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Black Rock Point, Western Carrizo Mountains, Apache County, Arizona

THE GEOLOGY, LEASING, AND PRODUCTION HISTORY OF THE RATTLESNAKE NO.8 AND ADJACENT URANIUM-VANADIUM MINES, APACHE COUNTY, ARIZONA

September 2011

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ARIZONA GEOLOGICAL SURVEY

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INTRODUCTION

The Rattlesnake No. 8 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 east side of Saytah (Tistah) Wash in the northwestern Carrizo Mountains, Apache County, Arizona (Figure 1). The mine operated in the early 1940's when the federal government was acquiring vanadium for a strategic stockpile. During the uranium boom of the 1950's, two small deposits, Carson and Grover Cleveland No. 1, were located and mined adjacent to the Rattlesnake No. 8 mine. Included with the report are maps of the three mines.

LOCATION

The Rattlesnake No. 8 mine and adjacent mines are located on the east rim of the canyon of Saytah Wash where that drainage cuts through the Toh Atin anticline in northeastern Apache County, Arizona. The area west of the canyon is known as Martin Mesa (Figure 1). The mines can be reached by traveling west on U.S. Highway 160 some seven miles from Teec Nos Pos, Arizona and then traveling five miles to the southwest on an unimproved dirt road. The area of the mines is covered by the Toh Chin Lini Mesa quadrangle [U.S. Geological Survey, 1982b] and the Toh Atin Mesa East quadrangle, [U.S. Geological Survey, 1982a].

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 1920’s and 1940’s 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 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 the leases and Navajo Tribal Mining Permits 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 were taken from a report by Chenoweth [1991]. The Carson and Grover Cleveland No.1 mines were mapped by the author and Ray J. Holmquist in August 1960.

**GEOLOGICAL SETTING**

The uranium-vanadium deposits in the Saytah Wash area occur in the Salt Wash Member of the Morrison Formation of late Jurassic age. In the Saytah Wash area, the Salt Wash is
approximately 200 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 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 Carson and Rattlesnake No. 8 mines, within the middle unit of the Salt Wash Member, is approximately 30 ft above the base of the member. Stokes [1953] measured a paleo stream direction of E-W for the ore-bearing sandstone at the Rattlesnake No. 8 mine.

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 plant material and range from several feet in width to over one hundred feet in length. Orebodies are at the Carson ranged from a feather-edge up to 1.5 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 nearby Martin mine (Figure 2), 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 CaCO₃, 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 Rattlesnake No. 8 and adjacent mines are located on the southwestern flank of the Toh Atin anticline. This structure extends from Black Rock Point of the Carrizo Mountains, northwesterly across Martin Mesa to Toh Atin Mesa (Figure 1). The beds of the Salt Wash at the Rattlesnake No. 8 and adjacent mines dip one degree to the south, southwest.

DESCRIPTION OF THE PROPERTIES

Rattlesnake No. 8, Plot 12

The plot is one of 16 tracts that comprise Lease No. I-149-IND-5465. Vanadium Corporation of America (VCA) was the highest bidder on a 144 sq. mi exploration lease in the western Carrizo Mountain, Apache County, Arizona when the sealed bids were opened on December 19, 1941, [Chenoweth, 1991]. Lease No. I-249-IND-5465 was executed with VCA on December 26, 1941, effective February 23, 1942 for a period of ten years. On September 2, 1943 the lease was reduced to 16 plots. Details of these plots are given in Table 1. This lease was commonly referred to as VCA’s “West Reservation lease”.

Between May 1942 and February 1944, VCA produced 7,504 tons of ore averaging 1.83 percent \( V_2O_5 \) from the West Reservation lease [Chenoweth, 1991]. All of this ore was processed at a vanadium mill at Monticello, Utah operated by VCA for the Metals Reserve Company. This company was an agency of the federal government acquiring vanadium for the national strategic stockpile during World War II. Vanadium was used to harden steel for war materials. At Monticello, uranium was secretly recovered for the Manhattan Engineer District.

When Sam K. Smyth of Union Mines Development Corporation examined Plot 12 on September 9, 1945 he found a small mine which he mapped and sampled [Harshbarger, 1946, fig. 42]. This mine, named Rattlesnake No. 8, is shown in Figure 3. Smyth [Harshbarger, 1946, fig. 42] described the ore in the Rattlesnake No. 8 mine as “light gray, streaked vanadium mineralization, in
light yellow sandstone, which crosses the bedding in places. Also some secondary stain (carnotite) and thin carbonaceous seams.” Several of the mines in the Saytah Wash area were named Rattlesnake. This was due to the “rattlesnake ore” found in them. The early Navajo miners observed that the yellow uranium minerals and the dark vanadium minerals occurred in a blotched pattern resembling the design on a rattlesnake’s back [Earl Saltwater, personal communication, 1954].

The ore production records of the AEC show that in 1950, Leo Redhouse, a VCA contract miner, shipped 27.78 tons of ore averaging 0.18 percent $U_3O_8$ and 1.80 percent $V_2O_5$ and containing 97.56 pounds $U_3O_8$ and 1,000.00 pounds $V_2O_5$ to the VCA mill in Durango, Colorado. This shipment was identified as coming from the Rattlesnake No. 8 property. After reviewing the old records, the author concluded that the ore came from the Rattlesnake No. 8 mine, not Plot 8 of the West Reservation lease as previously reported [Chenoweth, 1985].

In the fall of 1953, the AEC wagon drilled 11 holes with a total footage of 990 ft behind the Rattlesnake No. 8 on a 100 ft grid pattern. All of the holes penetrated some uranium-vanadium mineralization [Bollin and others, 1956]. When the mine was examined by the author in September 1960, it was impossible to determine where the 1950 ore had been mined. The Rattlesnake No. 8 mine is shown as a prospect on the Toh Atin Mesa East topographic quadrangle [U.S. Geological Survey, 1982a] at 36 52’32” North latitude and 109 17’10” West longitude.

**Plot 13**

This is another plot of Lease No. I-149-IND-5456 and is located on the east side of Saytah Wash, south of Plot 12, (Figure 2). There are no named mines on this plot. Sam K. Smyth examined this area of Saytah Wash on September 12, 1945. At that time he noted an 8 ft adit, another 8 ft adit with a 10 ft crosscut and a 17 by 8 ft pit; all of which showed
traces of uranium-vanadium minerals. Sample, No. 3514, collected in the adit with the crosscut assayed 1.1 ft of 0.02 percent $\text{U}_3\text{O}_8$ and 1.04 percent $\text{V}_2\text{O}_5$ [Harshbarger, 1946 figure 41]. In August 1960, the author determined there had been no additional mining since the early 1940’s. Only a few tons, if any, of vanadium had been shipped. The Plot 13 workings are erroneously labeled as the Sah Tah mine on the Toh Chin Lini Mesa topographic quadrangle [U.S. Geological Survey, 1982b]. The Saytah mine is on the west side of Saytah Wash (Figure 2).

**Plot 3**

This plot is one of 12 tracts that comprise Lease I-149-IND-6197. Curran Brothers and Wade was the highest bidder on a 168 square mi. exploration lease in the western and southern Carrizo Mountains, when the bids were opened August 3, 1943. Lease No. I-149-IND-6198 was executed on August 6, 1943, effective October 27, 1943, for a period of 10 years [Chenoweth, 1991]. On the date the lease became effective, a two thirds interest was assigned to U.S. Vanadium Corporation (USV). On March 22, 1944 the lease was reduced to a permanent operating lease with 12 plots selected to be retained (Table 2).

Union Mines Development Corporation, a civilian geologic and mining contractor to the U.S. Army’s Manhattan Engineer District (MED), acquired Curran Brothers and Wade’s one third interest on April 17, 1944 and USV’s two thirds interest on April 24, 1944. Both reassignments were approved by the Office of Indian Affairs on October 31, 1944 [Chenoweth, 1991].

When Plot 3 was examined by Sam K. Smyth of Union Mines on September 12, 1945, he noted a 30 ft. long rim cut on the plot with sparse uranium-vanadium minerals [Harshbarger, 1946, fig. 41]. Union Mines did no mining on the lease but did recommend that several of the plots be drilled. However, the MED did not approve any drilling.
The AEC came into existence in January 1947 and took over the lease from MED. On February 17, 1949, effective October 8, 1948, VCA signed a contract with the AEC to mine on the plots of Lease I-149-IND-6197. No exploration or mining was done on Plot 3. Union Mines quit claimed the entire lease to "The United States of America, Washington, D.C." on February 28, 1949 [unpublished AEC document]. This gave the AEC legal control of the lease.

VCA’s contract with the AEC expired on June 30, 1958. At that time the only mining on the lease was on Plot 7 on Cove Mesa. On July 1, 1958 all the plots, but the Cove Mesa plot, were returned to the Navajo Nation [unpublished AEC document].

Carson

In September 1945, Sam K. Smyth of Union Mines Development Corporation mapped the workings of mines and prospects in the Saytah Wash area. On September 12, 1945 he mapped a 20 by 8 ft pit exposing uranium-vanadium minerals in the Salt Wash rim between the Plot 3 and Plot 13. Sample No. 3515, collected in the pit assayed 0.8 ft of nil U₃O₈ and 1.48 percent V₂O₅ [Harshbarger, 1945 fig. 41].

Navajo Tribal Mining Permit No. 346 was issued to George R. Simpson on August 25, 1955. This permit covered the 65.44 acre Carson tract adjacent to Plot 3 and Plots 12 and 13 (Figure 2). Also included in this permit was the 120 acre Richard No. 1 tract, south and west the Carson tract [Speal, 1959]. Included in the Carson tract was the pit Smyth had mapped in 1945. The assignment of the mining rights to the Carson tract to the Capital Uranium Company of Farmington, New Mexico was approved on October 25, 1955. On October 1, 1957, Capital Uranium merged into Seaboard Oil and Gas Company and became the Capital-Seaboard Corporation. Capital-Seaboard's mining contractors, Clyde Teague drilled eight holes, totaling 300 ft, on the Carson tract and drove a drift to a small pod of ore. An initial shipment to the Durango, Colorado mill, operated by VCA,
was made in March 1958. Shipments continued into the second quarter of 1958. When mining was completed, a total of 93.35 tons of ore averaging 0.22 percent $U_3O_8$ and 1.52 percent $V_2O_8$ had been mined (Table 3). The shipments were made to VCA’s mill at Durango, Colorado since Capital-Seaboard was also operating a mine on VCA’s Plot 6 of Lease I-149-IND-5456 in 1958. Plot 6 is approximately 2 mi. northeast of Carson mine.

When the mine was operating, AEC engineers noted that the ore was wheel-barrowed to the portal, dumped over the rim and later loaded into a truck to be hauled to Durango, using a loader from the Plot 6 operation [USAEC, 1959]. Capital-Seaboard canceled their assignment on August 25, 1959.

The Carson mine is shown on the Toh Chin Lini Mesa topographic quadrangle [U.S. Geological Survey, 1982b] but is erroneously labeled the Martin mine which is on the west side of Saytah Wash (Fig. 2). Figure 4 is a map of the workings made by the author and R.J. Holmquist on August 23, 1960.

**Grover Cleveland No. 1**

In April 1944 geologists of Union Mines Development Corporation located and mapped an exposure of uranium-vanadium minerals in the Salt Wash sandstone east of the Rattlesnake No. 8 mine. The 80 ft. long exposure was described as "dark gray, calcareous, vanadiferous sandstone and small amounts of disseminated carnotite." Sample No. 3007 at the northeast margin of the exposure assayed 1.6 ft. at 0.32% $U_3O_8$ and 1.80 percent $V_2O_5$ [Harshbarger, 1946, fig. 43].

Navajo Tribal Mining Permit No. 454 was issued to Grover Cleveland on November 28, 1956. This permit covered 100 acres adjacent to Plot 12 of Lease I-149-IND-5456 (Figure 2) and included the exposure described by Union Mines geologists. The assignment of the mining rights to U and L Mining Company of Shiprock, New Mexico were approved on January 24, 1957. U and L
did some drilling behind the outcrop and drove two adits into it. During the first quarter of 1957, a 28.31 ton shipment containing 125.86 pounds $U_3O_8$ and 1040.08 pounds $V_2O_5$ and assaying 0.22 percent $U_3O_8$ and 1.94 percent $V_2O_5$ was made to the mill at Shiprock, New Mexico, operated by Kerr-McGee Oil Industries, Inc. U and L did no further mining and canceled their assignment on January 21, 1959.

A map of the workings (Figure 5) was made by the author and R.J. Holmquist on August 23, 1960. The mine is not shown on the Toh Atin Mesa East topographic quadrangle [USGS, 1982a] but is located at 36° 52' 50" North latitude and 109° 17' 00" West longitude.

**SUMMARY**

All of the vanadium recovered from the Rattlesnake No. 8 ore at the Monticello, Utah 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 Rattlesnake No. 8, Carson, and Grover Cleveland No. 1 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 as paid for but not all of it was recovered [Albrethsen and McGinley, 1982].

**Acknowledgements:**

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., contractor at the Department of Energy's Grand Junction office, provided information on how to obtain data on the Carson mine from the National Archives, Rocky
Mountain Region, Denver, Colorado.

David W. Brickey of TerraSpectra Geomatics (a technical support contactor to the U.S. Army Corps of Engineers for the Navajo Abandoned Uranium Mines Project), reviewed the old records and concurred with the author that the 27.78 ton shipment came from the Rattlesnake No. 8 mine, not the workings on Plot 8.
REFERENCES


Figure 1. Index map of the Carrizo Mountains, Arizona-New Mexico showing the location of the Rattlesnake No. 8 uranium-vanadium mine.
Figure 2. Map showing the location of the mineral leases and mining permits mentioned in this report.
Figure 3. Map of the Rattlesnake No. 8 mine, September 9, 1945. From Harshbarger [1946, fig. 42].
Figure 5. Map of the Grover Cleveland No. 1 mine. Mapped by W.L. Chenoweth and R.J. Holmquist, August 23, 1960.
Table 1 Location and Size of Plots, Lease I-149-IND-5455

<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>Canyon W. of Saytah Wash</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>10.33</td>
<td>Canyon W. Of Saytah Wash</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>10.33</td>
<td>Canyon W. Of Saytah Wash</td>
</tr>
<tr>
<td>4</td>
<td>Gila</td>
<td>10.33</td>
<td>Canyon W. Of Saytah Wash</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>10.33</td>
<td>W. side of Saytah Wash</td>
</tr>
<tr>
<td>6</td>
<td>Rattlesnake Mines</td>
<td>52.36</td>
<td>E. Of Saytah Wash</td>
</tr>
<tr>
<td>7</td>
<td>Rattlesnake No. 5</td>
<td>2.14</td>
<td>E. side of Saytah Wash</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>10.41</td>
<td>Canyon E. Of Saytah Wash</td>
</tr>
<tr>
<td>9</td>
<td>Horse</td>
<td>9.77</td>
<td>Rattlesnake Canyon</td>
</tr>
<tr>
<td>10</td>
<td>Horse</td>
<td>10.19</td>
<td>Rattlesnake Canyon</td>
</tr>
<tr>
<td>11</td>
<td>Two Level</td>
<td>7.41</td>
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</tr>
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<td>12</td>
<td>Rattlesnake No. 8</td>
<td>18.31</td>
<td>E. side of Saytah Wash</td>
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<tr>
<td>13</td>
<td></td>
<td>7.92</td>
<td>E. side of Saytah Wash</td>
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<td>14</td>
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<td>N. Eurida Mesa</td>
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<td>Eurida</td>
<td>31.74</td>
<td>S. Eurida Mesa</td>
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<td>16</td>
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<td>6.76</td>
<td>S.W. Eurida Mesa</td>
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<td>Total</td>
<td></td>
<td>229.14</td>
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* Mining and prospecting occurred on all plots, but only ten have named mines.

Table 2  Location, Mine Name, and Size of Plots, Lease I-149-IND-6197

<table>
<thead>
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<th>NUMBER</th>
<th>MINE NAME*</th>
<th>ACRES</th>
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<tr>
<td>1</td>
<td>Martin</td>
<td>20.2</td>
<td>Saytah Wash, west rim</td>
</tr>
<tr>
<td>2</td>
<td>North Martin</td>
<td>14.4</td>
<td>Saytah Wash, west rim</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2.2</td>
<td>Saytah Wash, east rim</td>
</tr>
<tr>
<td>4</td>
<td>Saytah Canyon</td>
<td>10.4</td>
<td>South Saytah Canyon ,north rim</td>
</tr>
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<td>5</td>
<td>CB &amp; W Main Claim</td>
<td>5.7</td>
<td>South Saytah Canyon, south rim</td>
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<tr>
<td>6</td>
<td>Eurida</td>
<td>20.6</td>
<td>Eurida Mesa</td>
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<td>7</td>
<td>Cove Mesa</td>
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<td>Cove Mesa, southern 3/4ths</td>
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<tr>
<td>A</td>
<td></td>
<td>16.0</td>
<td>South Saytah Canyon, north rim</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>17.3</td>
<td>Segi Ho Cho Mesa, north point</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>39.9</td>
<td>Segi Ho Cho Mesa, southwest point</td>
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<tr>
<td>D</td>
<td></td>
<td>37.8</td>
<td>Segi Ho Cho Mesa, southwest point</td>
</tr>
<tr>
<td>E</td>
<td>Tree Mesa</td>
<td>529.0</td>
<td>Kinusta Mesa, eastern end</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>959.7</strong></td>
<td></td>
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* No mines were developed on Plots 3, A, B, C, D

Table 3  Uranium and Vanadium Ore Production, Carson Mine, Apache County, Arizona

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<tr>
<th>YEAR</th>
<th>QUARTER</th>
<th>OPERATOR</th>
<th>TONS OF ORE</th>
<th>POUNDS U₃O₈</th>
<th>% U₃O₈</th>
<th>POUNDS V₂O₅</th>
<th>% V₂O₅</th>
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<td>1</td>
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<td>57.20</td>
<td>251.37</td>
<td>0.22</td>
<td>1,804.00</td>
<td>1.58</td>
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<td>1958</td>
<td>2</td>
<td>Capital-Seaboard</td>
<td>36.15</td>
<td>158.82</td>
<td>0.22</td>
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<td></td>
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<td></td>
<td>93.35</td>
<td>410.19</td>
<td>0.22</td>
<td>2,846.00</td>
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