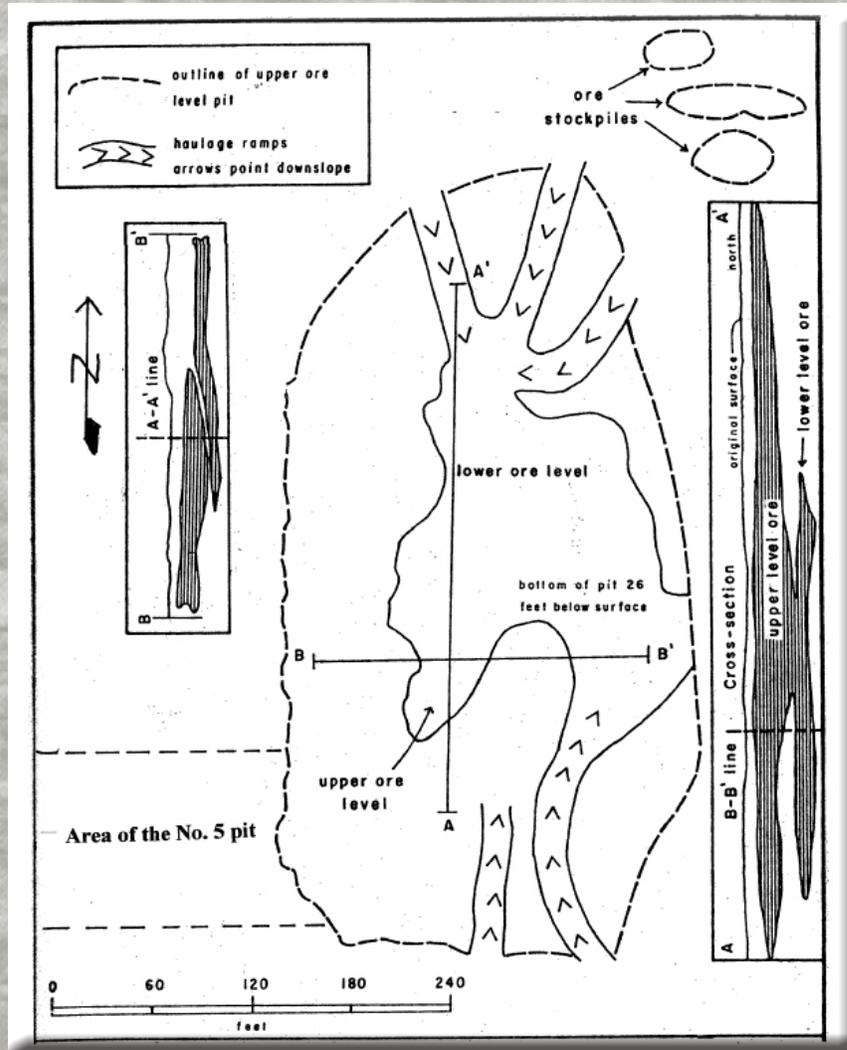


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August 2011

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ARIZONA GEOLOGICAL SURVEY

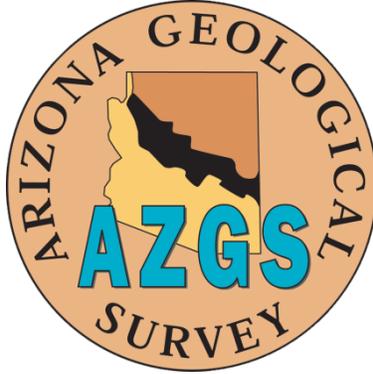
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The Geology and Production History of the
Jack Daniels Nos. 1,3,4 and 5 Uranium
Mines, Coconino County, Arizona

August 2011

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Note: Originally prepared for the Arizona Department of Mines and Mineral Resources
and the Navajo Abandoned Mine Lands Reclamation Project



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INTRODUCTION

The Jack Daniels open pit uranium mines are located in the Cameron area, Coconino County, Arizona. The host rocks for these deposits was the Petrified Forest Member of the Triassic Chinle Formation. The No. 1 mine produced more uranium than any other mine in the area. The Nos. 3 and 4 mines had minor production. The No. 5 mine was a later extension of the No. 1 pit.

Unlike most mines in the Cameron area, these mines were not named after the Navajo permittee, but after a discarded whiskey bottle found at the original discovery site.

The purpose of this report is to give the correct location of the No. 3 mine and to continue the ongoing study of the history of uranium mining on the Navajo Indian reservation.

Location

The Jack Daniels No. 1 mine, and adjacent Nos. 4 and 5 mines, were located approximately two miles north, northeast of the settlement of Cameron, Arizona (Figure 1). On the Cameron North quadrangle (USGS, 1988) the water-filled No. 1 pit is shown on the east side of U.S. Highway 89 north of Benchmark 4191.

The correct location of the No. 3 mine was 2.9 miles east northeast of the No. 1 mine (Figure 1).

Land Status

The Jack Daniels mines are within the Navajo Indian Reservation. Mining permits and leases were issued by the Navajo Tribal Council and approved by the Bureau of Indian Affairs (BIA), U.S. Department of Interior. Navajo individuals could obtain mining permits 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. Leases could be issued directly by the BIA. Permits were issued for periods up to 2 years and could be renewed for 2 years. Any one company or individual could hold no more than 960 acres of tribal land. The permittee and the tribal received royalties from ore production. Based on the mine value of the ore, the tribe received between 10 and 20 percent royalties and the permittee between 2 and 5 percent royalties.

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

Previous Studies

In his summary of uranium deposits in Arizona, Scarborough (1981, p. 37) published a map of the Jack Daniels No. 1 open pit, copied from the files of the U.S. Atomic Energy Commission (AEC). Chenoweth (1993, p. 3) in his summary of the uranium deposits in the

Cameron area noted that the Jack Daniels No. 1 was the largest orebody in the area. Chenoweth (2009) described the origin of the name Jack Daniels.

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 Mining Permits was obtained from the Navajo Tribal Mining Department, Window Rock, Arizona. Information on the location of the Jack Daniels No. 3 mine was obtained from AEC records in the National Archives, Rocky Mountain Region, Denver, Colorado. The ore production figures given in this report are now in the National Archives, Rocky Mountain Region in Record Group 434-00-287. The author last examined the Jack Daniels Nos. 1 and 5 mines on November 20, 1997. At that time the No.1 pit was filled with water from what appeared to be surface runoff.

GEOLOGIC SETTING

The Jack Daniels uranium deposits occurred in the Petrified Forest Member of the Triassic Chinle Formation. The member is composed of multicolored claystone and siltstone with some light-gray, fine- to coarse-grained sandstone, especially in the lower part of the member. The Petrified Forest Member erodes into badlands and has brilliant variegated colors typical of the Painted Desert. In the Cameron area, the member is up to 900 feet thick.

The Jack Daniels No. 1 orebody occurred in a lense of fine- to medium-grained sandstone, clay-pellet sandstone, and clay-pellet conglomerate that contain carbonaceous matter, including carbonaceous fossil logs. The sandstone lenses were deposited in irregular depressions cut into bentonitic claystones and mudstones and are probably ancient fluvial channel fills. The sandstone at the Jack Daniels No. 1 was located near the base of the Petrified Forest Member and had a maximum thickness from 2 to 18 feet. Figure 3 gives cross sections of the orebody.

Austin (1964) in his study of the uranium ores in the Cameron area, found that they had a complex mineralogy. In oxidized ore such as the Jack Daniels No. 1, he noted that oxidation produced a complex suite of uranium oxides, sulfates, silicates, phosphates, carbonates, molybdates, and rare vanadates. Table 1 gives the chemical composition of a sample from the Charles Huskon No. 1 deposit, located 2 miles south, southeast from the Jack Daniels No. 1 mine, the only uranium minerals (Austin 1964) identified from the Jack Daniels No. 1 deposit were boltwoodite, a potassium, uranium silicate, phosphuranylite, a calcium, uranium phosphate, and schrockingerite, a sodium, calcium, uranium carbonate, sulfate. Austin (1964) found that boltwoodite was the most common uranium mineral in the Cameron area. An oxidized fossil log in the Jack Daniels No. 1 deposit contained barite, gypsum and other sulfates (Austin, 1964).

DESCRIPTION OF THE MINES

Jack Daniels No. 1

During the summer of 1955, prospectors driving northward on U.S. Highway 89 detected a radioactive anomaly approximately 2 miles north of the settlement of Cameron, Arizona. Upon inspection of the site, on the highway right of way, the men discovered the highest radioactivity came from a pile of drill hole cuttings at the base of a power line pole.

Representatives from the Marcy Exploration and Mining Company, Durango, Colorado, located the nearby Denetso family and had them file for a Navajo Tribal Mining Permit for 41.3 acres adjacent to the highway right of way (Figure 2). Mining Permit No. 360 was issued to Denetso and Mary Denetso on October 4, 1955 (Table 2). The assignment of the mining rights of the permit to Marcy was approved on November 13, 1955 (Table 2). Instead of naming the permit the Denetso No. 1, the company decided to name it the Jack Daniels No. 1 for a discarded whiskey bottle observed near the radioactive drill cutting at the power line pole.

Marcy explored the area of the permit with a total of 70 wagon drill holes drilled to a depth of 20 ft. The company also drilled 7 rotary holes, also to the depth of 20 ft. These drilling projects discovered 2,500 tons of indicated and inferred ore with an additional 35,000 tons of potential ore, according to a company report (AEC, 1958).

Three ft. of overburden was removed with a Allis Chalmer HD-5 frontend loader. An initial 500 tons of ore was shipped to the AEC ore-buying station northeast of Tuba City, Arizona in February 1956. This shipment assayed 0.32 percent U_3O_8 and 0.09 percent V_2O_5 . The ore-buying station was on the site where Rare Metals Corporation of America was constructing a uranium processing mill (Figure 1).

Marcy continued producing ore during 1956, 1957 and 1958. By the fall of 1958, the company considered all the economic ore depleted and closed the mine. The company cancelled their assignment of their Mining Permit No. 360 on September 17, 1959.

During the three years Marcy had operated the mine they had produced 38,446.67 tons of ore averaging 0.22 percent U_3O_8 (Table 3). The open pit was 500 ft. long, 250 ft. wide, with a depth of 26 ft. (Figure 3).

After examining the abandoned pit, Page P. Blakemore of Salt Lake City, Utah, determined there was enough ore remaining to be mined at a profit. On December 2, 1959, the assignment of Mining Permit 360 was approved to him (Table 2). During 1960, Blakemore mined 993.74 tons of ore averaging 0.18 percent U_3O_8 from the Jack Daniels No. 1 pit. Blakemore cancelled his assignment on October 4, 1961 (Table 2).

During the four years the Jack Daniels No. 1 was under operation, the mine produced 39,440.41 tons of ore containing 176,208.84 pounds of U_3O_8 , averaging 0.22 percent U_3O_8 (Table 3). The shipments that were analyzed for vanadium averaged 0.06 percent V_2O_5 (Table 3).

Jack Daniels No. 2

On January 12, 1956, Navajo Tribal Mining Permit No. 389 was issued to Denetso and Mary Denetso. This permit covered 41.3 acres directly east of Mining Permit No. 360 (Figure 2). Although Marcy Exploration and Mining Company controlled this permit from February 6, 1956 until March 25, 1959 (Table 2) and drilled the permit, no ore grade material was ever found (AEC 1958).

Jack Daniels #3

In previous reports, Scarborough (1981) and Chenoweth (1993) considered this property to be in the area of the No. 1 property. A review of an AEC (1958) document located in the National Archives, Rocky Mountain Region, Denver, Colorado, placed this property, known as Navajo Tribal Mining Permit No. 390, 2.9 miles to the east, northeast of No. 1. The legal location of this 41.3-acre tract, assigned to Marcy Exploration and Mining Company on February 6, 1956, was 13,301.60 ft., N 65°, 41', 27" E of the southwest corner of the Jack Daniels No. 1 permit (Figure 2).

During the 2nd quarter of 1956, Marcy mined 12.22 tons of low grade ore from a small open pit (Table 4). The host rock for this occurrence was a sandstone lense in the Petrified Forest member of the Triassic Chinle Formation and was located approximately 150 ft. above the base of the member.

Jack Daniels No. 4

Marcy Exploration and Mining Company acquired Navajo Tribal Mining Permit No. 402 on May 2, 1956 (Table 2). This permit, known as the Jack Daniels No. 4, covered 101.3 acres south of the Jack Daniels Nos. 1 and 2 (Figure 2). Marcy drilled on the permit and during the 4th quarter 1956, mined 38.85 tons of low grade ore from a small open pit near the northwest corner of the permit (Table 4).

Jack Daniels No. 5

While doing clean-up mining in the Jack Daniels No. 1 open pit in 1960, Page P. Blakemore determined that the orebody in the southwest corner of the pit extended to the west under U.S. Highway 89. After the highway was relocated in 1961, Blakemore acquired Navajo Tribal Mining Permit No. 552, the Jack Daniels No. 5 property (Table 2). This permit covered 40.0 acres adjacent to the southwestern part of the No. 1 permit.

During January 1963, Blakemore mined 322.32 tons of ore averaging 0.27 percent U_3O_8 (Table 4) from an open pit 100 ft. wide, 240 ft. long and 10 ft. deep, extending from the southwest wall of the No. 1 pit (Figure 4).

SUMMARY

All of the uranium recovered from the Jack Daniels ores at the Tuba City mill was purchased by the AEC. While the AEC ore-buying station operated at Tuba City mill, vanadium was analyzed for and paid for. The Jack Daniels ore was below the minimum grade and no payment for vanadium was received. When the mill processed the ore-buying station's stockpiles, no vanadium was recovered (Albrethsen and McGinley, 1982).

NOTE: After this report was completed, Andrew Bain, USEPA, informed the author that tests on the water in the No.1 pit indicated that the water was surface runoff, not artesian flow.

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- U.S. Atomic Energy Commission, 1958, Certification file and recurring visits reports, Jack Daniels No. 1 property, Coconino County Arizona: U.S. Atomic Energy Commission document No. C-712 in the National Archives, Record Group 434-99-207, 35 p., 2 maps.
- U.S. Geological Survey, 1988, Cameron North quadrangle, Arizona, 7½ minute series (topographic) provisional, scale 1:24,000.

Table 1. Chemical analysis of an ore sample from the Charles Huskon No. 1 mine.

	Percent
U ₃ O ₈	0.207
Total Carbon	0.45
Si O ₂	62.1
Fe	2.61
Ca O	1.19
Mg O	1.89
P ₂ O ₅	0.55
V ₂ O ₅	0.03
SO ₄	4.71
CO ₂	0.24
Mo	0.033
Co	0.041

Source: From McArthur and others, 1955.

Table 2. Navajo Tribal Mining Permits issued to Denetso and Mary Denetso.

Mining Permit No.	Name	Acres	Date Issued	Date Assignment Approved	Assignee	Date Assignment Cancelled
360	Jack Daniels 1	41.3	10/4/55	11/15/55 12/2/59	Marcy Blakemore	9/17/59 10/4/61
389	Jack Daniels 2	41.3	1/12/56	2/6/56	Marcy	3/25/59
390	Jack Daniels 3	41.3	1/12/56	2/6/56	Marcy	3/25/59
402	Jack Daniels 4	101.3	3/15/56	5/2/56	Marcy	5/2/58
559	Jack Daniels 5	40.0	7/19/61	8/14/62	Blakemore	8/14/63

Source: Navajo Tribal Mining Department records, Window Rock, Arizona.

Table 3. Uranium Ore Production, Jack Daniels No. 1, Coconino County, Arizona.

Year	Qtr	Tons of Ore	Pounds U ₃ O ₈	% U ₃ O ₈	Pounds V ₂ O ₅	% V ₂ O ₅
1956	1	1,399.49	7,831.17	0.28	2,841.00	0.09
1956	2	5,063.82	25,756.62	0.25	6,022.00	0.06
1956	3	4,420.42	19,949.45	0.23	5,346.00	0.06
1956	4	4,469.37	20,245.84	0.23	7,810.00	0.09
1957	1	2,901.26	13,512.96	0.23	5,269.00	0.09
1957	2	4,363.56	18,466.63	0.21	7,365.00	0.08
1957	3	4,097.09	17,815.96	0.22	4,113.00	0.05
1957	4	3,402.59	13,796.48	0.20	1,167.00	0.02
1958	1	3,621.95	14,378.93	0.20	1,206.00	0.02
1958	2	3,040.72	12,294.17	0.21	N/A	
1958	3	1,666.12	8,035.57	0.24	N/A	
1960	1	213.31	992.97	0.23	NA	
1960	2	618.49	1,903.56	0.15	N/A	
1960	3	161.94	625.33	0.19	N/A	
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
		39,440.41	176,208.84	0.22	40,779.00	0.06

Operators: 1936-1958 – Marcy Exploration and Mining Co.
1960 – Page P. Blakemore

Source: Unpublished U.S. Atomic Energy Commission ore production records.

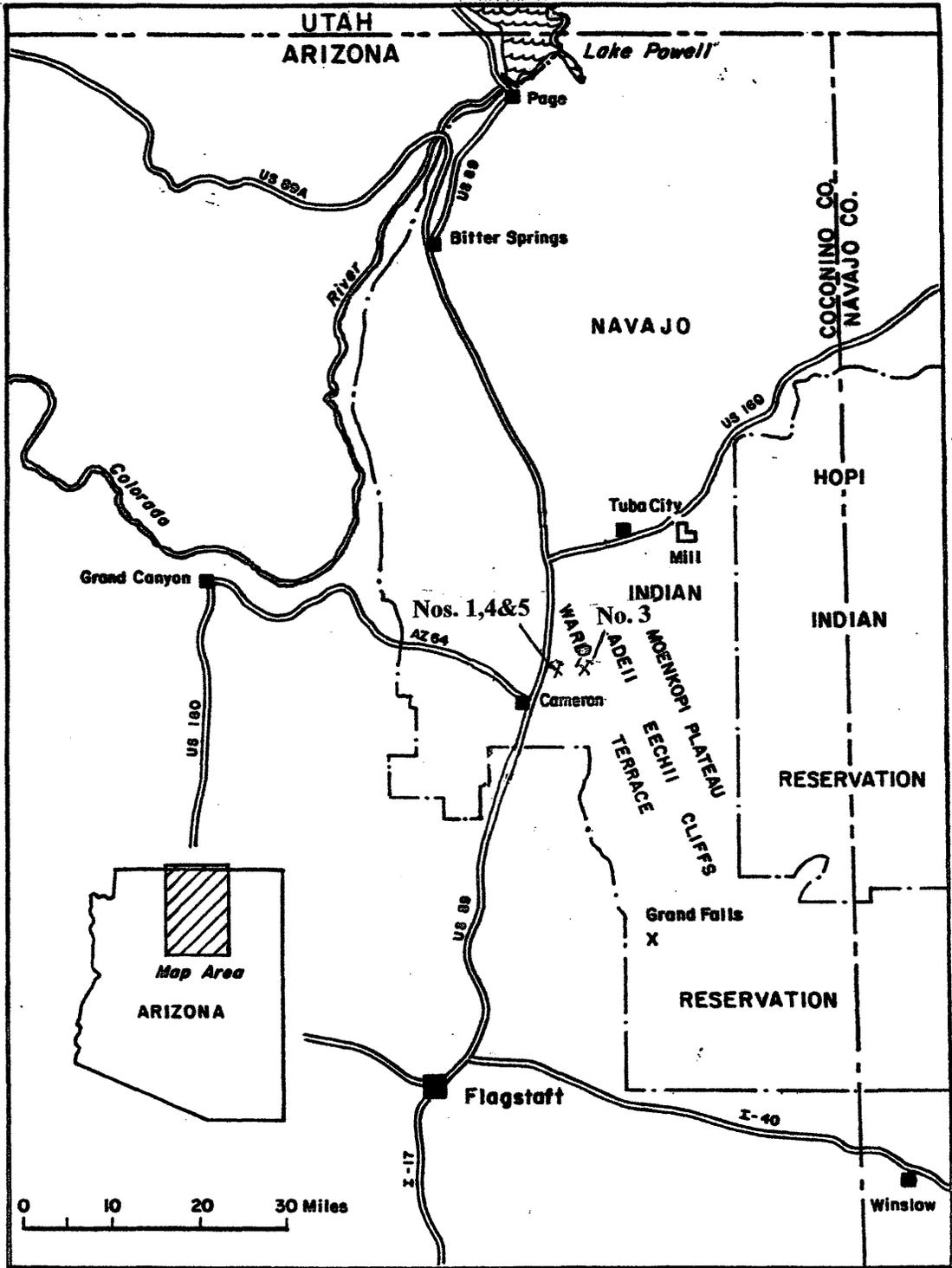
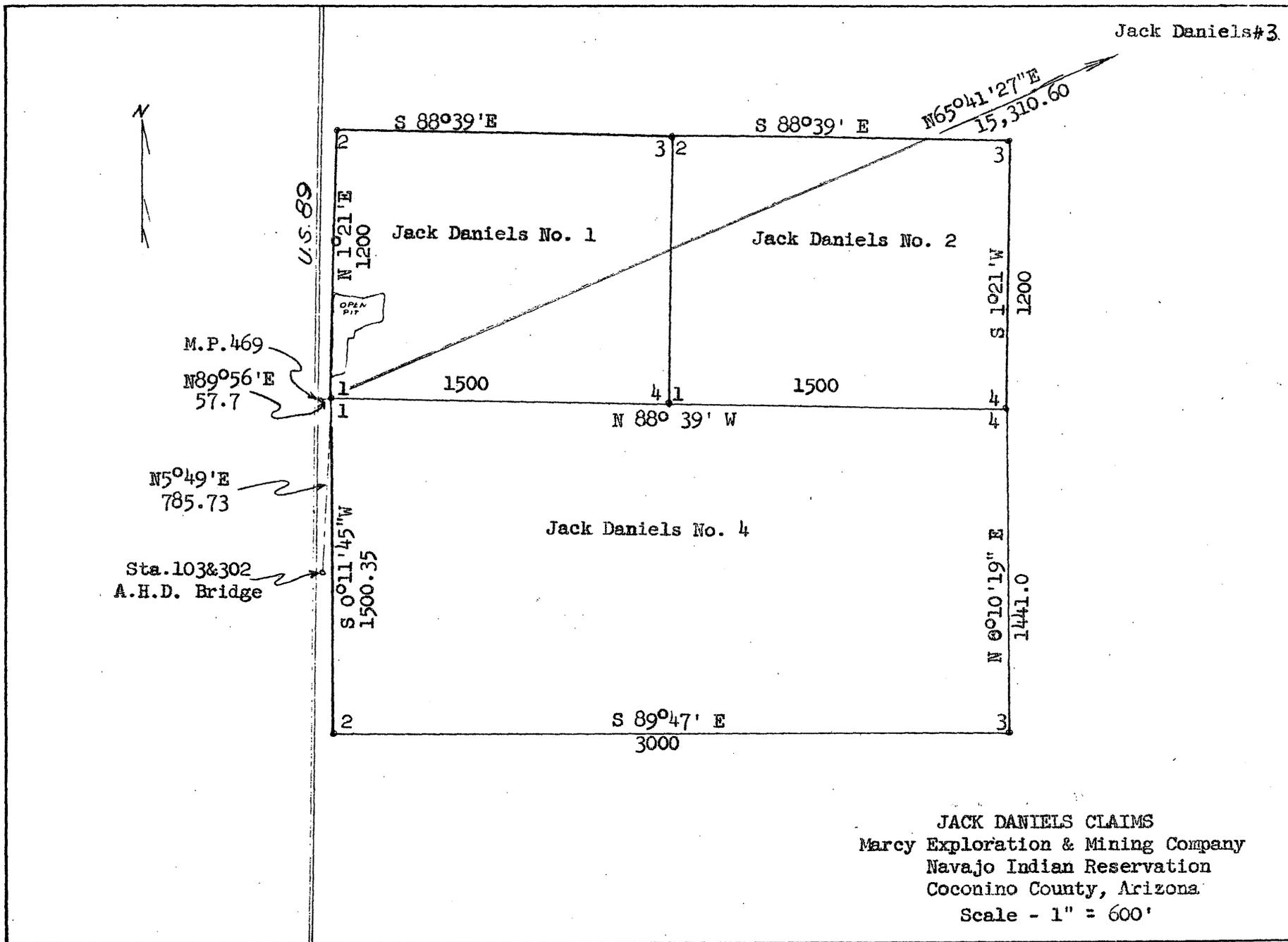


Figure 1. Index map of north central Arizona showing the location of the Jack Daniels Nos. 1, 3, 4 and 5 mines.

Figure 2. Jack Daniels Claims, from AEC, 1958.



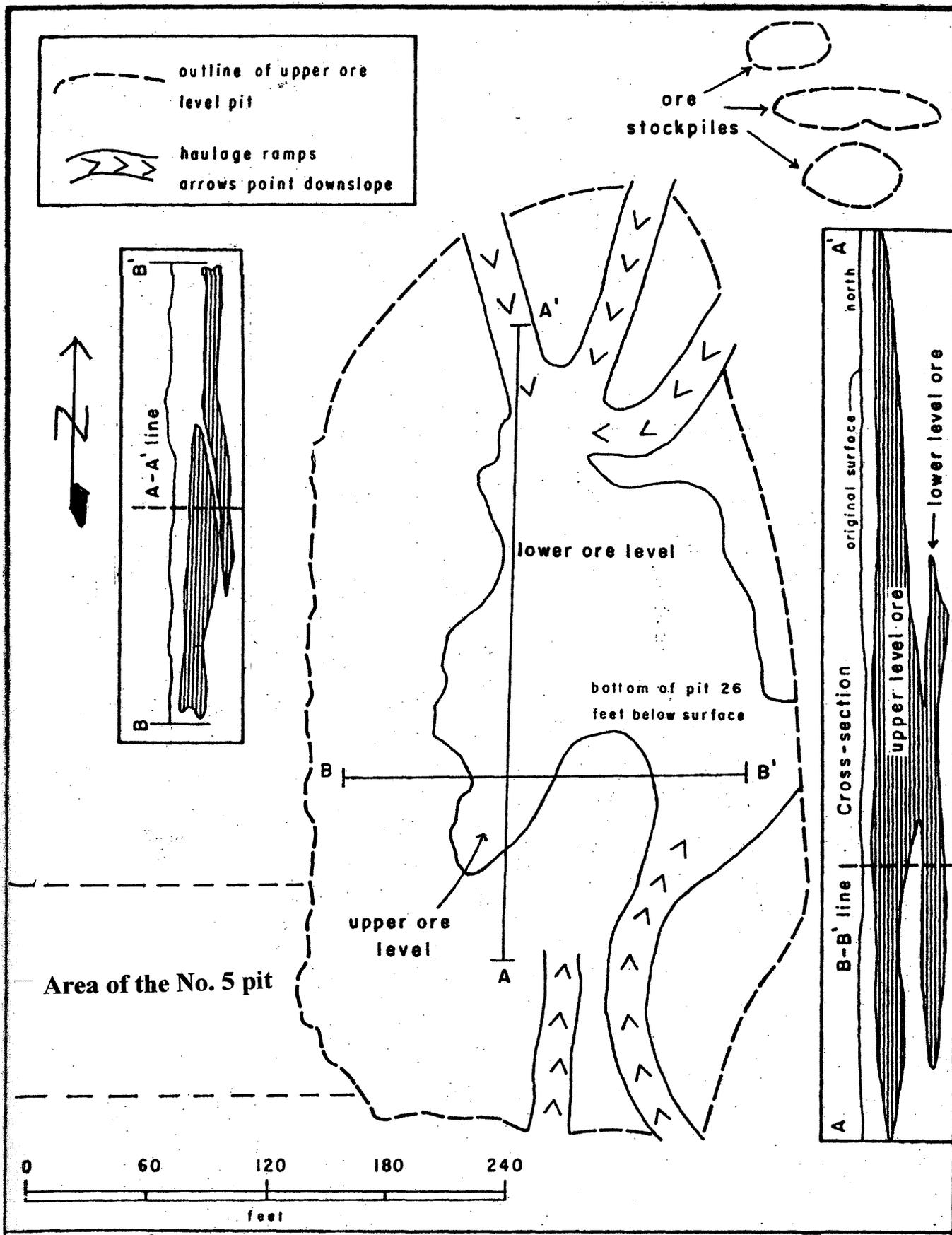


Figure 3. Map of the Jack Daniels Nos. 1 and 5 open pits, from AEC files.



Figure 4. Aerial view of the water filled Jack Daniels No. 1 pit. Note the No. 5 pit that was excavated into the former highway right of way. Light colored area in the upper left is the site of the reclaimed Charles Huskon No. 19 pit. Photo by Chenoweth, March 20, 1997.