The Geology, Leasing & Production History of the Uranium-Vanadium Mines, Plot 2, West Reservation Lease, Apache County, Arizona

William L. Chenoweth
Consulting Geologist

Yellow tyuyamunite (uranium-bearing vanadate mineral) coating a joint in exploration pit from Plot 2.

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Phil A. Pearthree, Director

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INTRODUCTION

Plot 2 is one of 16 plots (claims) that comprise a 229.14 acre lease for vanadium that was signed in 1941. This lease was called the West Reservation Lease by the lessee Vanadium Corporation of America (VCA). The large mines on Plot 6 of this lease were named Rattlesnake, not for the reptiles, but for the blotchy pattern of yellow uranium and black vanadium minerals that resembled a rattlesnake's back (Earl Saltwater, oral communication, 1954).

One of the objectives of this report is to point out the correct uranium-vanadium ore production from Plot 2. In the official U.S. Atomic Energy Commission (AEC) ore population records, available to the public at the National Archives, Bloomfield, Colorado, no ore production is listed for Plot 2. The Plot 2 ore production is credited to the Rattlesnake mines on Plot 6 (DOE, 1997, p. 674).

Location

The northwestern Carrizo Mountains uranium-vanadium mining area is centered around the Toh Atin anticline. Here, the Salt Wash Member of the Morrison Formation is exposed along the rims of several canyons on the northeast flank of the anticline. Sandstones in the Salt Wash Member are host to numerous uranium-vanadium ore deposits.

Saytah (Tsitah) Wash is the largest canyon on the anticline. Plot 2 is in the next canyon to the west, which the AEC named Hogan Canyon for a Navajo dwelling in that canyon (Figure 1). The pits on Plot 2 are located in the SW, NW, NE and SE, NE, NW Section 1, T.40 N., R.28 E., Gila and Salt River Meridian, per 2011 survey (USGS, 2014).

When the mine was operating, Plot 2 could be reached by traveling 9 miles west of Teec Nos Pos, Arizona on the Monument Valley road (Navajo Route 1), now U.S. Highway 160. Then turning south on a dirt road to Sweetwater Trading Post via Saytah Wash. After 3½ miles this road passes by the area of Plot 6 Rattlesnake mines and enters the canyon of Saytah Wash. A road to the right crosses Saytah Wash and goes along the northeast flank of the anticline to the Sweetwater road. After crossing the wash, Plot 2 is 2 miles on the left at the mouth of Hogan Canyon (Figure 2).

Land Status

The Plot 2 mines are in 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 (BIA), 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 in the Colorado Plateau, the Tribal Council adopted new regulations. The new regulations stated that all prospectors must have a permit. 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. Leases were issued for a period as long as 10 years. 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.

**Sources of Data**

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).

From December 1953 to May 1955, the author was stationed at the AEC’s Rattlesnake field camp, located about one mile northeast of the Rattlesnake mines on Plot 6 (Figure 2). During this time the author examined all of the mines in the northwestern Carrizo area.

Information on the West Reservation Lease and the early 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. A copy of the GSA report is now in the National Archives, Rocky Mountain Region, Bloomfield, Colorado, Record Group 434-99-200.

**GEOLOGIC SETTING**

The uranium-vanadium deposits at Plot 2 occurred in the Salt Wash Member of the Morrison Formation of Late Jurassic age. In the northwestern Carrizo Mountains, the Salt Wash Member is approximately 200 ft thick. It is composed of pale gray to greenish-gray, fine-grained, well-sorted sandstone with rounded to sub-rounded 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.

The uranium-vanadium orebodies were formed by the selected impregnation of the sandstone and absorption of 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 that were commonly associated with the plant material range from several feet wide to more than 100 ft long. Judging from the number of small pits on Plot 2, only small pockets of ore were located.

In a study of the mineralogy and petrology of the Martin mine in Saytah Wash (Figure 2), Corey (1956) found tyuyamunite to be the only uranium mineral. Vanadium was in the tyuyamunite, a calcium uranium vanadate, and in the mineral montroseite, an iron-vanadium oxide. Vanadium minerals pascoite and volborthite were found as stains on outcrops at the Martin mine. Calcite was the major cementing agent of the ore. The large amounts of calcite, greater than six percent CaCO₃, resulted in the ore being classified by the AEC as “high lime”, this created problems in
the acid leach circuits of processing mills. Pyrite, limonite, hematite, and gypsum were also in the ore at the Martin mine (Corey, 1956). Figure 3 shows tyuyamunite coating a fracture in a pit on Plot 2.

Plot 2 is located on the northeast flank of the Toh Atin anticline. Here, the beds of the Salt Wash Member strike N 75° W and dip 8° to the northeast.

WEST RESERVATION LEASE

On November 28, 1941, the Office of Indian Affairs advertised an exploration mining lease sale for carnotite and related minerals for 144 square miles in Apache County, Arizona. The tract was described as “unsurveyed land which was designated on an unapproved survey as Townships 12 and 13 North, Range 7 West, and Townships 12 and 13 North, Range 6, West, Navajo Meridian.”

Bids were opened on December 19, 1941, at which time two bids were received: Vanadium Corporation of America, Naturita, Colorado, $2,000.00; and King Lease, Inc., Ouray, Colorado, $100.00 (General Services Administration, 1981, exhibit 26). Lease I-149-IND-5456 was executed with VCA on December 26, 1941, effective February 23, 1942, for ten years. Ore shipments to the Monticello mill began in early May 1942 and continued through February 1944.

On September 2, 1943, the lease was reduced to a permanent operating lease and VCA selected 16 plots (claims) totaling 229.14 acres to be retained. Details of these plots are in Table 1. These 16 plots were commonly referred to as the “West Reservation Lease” by VCA. When mining stopped in February 1944, total production for lease I-149-IND-5456 was 7,504 tons of ore containing 274,411 pounds V₂O₅, averaging 1.83 percent V₂O₅. The value of the ore was reported as $90,513.96, from which the Navajo Tribe received $8,721.35 in royalties (GSA, 1981). The ore from Lease I-149-IND-5456 was trucked to the mill at Monticello, Utah operated by VCA for the Metals Reserve Company. At the Monticello mill, VCA secretly recovered uranium from the carnotite ore for the Manhattan Project (Chenoweth, 1988).

VCA resumed mining on the lease in November 1948, under the AEC’s program, and continued until June 1966.

MANHATTAN PROJECT

During World War II, the U.S. Army Corps of Engineers formed the Manhattan Engineer District (MED) for the development of atomic weapons and acquisition of raw materials for the production of weapons. The Murray Hill Area of MED was established on June 15, 1943, for the major purpose for the exploration and development of raw materials on which the Manhattan Project was dependent. Determination and evaluation of the uranium resources of the world was done first and the program was later expanded to include thorium ores.

Union Mines Development Corporation (UMDC), a subsidiary of Union Carbide and Carbon Corporation, was contracted to do the work (Contract No. W-7405, effective May 11, 1943). On
the Colorado Plateau, UMDC's geologic investigations were limited to the Salt Wash Member of the Morrison Formation, and the Entrada Sandstone in the areas of the roscoelite deposits.

Geologic studies and resource estimates for the northwestern Carrizo Mountains are contained in reports by Eakland and Wardwell (1943) and Harshbarger (1946). Party No. 3 under Edward Eakland was in the northwestern Carrizo area in October and November 1943 and in July through September 1945. All of the outcrops of uranium/vanadium minerals, prospects, and mines were mapped and described by UMDC geologists. The geologists also proposed an exploration program for developing additional ore reserves, but it was not approved by MED (Chenoweth, 1988).

Union Mines work in the northwestern Carrizo area was summarized by Harshbarger (1946). A map (AZ-CU-24) in this report shows 9 small pits in the area of Plot 2.

**U.S. GEOLOGICAL SURVEY INVESTIGATIONS FOR THE AEC**

In September 1949, the AEC requested that the Navajo Tribal Council withdraw 71 sections in Townships 40 and 41 N., Ranges 28 and 29 E., Gila and Salt River Meridian, in the northwest Carrizo area for a U.S. Geological Survey (USGS) exploration project. The request was approved by the Council and the BIA on October 14, 1949 (USDOI, 1949). To the author's knowledge this was the first, and only, withdrawal the AEC requested on the Navajo Indian Reservation.

From December 13, 1949 through January 6, 1950, the USGS core drilled 16 holes in the areas east and north of VCA's Plot 6. Two holes were drilled to the northwest along the road to Sweetwater Trading Post and six holes were drilled along Navajo Route 1 (now U.S. Highway 160). Total footage drilled was 3,032 ft (Hall and Moore, 1950).

The USGS also mapped the geology of the northeast flank of the Toh Atin anticline from Black Rock Point to the Sweetwater Trading Post road. The mines and prospect pits on VCA's Plots 1 through 8 were mapped and plotted. In the area of Plot 2, Hall and Moore (1950, fig.2) showed the same 9 pits as did Harshbarger (1946).

**EARLY AEC ACTIVITIES**

The AEC began a study of the northwest Carrizo area in 1952 for future drilling projects to located uranium ore deposits adjacent to old vanadium mines and in areas where the probing of seismic drill holes had penetrated uranium mineralization (Hatfield and Maise, 1953). This report planned 252 holes be drilled behind mines and adjacent to seismic holes penetrating uranium mineralization. No drilling was planned on Plot 2.
PRODUCTION HISTORY

The pits on Plot 2, mapped by Union Mine's geologists in 1945 (Harshbarger, 1946), suggest some vanadium ore could have been mined here during the 1949-1944 period. During the time the author was at the Rattlesnake AEC camp, 1953-1955, the only mining on the West Reservation Lease was on Plot 6.

From the fall of 1957 until the spring of 1961, the author was stationed at the Flagstaff, Arizona AEC Field Office. During that period, I made monthly trips to the mines in the Carrizo Mountains to collect uranium exploration and production data. On February 2, 1961, I contacted Woodrow Q. Weaver, VCA mine manager, at a VCA mine on King Tutt mesa in the eastern Carrizo Mountains (Figure 1). He informed me that Thomas Clani was now mining on Plot 2 of the West Reservation Lease and that Charley Corey had mined the previous year and there was no mining on Plot 6.

Shipments by Corey and Clani (Table 2) were confirmed later in an internal AEC ore production report (AEC, 1964). Corey's shipment was labeled Rattlesnake Plot 2 and Clani's was listed as Rattlesnake.

In the official summary of uranium-vanadium, ore production during the AEC program 1948-1970 (DOE, 1997, p. 674) available to the public at the National Archives, the Corey and Clani shipments are listed as from the Rattlesnake mines on Plot 6.

Shipments from Plot 2 were shipped to the VCA mill at Durango, Colorado. The uranium recorded from the ore was sold to the AEC and the vanadium was sold to the steel industry.

In preparing for the AEC's 1962-1966 allocation program, VCA indicated they were planning for future mining on Plot 2 by including it with Plot 1 as Mining Unit 63 (Figure 4). However, no mining occurred on either plots.
REFERENCES


U.S. Department of the Interior, 1949, Order of withdrawal of Navajo Tribal lands from future prospecting for vanadium and uranium: Memorandum, 3 p., in Chenoweth’s personal files.
Table 1. Location and size of plots, VCA’s West Reservation Lease I-149-IND-5456.

<table>
<thead>
<tr>
<th>Number</th>
<th>Mine Name*</th>
<th>Acres</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hogan</td>
<td>10.33</td>
<td>W. side Hogan Canyon</td>
</tr>
<tr>
<td>2</td>
<td>Plot 2</td>
<td>10.33</td>
<td>W. side Hogan Canyon</td>
</tr>
<tr>
<td>3</td>
<td>Gila</td>
<td>10.33</td>
<td>E. side Hogan Canyon</td>
</tr>
<tr>
<td>4</td>
<td>Rattlesnake Mines</td>
<td>52.36</td>
<td>E. of Saytah Wash</td>
</tr>
<tr>
<td>5</td>
<td>Rattlesnake No. 5</td>
<td>2.14</td>
<td>E. side Saytah Wash</td>
</tr>
<tr>
<td>6</td>
<td>Horse</td>
<td>10.19</td>
<td>Rattlesnake Canyon</td>
</tr>
<tr>
<td>7</td>
<td>Two Level</td>
<td>7.41</td>
<td>Rattlesnake Canyon</td>
</tr>
<tr>
<td>8</td>
<td>Rattlesnake No. 8</td>
<td>18.13</td>
<td>E. side Saytah Wash</td>
</tr>
<tr>
<td>9</td>
<td>Eurida</td>
<td>20.66</td>
<td>N. Eurida Mesa</td>
</tr>
<tr>
<td>10</td>
<td>Eurida</td>
<td>31.74</td>
<td>S. Eurida Mesa</td>
</tr>
<tr>
<td>11</td>
<td>Eurida</td>
<td>6.76</td>
<td>S.W. Eurida Mesa</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>229.14</td>
<td></td>
</tr>
</tbody>
</table>

*Mining has occurred on all plots, but only eleven have named mines.

Source: Unpublished AEC records.

Note: The correct location of Plot 8 is in the area between the canyon east of Saytah Wash and Rattlesnake Canyon.
Table 2. Uranium-vanadium ore production from Plot 2, West Reservation Lease, Apache County, Arizona.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>QTR</th>
<th>OPERATOR</th>
<th>TONS OF ORE</th>
<th>POUNDS</th>
<th>% U₃O₈</th>
<th>POUNDS V₂O₅</th>
<th>% V₂O₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>3rd</td>
<td>C.H. Corey Jr.</td>
<td>49.35</td>
<td>250.31</td>
<td>0.25</td>
<td>1,969.00</td>
<td>1.99</td>
</tr>
<tr>
<td>1960</td>
<td>4th</td>
<td>Thomas Clani</td>
<td>62.23</td>
<td>240.12</td>
<td>0.19</td>
<td>2,050.00</td>
<td>1.65</td>
</tr>
<tr>
<td>1961</td>
<td>1st</td>
<td>Thomas Clani</td>
<td>51.46</td>
<td>291.98</td>
<td>0.21</td>
<td>1,915.00</td>
<td>1.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>163.04</strong></td>
<td><strong>710.41</strong></td>
<td>0.22</td>
<td><strong>5,934.00</strong></td>
<td>1.82</td>
</tr>
</tbody>
</table>

Source: AEC (1964)

Corey's shipments were labeled Rattlesnake, Plot 2.
Clani's shipments were labeled Rattlesnake.

Both men were VCA contractors.
Figure 1. Index map of the Carrizo Mountains, Apache County, Arizona and San Juan County, New Mexico showing the location of Hogan Canyon.
Figure 2. Section of the Toh Atin Mesa East quadrangle (USGS, 1982) showing the location of the Plot 2, Rattlesnake (Plot 6) and Martin mines in the vicinity of Tsitah (Saytah) Wash. Scale 1:24,000.
Figure 3. Tyuyamunite coating a joint in one of the pits on Plot 2. Photo by Chenoweth, 1954.
NOTE: Each mining unit is identified by its number and is defined as the volume within the vertical projection of the mining unit boundary lines as set forth on this map.

Figure 4. Map showing the location of Plots 1 through 4 on the rim of Hogan Canyon and Plot 5 at the mouth of Saytah Wash. From AEC files.