish-gray | 88.6-111.5 |
| Sandstone: pale brow, trace of green mineral | 111.5-112.3 |
| Sandstone: yellowish-gray | 112.3-166.3 |
| Breccia dike: grayish green with garnets | 166.3-169.3 |
| Sandstone: yellowish-gray with 3 feet of limonite stain banding diffused away from the contact with breccia dike | 169.3-182.3 |
| Bottom of hole | 182.3 |

DRILL HOLE NO. 2

Direction S 81° 22' W
Inclined - 60°

| DESCRIPTION | DEPTH IN FEET |
|---|---|
| Plug bit, no core | 0-42.5 |
| Sandstone: yellowish-gray, crossbedded, very fine-grained, manganese spots through upper feet | 42.5-110.5 |
| Sandstone: dark yellowish-orange with limonite stain | 110.5-112.0 |
| Sandstone: pale bluish-gray with copper minerals | 112.0-112.7 |
| Sandstone: dark yellowish-orange with limonite staining | 112.7-114.0 |
| Sandstone: yellowish-gray | 114.0-151.6 |
| Breccia dike: dark greenish-gray | 151.6-153.5 |
| Sandstone: dark yellowish orange with limonite staining | 153.5-157.0 |
| Sandstone: yellowish-gray | 157.0-193.2 |
| Sandstone: pinkish-gray | 193.2-211.0 |
| Sandstone: pale red to pale pink | 211.0-216.0 |
| Sandstone: yellowish-gray | 216.0-218.5 |
| Sandstone: yellowish-gray | 218.5-232.5 |
| Pale pink siltstone seam at 218.5<br>Pale pink siltstone seam at 223.0<br>Green mudstone seam at 226.0<br>Pale pink siltstone seam at 228.0<br>Pale pink siltstone seam at 230.0 | |
| Sandstone: pale pink to pale red | 232.5-235.3 |
| Sandstone: yellowish-gray | 235.3-263.4 |
| Bottom of hole | 263.4 |

DRILL HOLE NO. 3

Direction S 40° 55' W
Inclined - 45°

| DESCRIPTION | DEPTH IN FEET |
|---|---|
| Plug bit, no core | 0-10.0 |
| Sandstone: yellowish gray, crossbedded, very fine-grained, manganese spots throughout upper feet, limonite staining at 102 feet | 10.0-140.0 |
| Breccia dike: dark yellowish gray | 140.0-143.0 |
| Sandstone: light brown | 143.0-144.0 |
| Bottom of hole | 144.0 |

DRILL HOLE NO. 4

Direction S 4° 08' W
Inclined - 45°

| DESCRIPTION | DEPTH IN FEET |
|---|---|
| Plug bit, no core | 0-45.0 |
| Sandstone: yellowish-gray, massive to crossbedded, very fine-grained, manganese spots throughout upper feet | 45.0-163.2 |
| Breccia dike: dark yellowish-green | 163.2-167.6 |
| Sandstone: light brown, crossbedded, very fine-grained, limonite-coated | 167.6-174.0 |
| Sandstone: yellowish-gray | 174.0-180.1 |
| Bottom of hole | 180.1 |

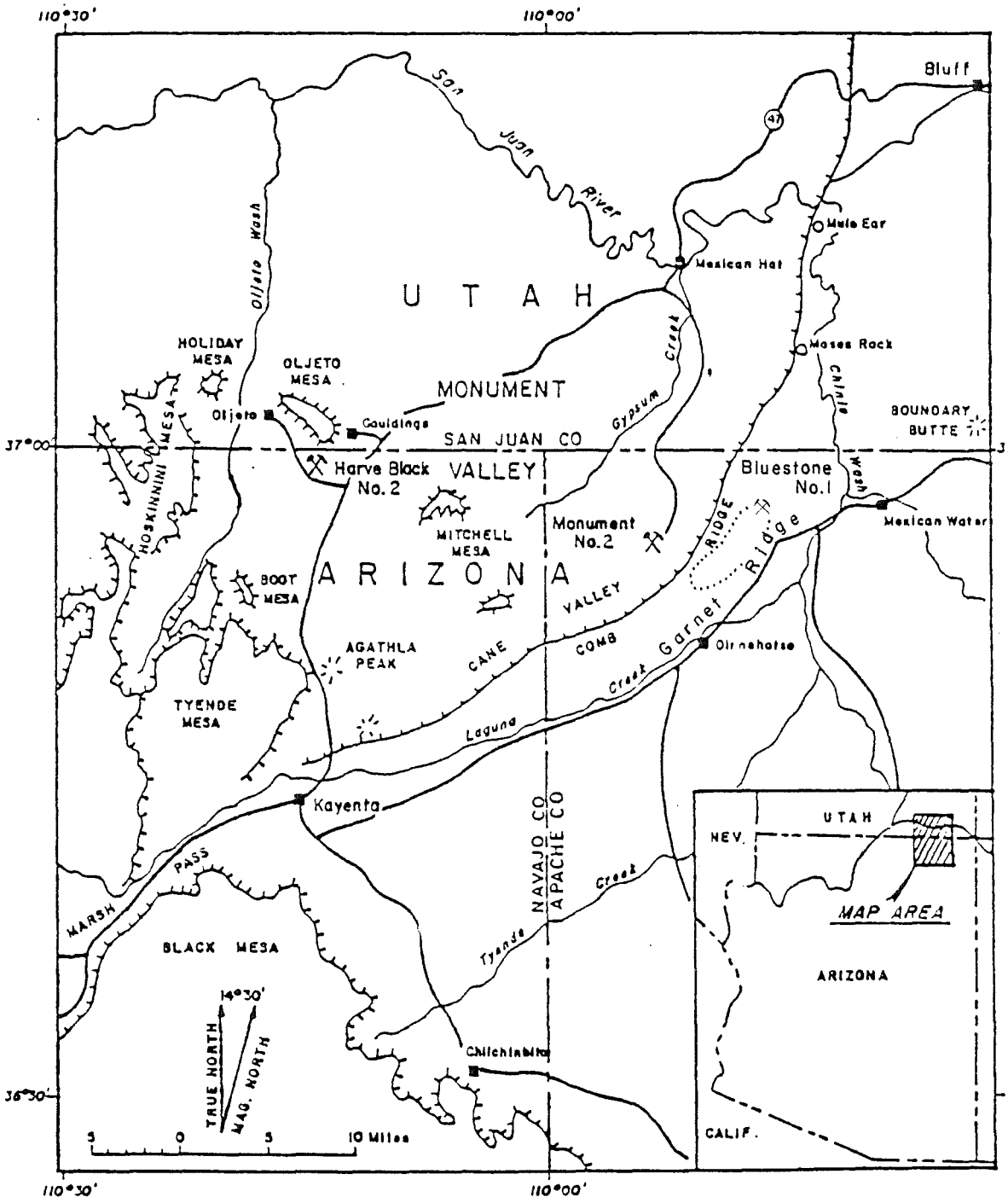


FIGURE 1. Index map of Monument Valley showing the location of the Bluestone No.1 mine.

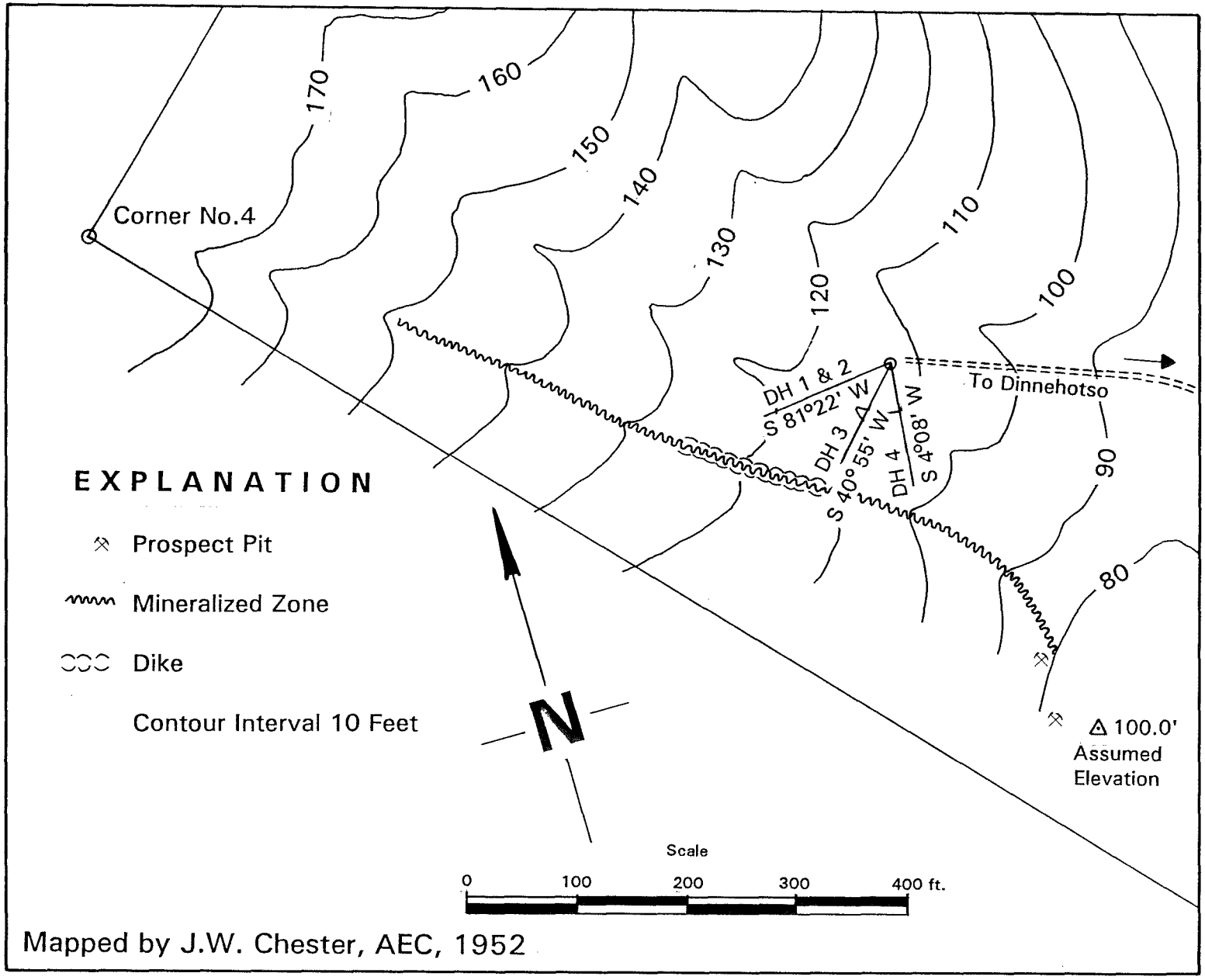


FIGURE 2: Topographic map of Keith Francis' claim showing the location of the AEC drill holes. From AEC files

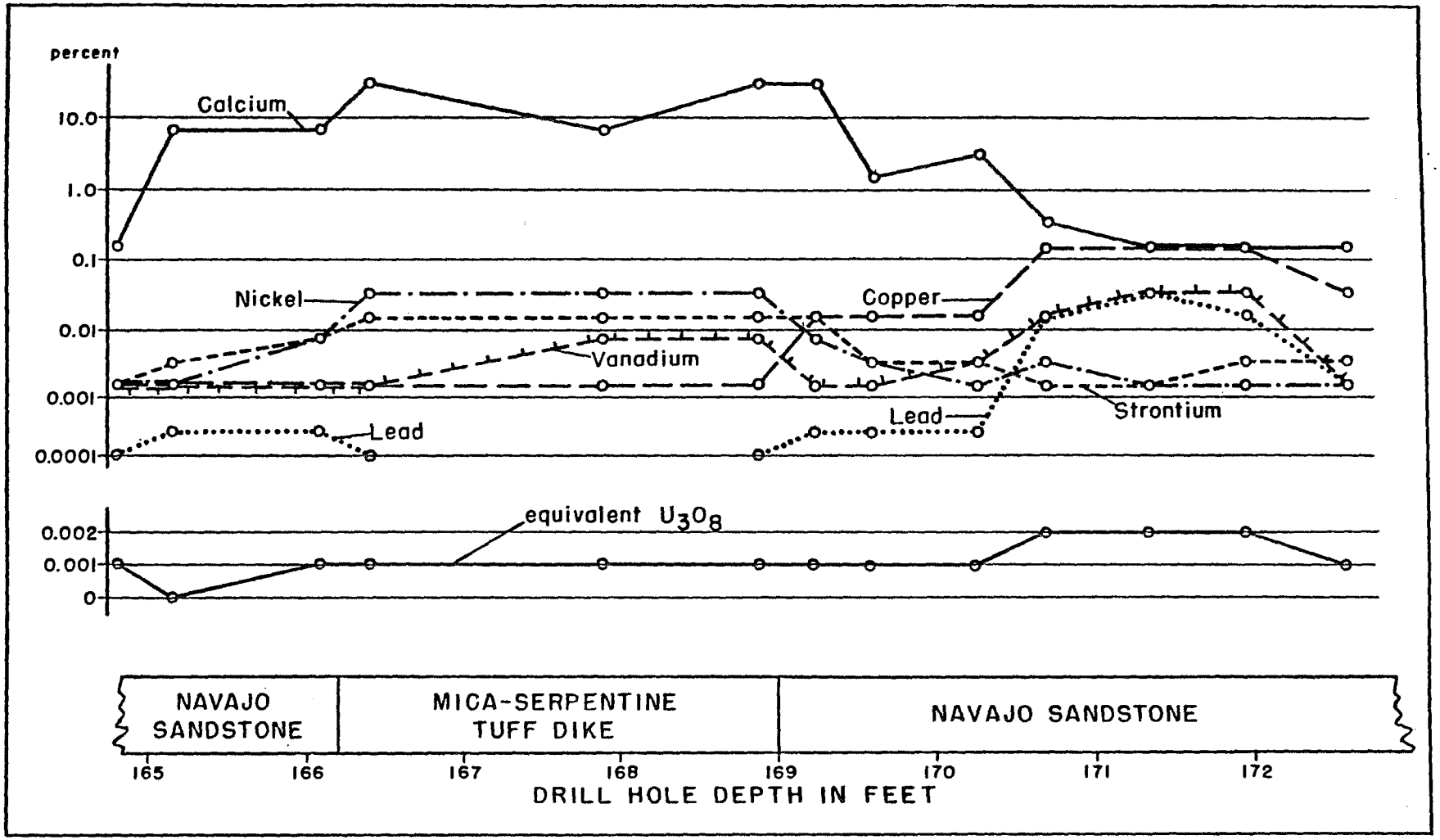


Figure 3. Diagram showing element concentration and radioactivity in core from Diamond Drill Hole No. 1, Garnet Ridge. From Shoemaker (1955).