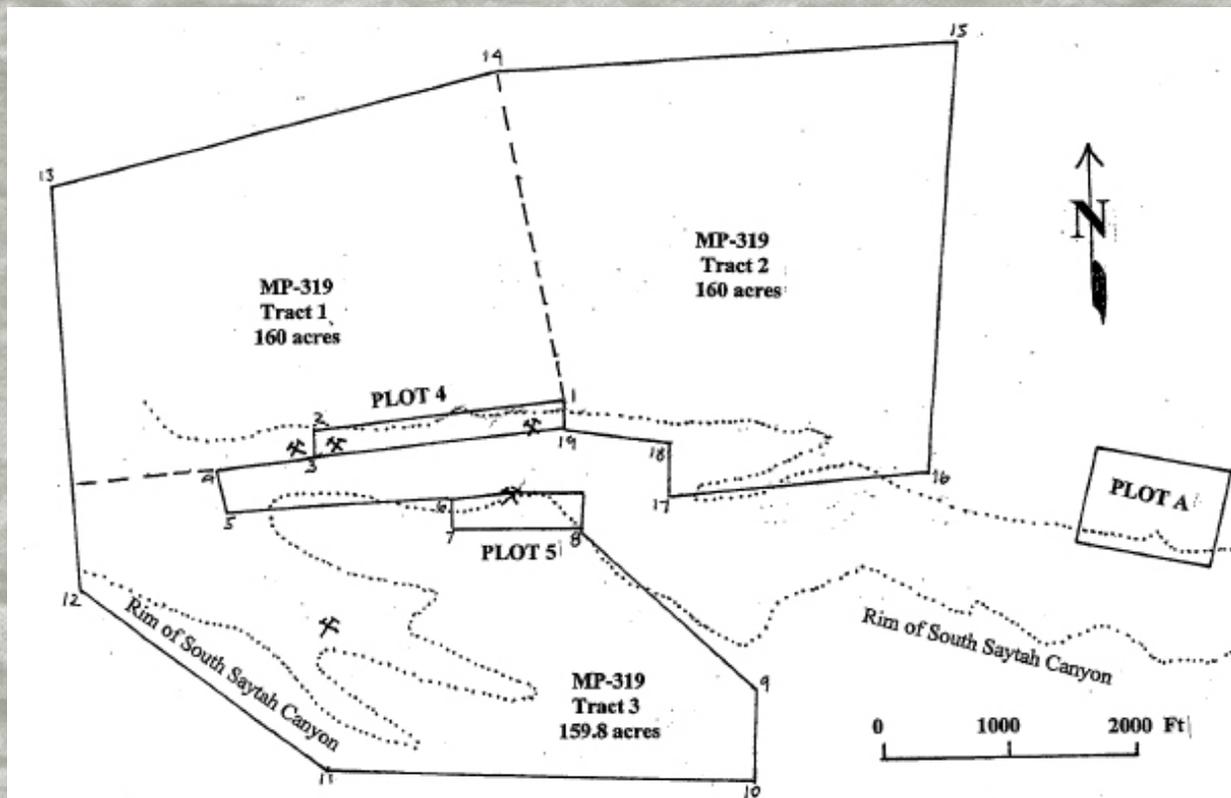


CONTRIBUTED REPORT CR-11-M

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Map of Navajo Tribal Mining Permit 319.

THE GEOLOGY, LEASING AND PRODUCTION HISTORY OF THE CB & WMC AND ADJACENT URANIUM-VANADIUM MINES IN SOUTH SAYTAH CANYON, APACHE COUNTY, ARIZONA

September 2011

William L. Chenoweth

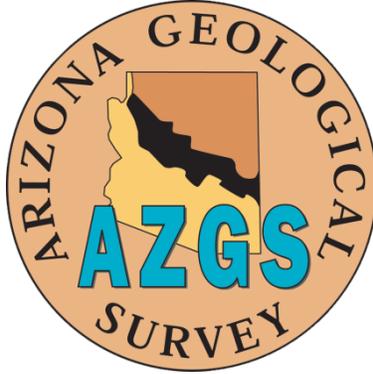
ARIZONA GEOLOGICAL SURVEY

Arizona Geological Survey Contributed Report CR-11-M

The Geology, Leasing and Production History of the CB & WMC
and Adjacent Uranium-Vanadium Mines in South Saytah
Canyon, Apache County, Arizona

September 2011

William L. Chenoweth
Consulting Geologist, Grand Junction, Colorado



Arizona Geological Survey Contributed Report Series

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INTRODUCTION

The CB&W-MC mine was developed on an outcrop of uranium-vanadium minerals that were exposed on a rim of the Salt Wash Member of the Jurassic Morrison Formation. The exposure was on the south rim of South Saytah Canyon in the northwestern Carrizo Mountains, Apache County, Arizona (Figure 1). The mine operated in 1943-1944 when the federal government was acquiring vanadium for a strategic stockpile. During the uranium boom of the 1950s, five smaller deposits, the Melvin Benally Nos. 1, 3, South Saytah and School Boy were mined in South Saytah Canyon. This report is part of an ongoing study of the history of uranium-vanadium mining on the Navajo Indian Reservation, Arizona and New Mexico.

LOCATION

South Saytah Canyon is on the northwestern flank of the Carrizo Mountains, south of Black Rock Point (Figure 1). This canyon and North Saytah Canyon are the headwater for Saytah (Tistah) Wash, a major drainage in the northwestern Carrizo Mountains. When the mines were operating they could be reached by traveling west on U.S. Highway 160, some seven miles from Teec Nos Pos, Arizona, and then traveling to the southwest on an unpaved dirt road that leads to Sweetwater Trading Post. After passing through the canyon where Saytah Wash cuts through the Toh Atin anticline, some nine miles from U.S. 160, take an unimproved dirt road to the left. This road leads into South Saytah Canyon. The CB&W-MC mine is three miles down this road on the right (south) rim of the canyon. The mine is not shown on the Toh Chin Lini Mesa quadrangle [U.S. Geological Survey, 1982] but is at longitude 109°15'40" W, latitude 36°49'35" N.

LAND STATUS

The mines are 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 1920s and 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. 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. Leases would be issued directly by the BIA, and approved by the Secretary of the Interior. Permits were issued for a 2-year period and could be renewed for an additional 2 years. Leases were issued for a period up to 10 years. No more than 960 acres of tribal land could be held by any one company or individual. Both the permittee and the tribe would receive royalties from ore production.

The location of the plots (tracts) of a lease and a Navajo Tribal Mining Permit mentioned in this report are shown in Figure 2.

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 (DOE). Information on the early vanadium leasing and mining was taken from a report by Chenoweth [1991]. The Melvin Benally No. 1 mine was last examined by the author in July 1982.

GEOLOGICAL SETTING

The uranium-vanadium deposits in the South Saytah Canyon area occur in the Salt Wash Member of the Morrison Formation of Late Jurassic age. In the South Saytah Canyon area, the Salt Wash is approximately 175 ft 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 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. 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 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 in a generally eastward flowing fluvial system [Craig and others, 1955].

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

The channel sandstone that contain the orebodies at the Saytah Canyon mines, within the middle unit of the Salt Wash Member, and are 15-30 ft above the base of the member. AEC

geologists measured a paleo stream direction of E-W for the ore-bearing sandstone at the Melvin Benally No. 1 mine.

The uranium-vanadium orebodies were formed by the selected impregnation of the sandstone and absorption 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 at the Melvin Benally No. 1 mine ranged from a feather-edge up to 4 ft thick.

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, 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. The large amounts of calcite, greater than six percent CaCO_3 , resulted in the ore being classified by the AEC as "high lime", which created problems in the acid leach circuits of processing mills. Pyrite, limonite, hematite and gypsum were also present in the ore at the Martin mine [Corey, 1956].

The beds of the Salt Wash Member in South Saytah Canyon strike approximately $N 13^\circ E$ and dip 10° to the northwest. This deformation is due to the igneous sills of the Carrizo laccolith, which are exposed to the east of the mining area.

LEASE I-149-IND-6197

On July 21, 1943, in response to requests from mining companies, the Office of Indian Affairs advertised an exploration mining lease sale for carnotite and related minerals in the northern and western Carrizo Mountains. The area offered consisted of 168 square miles in a tract 7 miles wide east-west, and 24 miles long, north-south, with the southeast corner located near Cove School (Figure 1). Excluded were all lands subject to prior approved mineral leases.

Bids were opened on August 3, 1943 at which time the only bid received was \$5,085.00 from Thomas F. V. Curran, Charles F. Curran, and John F. Wade, d.b.a. Curran Brothers and Wade [GSA, 1981, exhibit 38]. Lease I-149-IND-6197 was executed on August 6, 1943, effective October 27, 1943 for a period of ten years. On the date the lease became effective, a two-thirds interest was assigned to United States Vanadium Corporation (USV).

Shipments commenced in December 1943 and continued through February 1944. Total production was 388 tons of ore containing 15,060 pounds V_2O_5 and averaging 1.94 percent V_2O_5 (Table 1). The ore was mined from the Saytah Canyon mine and the CB&W Main Claim mine in South Saytah Canyon and from the North Martin mine in Saytah Wash. A small amount may have been mined from the west side of Cove Mesa [Harshbarger, 1946, fig. 3].

On March 22, 1944 the lease was reduced to a permanent operating lease with 12 plots, totaling 959.7 acres, selected to be retained. Details of these plots are given in Table 2. Selection and surveying of the plots were done primarily by personnel of the Union Mines Development Corporation. Union Mines was a private contractor to the Army's Corps of Engineers Manhattan Engineer District, who were appraising the uranium resources of the Colorado Plateau [Chenoweth, 1988]. On April 17, 1944, Union Mines acquired Curran Brothers and Wade's one-third interest in the lease, and on April 24, 1944 they acquired USV's two-thirds interest. Both reassignments were approved by the Office of Indian Affairs on October 31, 1944 [GSA, 1981].

The cost of acquiring the lease was reported at \$16,000 or about \$16.50 an acre [Manhattan Engineer District, 1947, p. 2-6]. Union Mines did no physical exploration or mining on the lease, a planned drilling project was never approved by the Manhattan Engineer District.

During the summer and fall of 1943, Field Party No. 3 of Union Mines, under Edward H. Eakland, mapped, described and sampled the uranium-vanadium occurrences on Kinusta, Alcove and Martin Mesas and in Saytah Canyon (Figure 1). In July and August 1945, Field Party No. 3, now under John W. Harshbarger, returned to the southern and western Carrizo Mountains to reexamine and resample the occurrences located and mapped in 1943. Several new outcrops were located and described.

Due to the secret nature of Union Mines work, the words uranium and uranium oxide could not be used in their reports although the word carnotite was permitted. In the reports on the Carrizo Mountains, SOQ was the code for U_3O_8 .

All of the functions and facilities of the Manhattan Engineer District were transferred to the newly created U.S. Atomic Energy Commission (AEC) on January 1, 1947. This included Lease I-149-IND-16197 which was officially transferred to the "United States Government" by the Union Mines Development Corp. on February 28, 1949. However, on February 17, 1949, effective October 8, 1948, the Vanadium Corporation of America (VCA) entered into contract AT(49-1)-305 with the AEC to mine uranium-vanadium ore on the plots of the lease. VCA shipped ore from Plots 1, 2, 4, 7 and E. On July 1, 1958, all the plots but 7, on Cove Mesa, were returned to the Navajo Nation.

DESCRIPTION OF DEPOSITS

Saytah Canyon Mines, Plot 4, Lease I-149-IND-6197

Prospecting by John Wade and Charles Curran and by Union Mines geologists in the fall of 1943 located two exposures of uranium-vanadium minerals in an area on the south rim of

South Saytah Canyon. The western most exposure was described by Eakland and Wardwell [1943, p. 15] as follows:

“CB&W-17 – This ore deposit lies 14 feet above the top of the Entrada formation (Bluff Sandstone) and 11 feet below the rim in the south branch of Saytah Canyon.

The ore deposit consists of two separate outcrops, each about 25 feet in length. At the southwest end is a band of ore 13 feet in length, 3” to 6” in thickness, and of 2% V_2O_5 content with considerable disseminated carnotite. This ore extended intermittently in thinner traces for an additional 11 feet. This portion of the ore deposit occurs in a diastem composed of contorted, cross-bedded, thin-bedded sandstone rubble with abundant tree fragments.

The second portion of the outcrop is exposed 20 feet beyond the intermittent ore and 4 feet higher in the stratigraphic section. This outcrop consists of 11 feet of ore with an average thickness of 18”, a grade of 1% V_2O_5 ; and then 15 feet of ore from 1” to 4” thick of less than 1% grade. The latter portion of the ore body and the overlying banded sandstone beds contain cellular tree fragments.”

A sample collected from this exposure assayed 0.9 feet at 0.17% U_3O_8 and 2.61% V_2O_5 [Harshbarger, 1946, appendix 2].

An eastern exposure was described by Eakland and Wardell [1943, p. 9] as follows:

“S-1 – This ore deposit lies 21’ above the top of the Entrada formation (Bluff Sandstone) in the south branch of Saytah Canyon. The ore body has an overall length of 55’. Beginning at the southwestern end of the outcrop there are 10 feet of 2% minus V_2O_5 ore, 12” in thickness, and containing richly disseminated carnotite; 10 feet of 1% ore about 4” in average thickness; 10 feet of ore that is 15” thick and of 2% minus grade; 10 feet of better than 1% ore about 8” thick with some disseminated carnotite; and 15 feet of 1% minus ore varying from 2-8” in thickness.

This ore body is underlain and overlain by a thick, cross-bedded, friable gray sandstone. The ore horizon is predominantly a thin-bedded, strongly cross-bedded, gray sandstone with ¼” to 1” beds. Locally the ore occurs in a wavy, contorted rubble with some ½” tree fragments.”

A sample collection from this outcrop assayed 1.0 ft at 0.24% U_3O_8 and 1.19% V_2O_5 [Harshbarger, 1946, appendix 2].

A few tons of ore may have been mined from this exposure in late 1943, early 1944 by Curran Brothers and Wade-U.S. Vanadium. A 10.4 acre tract covering these two exposures became Plot 4 of Lease I-149-IND-6197 on March 22, 1944.

While talking to Albert, S.J. Taylor, an AEC engineer, on December 7, 1955, Mr. Hadden, a contractor at the Melvin Benally Nos. 1, 3 mines, indicated he hoped to begin mining on the adjacent Plot 4 where VCA had drilled out a small orebody [Taylor, 1956]. He apparently did not get the job, as the ore from Plot 4 was shipped by James Benally. VCA's contract with the AEC stated that ore mined by Navajo contractors was exempt from a royalty due to the AEC.

VCA's contract to mine on the lease became effective October 8, 1948. In the first quarter of 1956, James Benally, a VCA contractor, mined 112.33 tons of ore averaging 0.18% U_3O_8 and 1.70% V_2O_5 from the two outcrops (Table 3). This ore was shipped to VCA's mill at Durango, Colorado. Since there was no further mining on this plot it was returned to the Navajo Nation on July 1, 1958.

In the area of mineralized outcrops CB&W-17, field parties of the Navajo Abandoned Mine Lands Reclamation Project mapped one 30 ft long adit. In the area of outcrop S-1, the field team recorded a 15 ft long adit and a 10 ft long adit connected by a tunnel [personal communication, 2008].

CB&W-MC Mine, Plot 5, Lease I-149-IND-6197

After Lease I-149-IND-6197 became effective on October 27, 1943, John Wade and Charles Curran began prospecting for uranium-vanadium exposures along Saytah Wash and in the North and South Saytah Canyons. They located a large exposure of minerals on the south rim of South Saytah Canyon. This outcrop was described by [Eakland and Wardwell, 1943, p. 12, 13] as follows:

“This ore deposit lies 25' above the top of the Entrada formation (Bluff Sandstone) on the south side of the south branch of Saytah Canyon. The outcrop is 30-40' below the bench gravels than cap the mesa.

The ore body crops out continuously throughout 75' of length and an additional intermittent length of 6'. The average thickness of ore of which the bottom is not covered by talus is more than 36". About 30' of the ore outcrop is not completely exposed. The thickest ore is 81" from top to talus cover, west of the break in the section shown on the sketch. Immediately east of the break in the section an additional thickness of 36" of ore occurs 3 feet lower, the bottom of which is likewise covered by talus. Consequently the maximum possible thickness of this block of ore is ten feet, plus whatever thickness of ore lies below the talus.

Grade of ore in the thickest block of 2% V_2O_5 with carnotite well disseminated throughout. The remaining ore is about half 1% plus and half 2% in grade with some disseminated carnotite in places.

This ore deposit is unquestionably the best in Saytah Canyon and is the one that the Currans and Wade plan to open up in the near future.”

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The cross-section mentioned in the above description could not be located in the Union Mines document. Eakland and Wardwell [1943] recommended that four holes each with a depth of 40 ft be drilled behind the outcrop. This drilling was never approved by the Manhattan Engineer District.

Curran Brothers and Wade built a road into the canyon of South Saytah Wash for access to develop and mine this outcrop. The mine was named CB&W-MC, for Curran Brothers and Wade Main Claim. The ore was hauled to the Metals Reserve ore-buying station in Farmington, New Mexico operated by U.S. Vanadium Corporation. After being sampled and weighed, the ore was shipped via the Denver, Rio Grande and Western Railroad to the vanadium mill at Durango, Colorado operated by U.S. Vanadium for Metal Reserve. Metals Reserve Company, a subsidiary of the Reconstruction Finance Corporation, was created to acquire some 40 commodities for the Nation's strategic stockpile, including vanadium. Vanadium was in demand, during the war, to harden steel.

Records of the Farmington ore-buying station [U.S. Vanadium Corp, 1945] show a total of 273.67 tons of ore received from the Curran Brothers and Wade's "South Saytah mine" during December 1943 through February 1944. The majority of this ore came from the CB&W-MC mine, but could have included a few tons from a rim cut on Plot 4.

On March 22, 1944, some 5.7 acres of land surrounding the mine was selected as Plot 5 of Lease I-149-IND-6197 (Table 2, Figure 2).

Geologists of Union Mines mapped and sampled the abandoned mine in October 1945 (Figure 3). Union Mines described the host rock in the mine as "shaly, carbonaceous sandstone, abundant with carnotite." The ore was noted as "dark gray to brown, massive to thin-bedded, vaniferous calcareous sandstone, abundant disseminated carnotite in thick ore zones. Also a few mineralized carbonaceous seams." [Harshbarger, 1946, Figure 32].

During the time Lease I-149-IND-6197 was controlled by VCA there was no activity at this mine. This plot was returned to the Navajo Nation on July 1, 1958 by the AEC.

Plot A, Lease I-149-IND-6197

Reconnaissance by Union Mines geologists in the fall of 1943 located three outcrops of uranium-vanadium minerals on the north rim of South Saytah Canyon. (Figure 4), the most promising exposure was described by [Eakland and Wardwell, 1943, p. 10] as follows:

"S-6 – This ore deposit lies 16' above the top of the Entrada formation (Bluff Sandstone) and about 10' below the rim of the canyon, on the north side of the south branch of Saytah Canyon.

The ore is exposed along the face of an almost vertical cliff and is in most part inaccessible. Going east along the ore horizon are 13 feet of ore varying in thickness from 1" to 3", of a 1% minus V₂O₅ grade. The following 7 feet are barren sandstone. From the 20-foot mark to the 40-foot mark is a 3" to 8"

thickness of inaccessible ore apparently about 2% in grade, followed by 10 feet of 2% ore that is 36" thick. In the next 10 feet the ore pinches out.

At the 110-foot mark, in the corner of the embayment and at the same stratigraphic horizon, are 10 feet of apparently 1% plus or 2% minus ore approximately 36" thick, rounding the embayment, in a southeasterly direction. Thence the outcrop rounds the embayment in a southwesterly direction for 25 feet with about 36" of apparently 1% plus to 2% minus V_2O_5 ore exposed along the inaccessible cliff. Rounding a sharp point, the outcrop continues for a length of 40' in a southeasterly direction, but is cut off at the end by the rising talus. This last showing is 36" thick at the point of the embayment and 24" thick where it is intercepted by the talus. Grade of this ore at the accessible end of the ore body alongside the talus is 1% plus. Grade of the inaccessible ore cannot be well estimated because of a heavy surface stain of hematite on the outcrop.

Next to the Main Claim of the Curran Brothers, this is the best body of ore in Saytah Canyon. Continuation of the ore outcrop around the point of embayment blocks out an ore body consistently about 30" in thickness and covering a triangular area of about 420 sq. ft. This block, of 1050 cu. ft., has an average grade of about 1½% V_2O_5 ."

Samples taken at this outcrop assayed 2.8 feet at 0.02% U_3O_8 and 0.81% V_2O_5 and 2.3 feet at 0.01% U_3O_8 and 1.21% V_2O_5 [Harshbarger, 1946, appendix 2]. An area of 16 acres covering these three occurrences was later selected to be Plot A of Lease I-149-IND-6169 (Figure 2). There was never any drilling or mining on this plot and the AEC returned this land to the Navajo Nation on July 1, 1958.

Melvin Benally Nos. 1, 3 Mines

Reconnaissance by John Wade and Charles Curran in the fall of 1943 located an exposure of uranium-vanadium minerals on the north rim of South Saytah Canyon near its western end. It was described by Eakland and Wardwell [1943 p. 15-16] as follows:

"CB&W-18 – This showing lies 17 feet above the top of the Entrada formation (Bluff Sandstone) in the south branch of Saytah Canyon. A 12-foot length of ore outcrop is exposed. Both ends of this outcrop are cut off by rising talus slopes.

The ore body varies in thickness from 1" to 6". It has a 2% V_2O_5 content. Abundant tree fragments, some altered to shiny black coal, occur throughout the deposit. All beds are coated with a heavy hematite stain.

Sixty-two feet east of this outcrop and 6 feet higher stratigraphically, is an outcrop of 1% ore apparently adjacent to a former tree trunk. Fragments of the tree trunk remain around the rim of an elliptical-shaped cave that is 3 feet wide, 1 foot high and 10 feet deep. On the west side of this small hollow is the band of ore which is 3 feet long and 7 inches wide. Very little carnotite is exposed in this outcrop.

Fifty-four feet east of this second outcrop and two feet lower, another band of ore crops out in a small diastem. This outcrop is less than ten feet in length, has a thickness varying from 1" to 8" and a grade of less than 1% V_2O_5 . It occurs in a wavy, contorted, irregularly-bedded sandstone with hematite-replaced organic material."

A sample from this outcrop assayed 1 ft at 0.16% U_3O_8 and 3.47% V_2O_5 [Harshbarger 1946, appendix 2]. Although this exposure was very near exposure CB&W-17, it was not included in Plot 4 (Figure 2).

On June 13, 1955, Navajo Tribal Mining Permit No. 319 was approved to Melvin Benally. The permit consisted of three tracts totaling 480 acres (Figure 2). The mining rights to this permit were approved to Byden Mines, Inc. of Cortez, Colorado on July 22, 1955. According to Taylor [1956] Climax Uranium Co. of Grand Junction, Colorado had a 51% interest in this mining venture.

Byden did 13,000 ft of wagon drilling on tract 1 and failed to locate any ore bodies. An adit was driven into the outcrop and the first shipment of ore was made to the mill at Shiprock, New Mexico, operated by Kerr-McGee Oil Industries, Inc. in September 1955.

Mining was done by Mr. T. S. Hadden, a contractor for Byden. Initially, he used a shuttle buggy to transport the ore, but the Arizona mine inspector did not allow internal combustion machinery underground. A mule and cart replaced the shuttle buggy. When mining on tract 1 was completed in October 1955, the workings consisted of a 90 ft long adit with a stope at the end of the drift. There was a 32 ft raise in the stope searching for a mineralized drill hole.

Mr. Hadden built a half-mile-long road up to a mineralized outcrop on the south rim of the canyon on tract 3. This was an exposure that was missed by Wade and Curran and Union Mines. Taylor [1956] estimated that approximately 90 tons of ore had been mined from a small open pit on tract 3. The total production for both the underground and open pit mines was 147.36 tons of ore averaging 0.18% U_3O_8 and 1.58% V_2O_5 (Table 4). Byden Mines cancelled their assignment of Mining Permit 319 on July 22, 1957.

School Boy Mine

A reconnaissance by Union Mines geologists in the fall of 1943 located two exposures of uranium-vanadium minerals, 1,500 ft southeast of Plot A near the head of South Saytah Canyon (Figure 4). These exposures were described by Eakland and Wardwell [1943, p. 11] as follows:

"S-10 – small showing of ore 12-15' above the Entrada formation (Bluff Sandstone) in the eastern end of the south branch of Saytah Canyon. The outcrop is 50 feet long from the western to the eastern end, but 11 feet of this distance is barren and 5' is covered by talus.

Beginning at the western end there is 20 feet of 1% V_2O_5 ore with an average thickness of about 4". At the 20-foot mark the ore is 8" thick and swells to 22" at 22 feet where it is cut off by the talus.

The ore reappears above the talus at 27' where it is 13" thick and of 1% plus grade with some carnotite. The mineralization gradually thins out to nothing at 37 feet and the horizon is barren to the 48-foot mark. From 48' to 50' there is a bed of ore 24" thick of 1% plus grade with some disseminated carnotite."

A sample from the outcrop assayed 1.2 ft of 0.10% U_3O_8 and 2.30% V_2O_5 [Harshbarger 1946, appendix 2].

"S-11 – A showing 30' above the top of the Entrada formation (Bluff Sandstone) and near the eastern end of the south branch of Saytah Canyon. The ore was exposed intermittently over a length of 60' by digging shallow pits through the talus which covers the mineralization almost completely. Starting at the western end of the outcrop, 3 feet of 1% V_2O_5 ore is exposed for a thickness of 6". At 10 feet a shallow pit showed 4" of 1% ore. At 22 feet another pit showed 6" of 1% ore and at the 60-foot mark a third pit showed 6" of less than 1% ore. Float covers the surface for the first 25 feet of the length measured."

On June 14, 1955, Navajo Tribal Mining Permit No. 293 was approved to John Benally. Taylor [1956] reported that this mining permit was contiguous with MP-319 to the west and surrounded Plot A. Since no map of MP-293 could be located, it is assumed that it covered the area of the two exposures described by Eakland and Wardwell.

The mining rights to MP-293 were assigned to the American Uranium Company of Albuquerque, New Mexico on September 30, 1955. During the last quarter of 1955 and the first quarter of 1956, American Uranium shipped 108.7 tons of ore averaging 0.09% V_3O_6 and 2.33% V_2O_5 (Table 3) to the mill at Shiprock, New Mexico operated by Kerr-McGee Oil Industries, Inc. American Uranium cancelled its assignment on September 30, 1958. The author was never able to examine this mine.

SUMMARY

All of the vanadium recovered from Plot 5 ore at the Durango, Colorado mill went into the nation's strategic stockpile during World War II. Uranium in the ore was recovered for the Manhattan Engineer District for use in atomic weapons.

The uranium recovered from the Plot 4, Benally and School Boy 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].

Acknowledgements

The Navajo Abandoned Mine Lands Reclamation Project office in Shiprock, New Mexico provided the author with the descriptions of the mine workings on Plot 4, and is gratefully acknowledged.

Jeffrey G. Tack, S.M. Stoller, contractor at the Department of Energy's Grand Junction office, provided information on how to obtain data on the Melvin Benally mines from the National Archives, Rocky Mountain Region, Denver, Colorado.

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Taylor, A.S.J., 1956, Certification of the Benally Nos. 1, 2, and 3 (Permit No. 319) Shiprock Mining District, Apache County, Arizona (Application No. 1210): U.S. Atomic Energy Commission document in National Archives, Record Group 434-99-207, 10p.

U.S. Geological Survey, 1982b, Ton Chin Lini Mesa quadrangle, Arizona, 7½ minute series (topographic), provisional, scale 1:24,000.

U.S. Vanadium Corp., 1944, Scale tickets, Farmington, New Mexico ore buying station, operated for the Metals Reserve Company 1943-1944: U.S. Department of Energy documents in the National Archives, Record Group 434-00-054, 187p.

APPENDIX

Legal Description of Navajo Tribal Mining Permit No. 319

Beginning at corner No. 1, which bears N 31° 18' 50" E 12,982.8 ft. from Mineral Monument No. 2 and is common with the NE corner of AEC Plot No. 4, thence S 83°40'W 1949 ft. to corner No. 2, which is also the NW corner of AEC Plot No. 4; thence S 5°25' E 237 ft. to corner No. 3, which is also the SW corner of AEC Plot No. 4; thence S 84° W 760 ft. to corner No. 4; thence S 20°45' E 350 ft. to corner No. 5; thence N 86° E 1660 ft. to corner No. 6, which is also the NW corner of AEC Plot No. 5; thence S4°40' E 213 ft. to corner No. 7, which is also the SW corner of AEC Plot No. 5; thence S 89°50' E 983 ft. to corner No. 8, which is also the SE corner of AEC Plot No. 5; thence S 48° E 1795 ft. to corner No. 9; thence S 01° E 695 ft. to corner No. 10; thence N 88° 15' W 3305 ft. to corner No. 11; thence N 53° 55' W 2295 ft. to corner No. 12; thence N 4° 28' W 3009 ft. to corner No. 13; thence N 75° 55' E 3497 ft. to corner No. 14; thence N 86° E 3422 ft. to corner No. 15; thence S8° 22' W 3252 ft. to corner No. 16; thence S 84°35' W 1969 ft. to corner No. 17; thence N 4°45' E 400 ft. to corner No. 18; thence N 85°10' W 790 ft. to corner No. 19; which is also the SE corner of AEC Plot No. 4; thence N 3° 45' W 239 ft. to corner No. 1, the point of beginning, containing in all 480 acres, more or less.

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

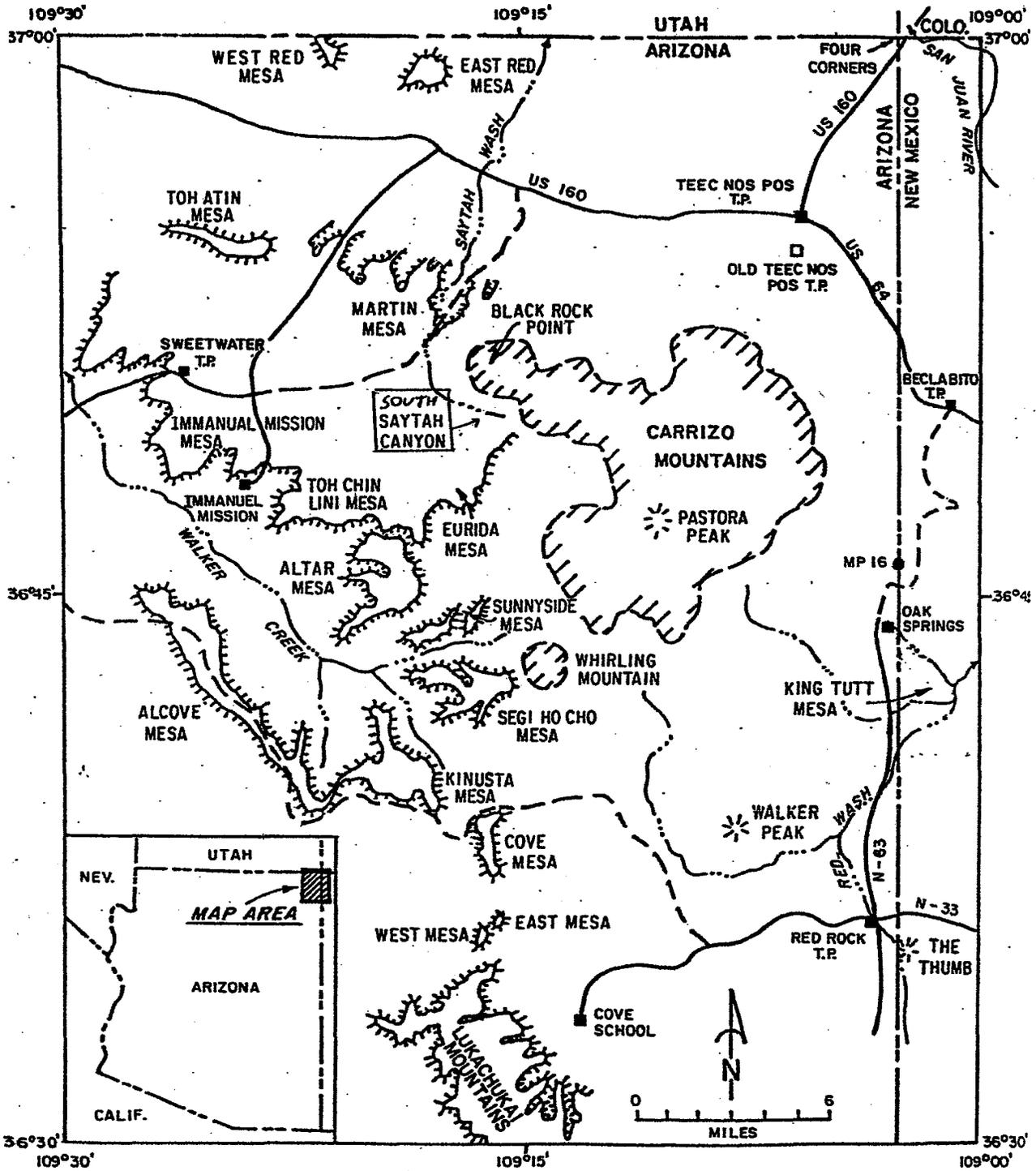


Figure 1 Index map of the Carrizo Mountains, Arizona-New Mexico showing the location of the South Saytah Canyon area.

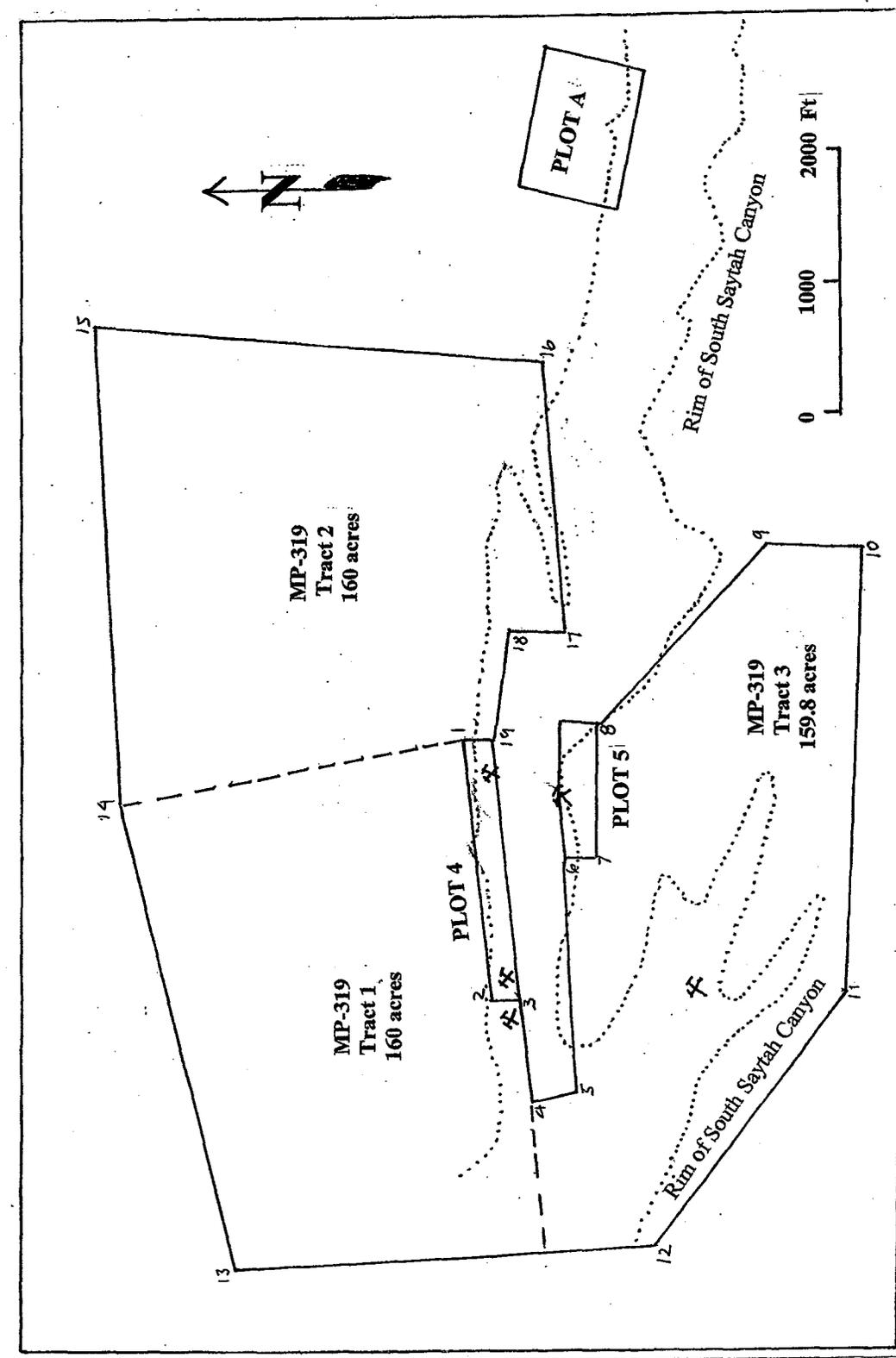


Figure 2 Map showing the location of Navajo Tribal Mining Permit 319 and Plots 4, 5 and A of Lease I-149-IND-6197.

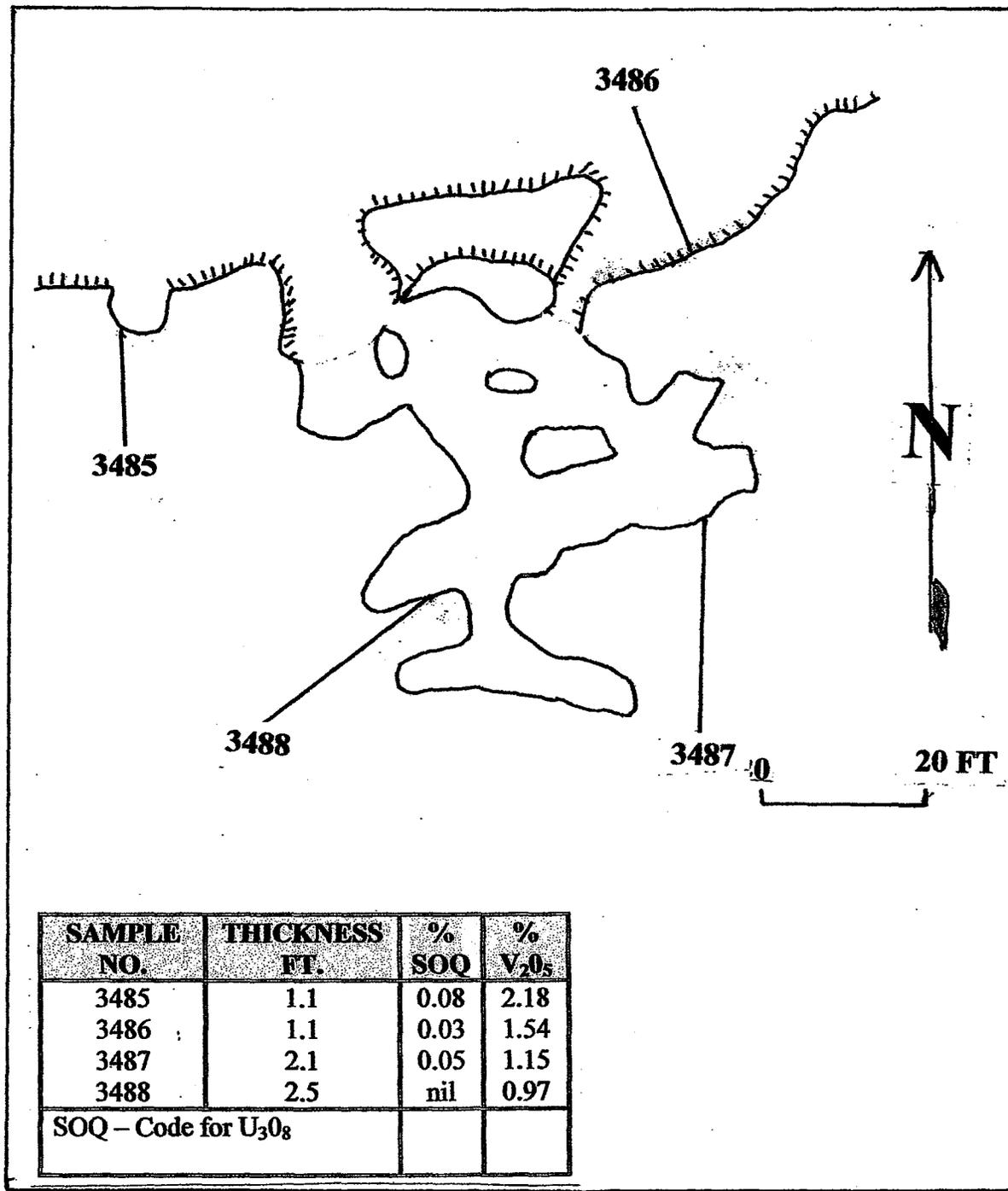


Figure 3 Map of the CB&W-MC mine on Plot 5, Lease I-149-IND-6197, October 1945. From Harshbarger, 1946, fig. 32.

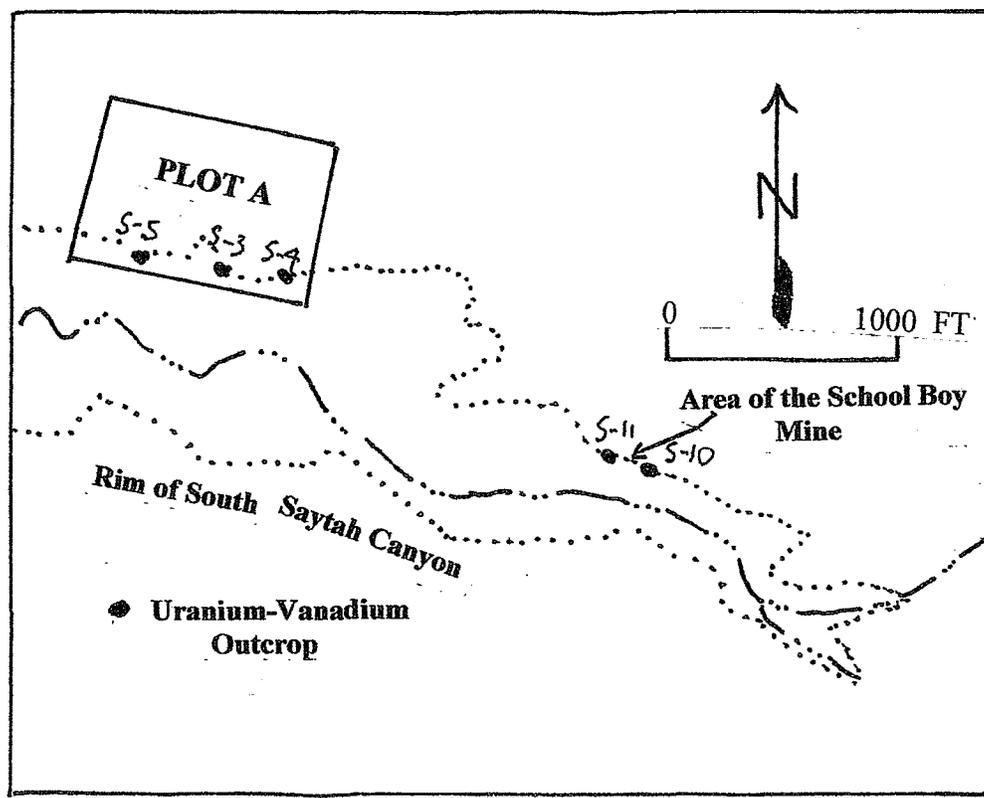


Figure 4 Map showing the location of Plot A, Lease I-149-IND-6196 and the probable location of the School Boy mine.