

**THE GEOLOGY AND PRODUCTION
HISTORY OF THE TRACT 11 AND
TRACT 17 URANIUM MINES,
NAVAJO COUNTY, ARIZONA**

by

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*Interpretations and conclusions in this report are those of the consultant
and do not necessarily coincide with those of the staff of the Arizona
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INTRODUCTION

The Tract 11 and Tract 17 uranium mines, in the Monument Valley area of Navajo County, Arizona, were developed as the result of sealed, competitive bidding for Navajo Tribal lands to be opened for uranium exploration. They are the western most uranium mines in the Arizona portion of Monument Valley.

The information presented in this report is from documents and maps of the U.S. Atomic Energy Commission (AEC) that were located in the files of the U.S. Geological Survey (USGS) at the Denver Federal Center. This information is part of the collection of geological data that was moved to the Denver Federal Center by the Department of Energy (DOE). In 1983 the uranium resource and liaison programs of the DOE were transferred from Grand Junction, Colorado, to Washington, D.C. During the next few years, all of the geologic data and publications that the AEC, Energy Research and Development Administration, and DOE had collected and produced from 1947 to 1983 were relocated to the USGS in Denver. Warren I. Finch of the USGS permitted me to copy the maps for the Arizona Geological Survey.

In his compilation of Arizona uranium deposits, Scarborough (1981, p.225) lists a Tract 2 in Monument Valley as having produced 13,523 tons of ore, averaging 0.34% U_3O_8 from 1958 through 1962. Navajo Tribal Mining Department and AEC records indicate that Tract 2 was never leased and there was no production. It is believed that Scarborough mistook an 11 in the AEC files for a Roman numeral two (II) since this production checks with the AEC records for Tract 11 through 1962.

LOCATION AND LAND STATUS

The Tract 11 Mines were located on the southeastern part of Hoskinnini Mesa, approximately 15 miles north-northwest of Kayenta, Arizona in Navajo County (Figure 1). Although not noted by Scarborough (1981, p.226), there were two mines on Tract 11. One deposit was mined from a vertical shaft on the mesa top and the other deposit via an adit on the rim of the mesa. On AEC maps (Young and others, 1964; and Kopf, 1966) the shaft is labeled Tract 11 and the adit, Tract 11 E. Both mines are shown on the Big Point topographic quadrangle (U.S. Geological Survey, 1988). The shaft is at latitude $110^{\circ} 23' 32''$ N, longitude $36^{\circ} 58' 05''$ W., and the adits are at latitude $110^{\circ} 23' 00''$ N., longitude $36^{\circ} 57' 48''$ W. Copper Canyon separates Hoskinnini and Nokai Mesa.

The Tract 17 Mine is located on the south rim of Nokai Mesa, approximately 22 miles northwest of Kayenta, Arizona (Figure 1). The mine site is not shown on the Cattle Canyon $7 \frac{1}{2}'$ topographic quadrangle but is at latitude $110^{\circ} 30' 30''$ N., longitude $36^{\circ} 57' 00''$ W. Both mines were reached by a series of unimproved dirt roads from U.S. Highway 163, north of Kayenta.

The Tract 11 and 17 Mines were 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 the 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. No more than 960 acres of tribal land could be held by any one company or individual. Both the permittee and the tribe received royalties from ore production.

The Tract 11 and 17 Mines were located on leases that were issued as the result of competitive bidding, and no individual Navajos were involved. These leases were issued for two years, but could be held as long as ore was produced. Royalties for these leases were as follows:

Mine Value Per Dry Ton	Percentage
\$0.01 to \$10.00	12.0
10.01 to 20.00	13.3
20.01 to 30.00	14.6
30.01 to 40.00	15.9
40.01 to 50.00	17.2

The AEC's Circular 5, Revised ore purchase schedule gave the following values for uranium ores:

Grade of ore (%U ₃ O ₈)	Value before haulage allowance (dollars/ton of ore)
0.10	4.00
0.15	9.00
0.20	16.00
0.25	20.75
0.30	25.50
0.35	30.25
0.40	35.00
0.45	39.75
0.50	44.50
0.55	49.50

The tribe also received a 10% royalty on AEC Circular 6 bonus payments and on the value of the copper recovered.

GEOLOGICAL SETTING

The ore bodies at both the Tract 11 and Tract 17 Mines are located in channel deposits in the basal portion of the Shinarump Member of the Upper Triassic Chinle Formation. These channels, scoured into the underlying Moenkopi Formation of Middle Triassic age, are filled with medium- to coarse-grained sandstone and conglomerate. Carbonaceous plant materials, including fossil logs were abundant in the channel sediments.

Both ore deposits were located by exploration drilling behind exposures of channels which cropped out on the rims of Hoskinnini and Nokai Mesas. Hoskinnini Mesa is on the axis of the Organ Rock anticline and the beds are flat lying. Nokai Mesa is on the west flank of the anticline and the beds dip 3 degrees to the west. Both mesas are capped with sandstone beds in the upper part of the Shinarump. Deposits of dune sand are present on the mesa tops.

The rim exposure of the channel containing the Tract 11 ore bodies was originally known as the Hoskinnini No. 1 channel. It is 250 wide and 75 feet deep and contained no abnormal radioactivity (Witkind and Thaden, 1963). The outline of the channel near the northwest ore body, as determined by Phillips Petroleum Company's drilling, is somewhat smaller (Figure 2).

Very little is recorded about the outcrop of the channel containing the Tract 17 ore deposit. Witkind and Thaden's (1963) mapping did not extend as far west as this deposit and there is no published description of the channel exposed on Tract 17. A map of the Shinarump channels in Monument Valley by Young and others (1964) indicates this large channel trends northeasterly across the southern part of Nokai Mesa, and crops out on the east side of the mesa on Tract 14 (Figure 3). This exposure, known as the Alfred Miles No. 1 channel, is 2,150 feet wide and 75 feet deep (Witkind and Thaden, 1963). It was drilled by the AEC in 1952 with discouraging results (Gregg, 1952).

Both ore deposits were largely unoxidized as the AEC classified the ore as "uraninite, low vanadium", and noted that chalcocite was present, especially in fragments of fossil plant material in the channels. Halos of malachite and azurite were noted surrounding the chalcocite. Calcium carbonate was the principal cementing agent in the sandstone. A sample of ore collected by AEC geologists from Tract 17 was examined by S. Ralph Austin, AEC petrologist. He identified uraninite, chalcopyrite, bornite, and pyrite in the sample. The uraninite was in pyritic mudstone pebbles and as a coating on grains of rock and other minerals (Austin, 1959). Data compiled by Roger C. Malan of the AEC, for his published report on Monument Valley (Malan, 1968) indicated that the ore shipped from the Tract 11 Mines averaged 2.50% Cu and 5.00% CaCO₃, and the ore shipped from Tract 17 averaged 0.37% Cu and 8.50% CaCO₃.

PRODUCTION HISTORY

As uranium exploration continued to be successful in the Oljeto syncline area, many individual Navajos acquired mining permits in the extreme western part of Monument Valley. Due to confusion and conflict regarding mining permits in this remote

area, the Navajo Tribal Council (Advisory Committee Resolution No. ACJ-26-55) withdrew a large area from mining on July 19, 1955. This withdrawal was approved by the Commissioner of Indian Affairs on November 8, 1955. The area withdrawn was described as follows:

"The point of beginning is at the junction of Oljeto Wash with the San Juan River; thence south along the western bank of Oljeto for a distance of approximately 25 miles to the junction of Oljeto Wash and Taeye-ha-tsazi Canyon¹; thence westward around the northern base of Tyende Mesa, Skeleton Mesa, to the head of Nokai Canyon; thence around the northern end of Zilner Mesa to the head of Piute Canyon; thence northward along the eastern bank of Piute Wash to its junction with the San Juan River; thence easterly along the south bank of the San Juan River to its junction with Oljeto Wash; the point of beginning."

Areas of former mining permits were described as "tracts". Twenty three of the tracts were in Navajo County, Arizona and six were in San Juan County, Utah (Figure 3). The tracts were offered for mining leases at a sealed bid sale held by the BIA at Window Rock, Arizona late in 1955.

Although no details of the lease sale could be located, it was publicized that several major uranium firms were high bidders on several of the tracts. The highest bidder on each tract was given 18 months, beginning on January 24, 1956, to explore its tracts. If exploration was successful the company could then obtain a mining lease. After the exploration period expired, only Phillips Petroleum Company, Strategic Minerals Department, Salt Lake City, Utah, who was the highest bidder on Tracts 10, 11, and 17 would apply for leases.

TRACT 11

Phillips conducted an extensive exploration program on Tracts 10 and 11 known as Strategic Minerals Project 68 (SM-68). This drilling, 245 holes with a total footage of 40,000 feet, located on an ore body at a depth of 200 feet reported to contain 8,300 tons with an average grade of 0.75% U_3O_8 , and an average thickness of 5.3 feet. After this initial exploration, Phillips decided to drop Tract 10 and lease only 81.76 acres of Tract 11. Lease 14-20-603-2374² was approved by the BIA on March 19, 1957.

To mine the ore, Phillips signed an Operating Agreement with Inar Norgaard of Kellogg, Idaho on September 6, 1957. This agreement was approved by the BIA on March 12, 1958. The agreement provided for Norgaard to operate the mine as if he was the owner. The sum of \$35,000 was allowed as a recoverable cost for shaft sinking, camp construction, etc., before any profits were calculated. Norgaard was allowed \$10.00 per ton for mining and \$0.02 per ton mile for excess haulage costs and received 33 1/3% of the net profits.

Norgaard sank a 210 foot-deep shaft (Figure 2) and made an initial shipment of 152.26 tons of ore to the Texas-Zinc Minerals Corporation's mill at Mexican Hat, Utah between March 28 and April 1, 1958. This ore was shipped under the name of Phillips Petroleum Company since Norgaard had not heard that the Operating Agreement had been approved. Amenability tests on this initial shipment indicated it averaged 0.35% U_3O_8 , 0.06% V_2O_5 , 2.82% Cu and 2.20% $CaCO_3$. An additional 219.21 tons averaging 0.67% U_3O_8 was shipped under Phillips' name to Mexican Hat in 1958 (Table 1). The Phillips' shipments were labeled as the SM-68-11 Mine.

¹ The U. S. Geological Survey spells this name Tseyi-hatsosi.

² Legal Description of Navajo Mining Lease 14-20-603-2374 from the files of the Navajo Tribal Mining Department, Window Rock, Arizona.

"Beginning at the southeast corner of Section 32, T.43S., R.14E., Salt Lake Base and Meridian, thence S. 02° 36' W., 10,774 feet to survey station H-67; thence N.44° 24' W., 3,559.4 feet to a unnumbered survey station; thence S.34° 35' W., 2,130 feet to the northeast corner of the mining lease; thence S. 51° 30' E., 5,100 feet to the southeast corner of the mining lease; thence S. 34° 35' W., 700 feet to the southwest corner of the mining lease; thence N. 51° 30' W. 5,100 feet to the northwest corner of the mining lease; thence N 34° 35' E., 700 feet to the northeast corner of the mining lease, closing the boundaries of mining lease, Tract 11, containing 81.76 acres more or less".

During 1958, Norgaard shipped, under his own name, 5,046.06 tons of ore averaging 0.44% U_3O_8 . Most of this ore went to the mill at Mexican Hat, but several small shipments were delivered to the AEC ore-buying station at Monticello, Utah and the mill at Tuba City, Arizona operated by the Rare Metals Corporation of America (Table 1). Copper in uranium ores was paid for, and recovered only at the Mexican Hat mill.

Initial mining from the shaft was to the northwest along the southwest flank of the channel (Figure 2). Modified room and pillar methods were used with an average crew of four men underground and three men on the surface. Late in 1959, Norgaard began mining the area southeast of the shaft.

Exploration drilling by Phillips had located some ore in a few drill holes in the southeast part of Tract 11. As of January 1960 this ore had not yet been mined but the ore body was reported to contain 2,300 tons with an average grade of 0.23% U_3O_8 . This is the Tract 11 E deposit shown on AEC maps (Kopf, 1966; Young and others, 1964).

During 1960, Norgaard drove a 36° decline, 127 feet long, bearing N 75°W, from the rim of the mesa to reach the southeast ore body. In 1960, the mining crew consisted of five men underground and one man on the surface.

Norgaard continued to produce from both mines through early 1961 (Table 1). On August 16, 1962, the BIA approved the transfer of the Operating Agreement to Howard Kimmerle and Preston Redd of Blanding, Utah. They planned to do clean up mining of the mine workings and explore for additional ore in the channel.

The AEC allocation system (market quotas) went into effect in 1962. Kimmerle and Redd received an allocation (A-662) to produce up to 22,899 pounds U_3O_8 per year. They produced ore during 1962 and 1963 but only at a fraction of their allocation (Table 1). Mine inspection reports indicate that during these two years there was an average of four men underground and one on the surface. The final shipment of ore from the Tract 11 Mines was made in May 1964. By September 1964 all equipment had been removed and the mines were abandoned.

During the 58 months the mines were active, a total of 14,913.09 tons of ore with an average grade of 0.32% U_3O_8 was mined (Table 1). Data in the AEC files indicates the ore shipped from the two mines on Tract 11 averaged 2.50% Cu and 5.00% $CaCO_3$.

Scarborough (1981, p. 226) listed the production from the Tract 11 Mine as 12,384 tons averaging 0.35% U_3O_8 . Since this is less than the AEC figures for the entire lease, it may represent the shipments from the shaft mine only.

TRACT 17

As the highest bidder on this tract, Phillips commenced an exploration drilling program in 1956. The company did 16,257 feet of drilling in 78 holes and located a ore body in southwest part of the tract. This ore body contained a reported 3,800 tons of ore with an average grade of 0.40 % U_3O_8 . Drill holes encountered ore thicknesses ranging from 2.5 to 5.5 feet with an average thickness of 4 feet.

Lease No. 14-20-603-3469³, consisting of only 40.57 acres of the original tract, was issued by the Navajo Tribe on September 4, 1957 and was approved by the BIA on February 11, 1958. Phillips Petroleum signed an Operating Agreement with Inar Norgaard, which was approved by the BIA on May 28, 1958. In the agreement, Norgaard agreed to 1) pay the Navajo royalty, and 2) pay Phillips 50% of the net profits.

Norgaard drove a 400 foot-long nearly level drift from the mesa rim below the ore body. Raises provided access to the ore horizon. An initial shipment of 474 tons of ore, averaging 0.42% U_3O_8 , was made to the Texas-Zinc mill in April 1959. Mining

³ Legal Description of Navajo Mining Lease 14-20-603-3469 from the files of the Navajo Tribal Mining Department, Window Rock, Arizona.

"Beginning at Mile Post 197, Utah-Arizona boundary, thence S.22° 2.5' W., 18,540.8 feet to survey station PP-5; thence S. 3° 45' W., 3,180 feet; thence S. 45° 00' E., 150 feet; thence N. 45°00' E., 150 feet to corner No. 1 of the mining lease; thence S.45° 00' W., 2,050 to corner No. 2 of the mining lease; thence N. 45° 00' W., 800 feet to corner no. 3 of the mining lease; thence N. 45° 00' E., 1,200 feet to corner No. 4 of the mining lease; thence N. 45° 00' W., 150 feet to corner No. 5 of the mining lease; thence N. 45° 00' E., 850 feet to corner No. 6 of the mining lease; thence S. 45° 00' E, 950 feet to corner No. 1; closing the boundaries of the mining lease Tract 17. Containing 40.57 acres".

continued with a crew of four men underground and two on the surface throughout the summer and fall of 1959. By November 1959, the ore body was mined out and the mine closed.

During the eight months the mine was active it produced a total of 4,131.67 tons of ore with an average grade of 0.40% U_3O_8 (Table 2). Data in the AEC files indicates the ore from Tract 17 averaged 0.37% Cu and 8.50% $CaCO_3$.

SUMMARY

All of the uranium concentrate produced from the ores from the Tract 11 and 17 Mines was sold to the U.S. Atomic Energy Commission. Copper recovered at the Texas-Zinc Minerals Corporation's mill at Mexican Hat, Utah was sold to a smelter in Arizona.

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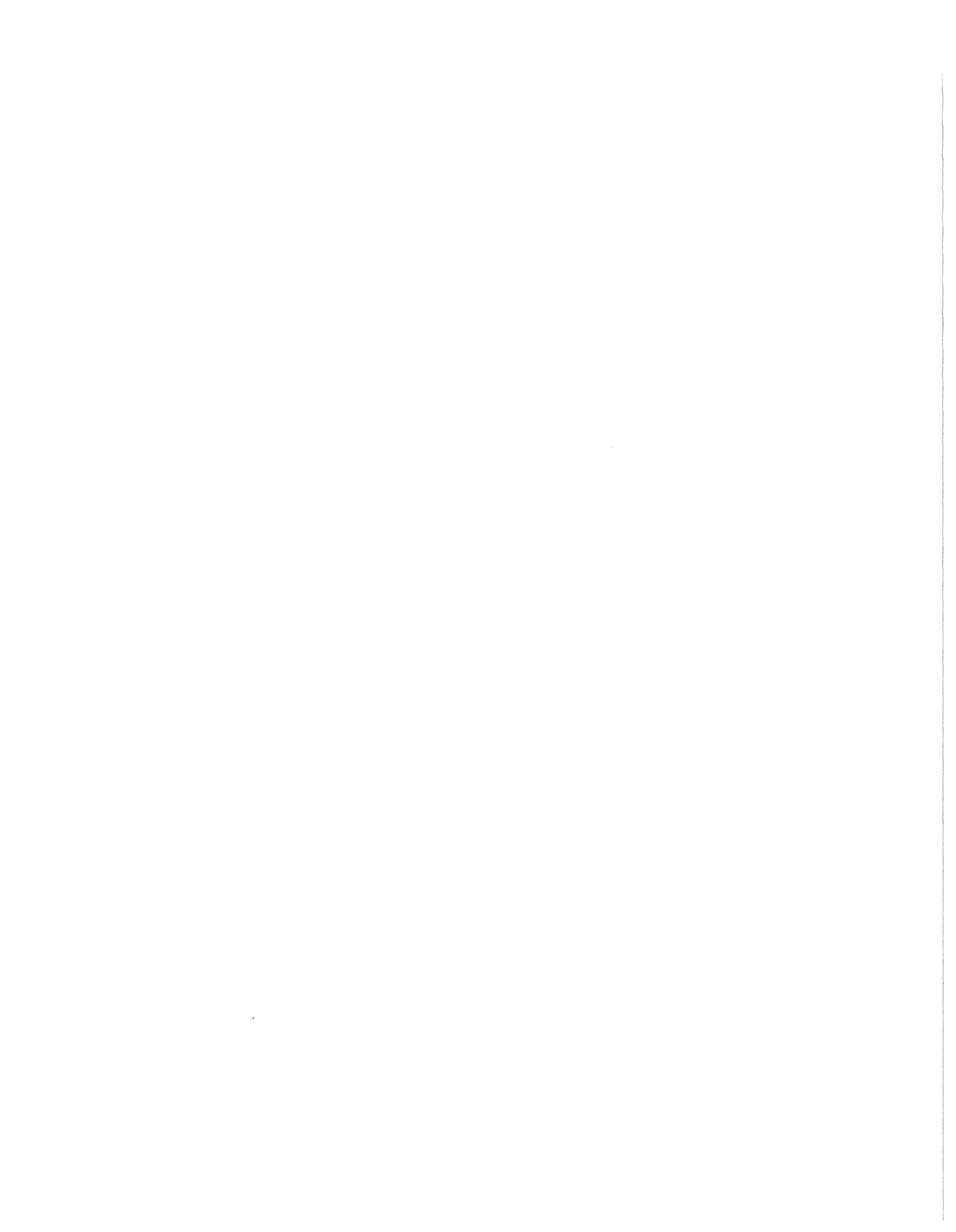


Table 1. Ore production, Tract 11 Mines, Navajo County, Arizona

YEAR	SHIPPER	TONS OF ORE	POUNDS U ₃ O ₈	% U ₃ O ₈	DELIVERY POINT
1958	Phillips Petroleum	371.47	3,997.91	0.54	Mexican Hat
1958	Inar Norgaard	5,046.06	44,777.14	0.44	Mexican Hat Monticello, Tuba City
1959	Inar Norgaard	2,268.80	11,412.06	0.25	Mexican Hat
1960	Inar Norgaard	4,374.71	25,821.70	0.20	Mexican Hat
1961	Inar Norgaard	273.30	1,147.84	0.21	Mexican Hat
1962	Kimmerle & Redd	1,188.83	3,566.39	0.15	Mexican Hat
1963	Kimmerle & Redd	1,003.51	2,601.85	0.13	Mexican Hat
1964	Kimmerle & Redd	386.41	1,778.42	0.23	Mexican Hat
Total		14,913.09	95,103.31	0.32	

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

Table 2. Ore production, Tract 17 Mine, Navajo County, Arizona

YEAR	SHIPPER	TONS OF ORE	POUNDS U ₃ O ₈	% U ₃ O ₈	DELIVERY POINT
1959	Inar Norgaard	4,131.67	32,962.09	0.40	Mexican Hat
Total		4,131.67	32,962.09	0.40	

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

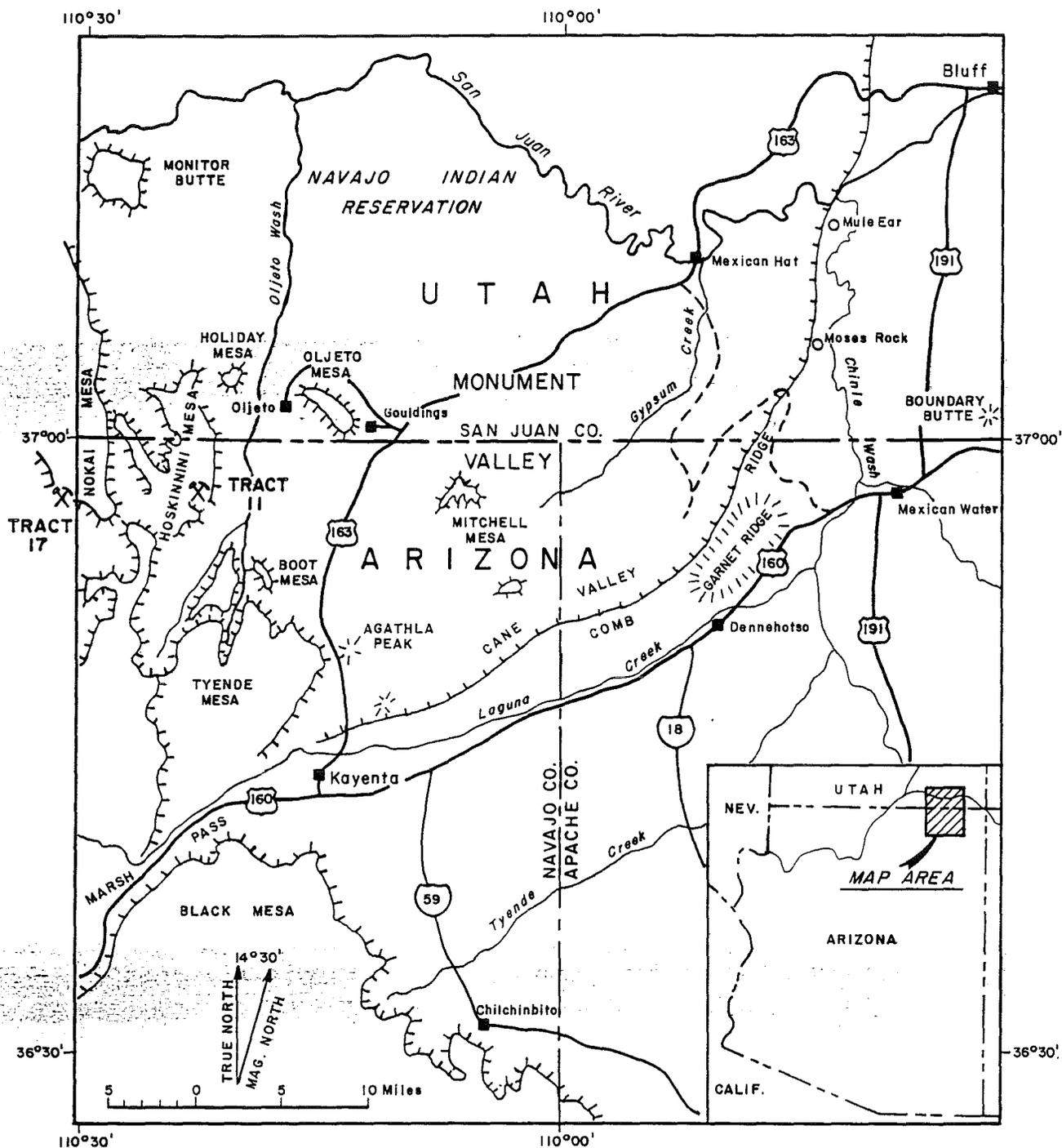
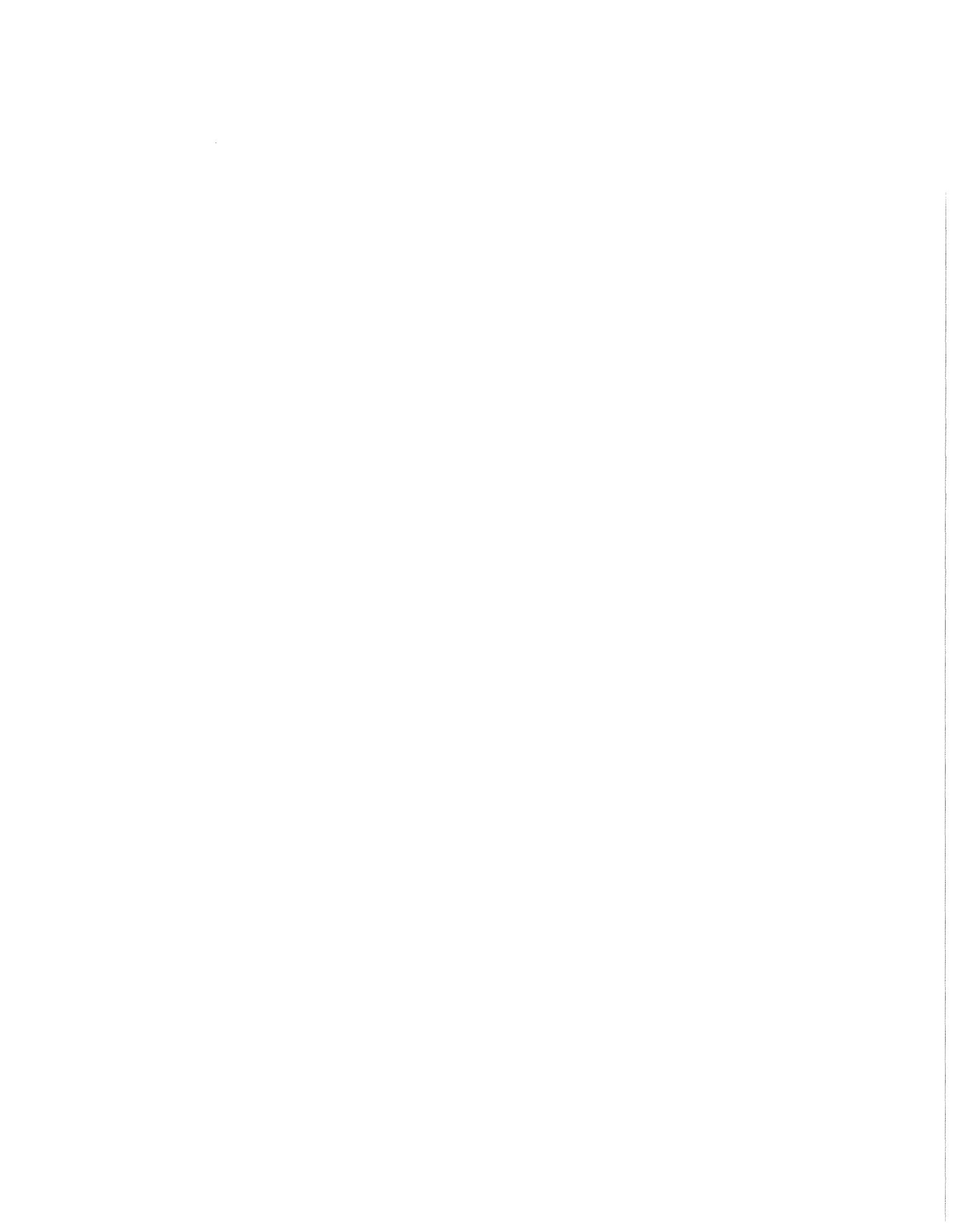


Figure 1. Index map of Monument Valley, Arizona - Utah showing the location of the Tracts II and 17 uranium mines



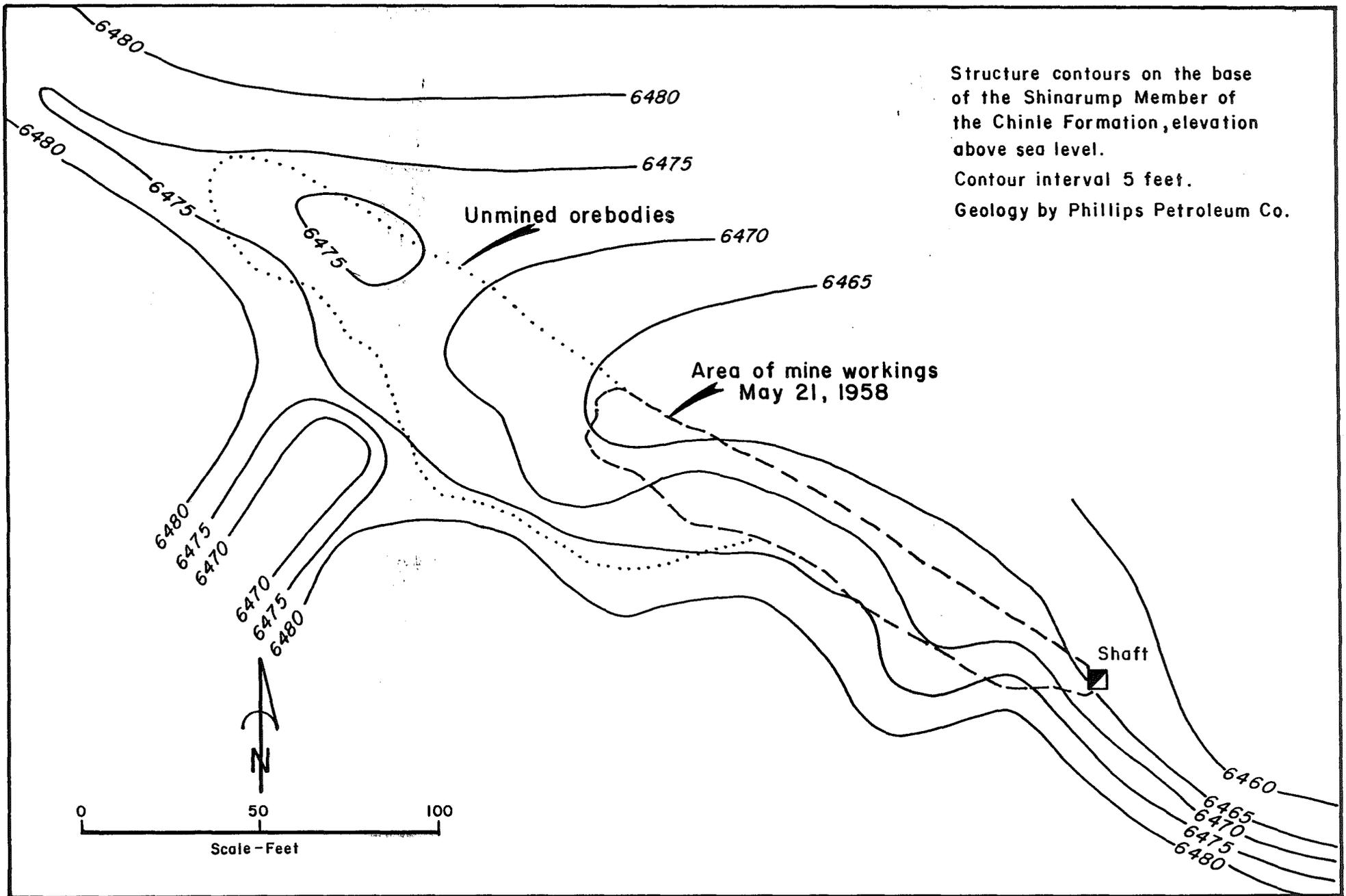


Figure 2. Map of the area of the Tract II shaft mine, Navajo County, Arizona showing paleochannel in the Shinarump Member of the Chinle Formation

