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TUNGSTEN DEPOSITS OF YUMA, MARICOPA, PINAL, AND GRAHAM COUNTIES, ARIZ.

By V. B. Dale

United States Department of the Interior—1959

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TUNGSTEN DEPOSITS OF YUMA, MARICOPA, PINAL, AND GRAHAM COUNTIES, ARIZ.[1/]

by

V. B. Dale[2/]

SUMMARY AND INTRODUCTION

This is one of a series of reports covering the mineral resources of the Nation. It describes briefly most of the known tungsten deposits in Yuma, Maricopa, Pinal, and Graham Counties, Ariz. Most of those described were examined by the author.

An effort was made to determine the position of the various deposits by section, township, and range and to give accurate road direction to each property from a prominent landmark. All available maps have been used in making these determinations, but in unsurveyed areas it was necessary to make approximate projections of subdivisions. The township and range numbers refer to the Gila and Salt River base and meridian.

Work was being done on only one property visited during the course of this investigation. Only necessary annual assessment work had been done on the majority of the properties during the past 2 years (July 1956-June 1958).

Production figures are given for each deposit, where known, and for each county. Reserve estimates were made for the individual counties. All elevations are approximate, having been obtained by aneroid barometer.

The occurrence of tungsten minerals is sporadic and discontinuous; hence, samples taken by conventional methods, other than bulk mining, are usually unreliable. The appendix contains a log of all assays made during this investigation.

Most of the deposits examined contained shallow surface workings only. At virtually all of them the commercial tungsten ores had been removed as they were found, leaving only marginal and low-grade material exposed. Development workings were found in only three areas, and they were not extensive.

1/ Work on manuscript completed February 1959.

2/ Mining engineer, Bureau of Mines, Region III, Tucson, Ariz.

The search for new occurrences of tungsten minerals was greatly stimulated in this area by the Government purchasing program announced May 10, 1951, wherein the Government agreed to purchase Standard-grade tungsten concentrates at $63 per short-ton unit.3/ The program, with slight modifications, lasted until December 1956. An investigation was made and a report written on all known tungsten occurrences in Arizona in 1941.4/ Yuma County had 1 known tungsten occurrence in 1941, compared with the 26 described in this paper. On 19 of these properties tungsten minerals were discovered after May 1951. Wilson described only one Maricopa County deposit compared with six described in this paper, five of which were discovered after May 1951. All tungsten occurrences in Pinal County were discovered before May 1951.

Field work for this report was done from January to June 1958.

ACKNOWLEDGMENTS

The author acknowledges the willing cooperation of owners and operators in aiding him to collect information concerning their properties and others and in furnishing maps for this report. Histories of the various deposits were procured principally from present owners and previous operators, partly from previous publications, and from unpublished reports of mine investigations in the files at the Federal Bureau of Mines field office (Mineral Resources) Tucson, Ariz. Information also was procured from confidential reports to the Defense Minerals Exploration Administration (DMEA), and permission to publish that information was obtained from the mine owners and others concerned.

DESCRIPTION OF DEPOSITS

Yuma County

Tungsten-ore mining was begun in Yuma County about 1942 in mines near Quartzsite. Several new discoveries were made during the Government purchasing program from May 1951 to December 1956.

Tungsten deposits have been found in the Dome Rock, Plomosa, Harquahala, Granite Wash, Kofa, Trigo, Gila, and Little Harquahala Mountains. Altitudes at the various deposits range from 300 to 2,200 feet. All deposits lie in typical southwestern desert country. Trails to the properties are generally in fair condition. Ore transportation has been a problem, however, as there have been no nearby markets. Water is scarce, which adds to transportation problems, because ore must be hauled to mills near a water source. There are now (early 1958) three small mills in the county, each set up for a certain type of ore.

3/ A short-ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten (W). A short ton of 60-percent WO_3 (Standard grade concentrates) contains 951.72 pounds of tungsten.

4/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, April 1941, 54 pp.

The predominant tungsten mineral is scheelite. It is found in four formations: Gneiss, schist, limestone, and granitic rocks. Calcareous schist, such as that found at the Jackpot, Bright Star, and other mines, is the best host rock in Yuma County. The scheelite found in limestone and schist is associated with epidote, and that found in the granite is associated with quartz. The deposits are all very sporadic, and the ore generally occurs in small pockets and lenses that usually are related to structure.

Production figures are incomplete, but it is thought that total production from Yuma County is between 3,000 and 3,500 short-ton units of WO_3.

The following shows tungsten production in Yuma County from 1951 through 1956:

		Units of WO_3 produced
Year:	1951	145
	1952	576
	1953	441
	1954	478
	1955	379
	1956	674

Nearly all the ore in the deposits is amenable to simple gravity concentration.

Measurable ore reserves are nil. Ore has been extracted as encountered, and no exploration or development work has been done. Ore reserves of tungsten deposits are extremely difficult to estimate because of the unreliability of conventional sampling methods. High-grade pockets will continue to be found; but, judging from past production records, production from those sources doubtless will be small. Indicated reserves in Yuma County are about 15,500 tons at an estimated grade of 0.35 percent WO_3. Inferred reserves are about 178,000 tons at an estimated grade of 0.3 percent WO_3.

Saturday Claims

The Saturday group of four unpatented lode claims is in the NE1/4 sec. 31, T. 5 N., R. 10 W., on the south side of the Harquahala Mountains at an altitude of about 2,000 feet. The claims are reached by driving 13.3 miles southeasterly from Salome on the Buckeye Road, 1.6 miles easterly to a cattleguard, 4.1 miles easterly to a dim trail that turns northerly from the road, and on this trail, 2.9 miles to the central part of the Saturday claims (fig. 1).

Bruce Alsop located these claims in March 1956. There has been no production from the property. The workings consist of several shallow prospect holes and trenches, none exceeding 15 feet in depth.

The geologic setting comprises a series of schist, gneiss, and limestone intruded by granite and diabase dikes.

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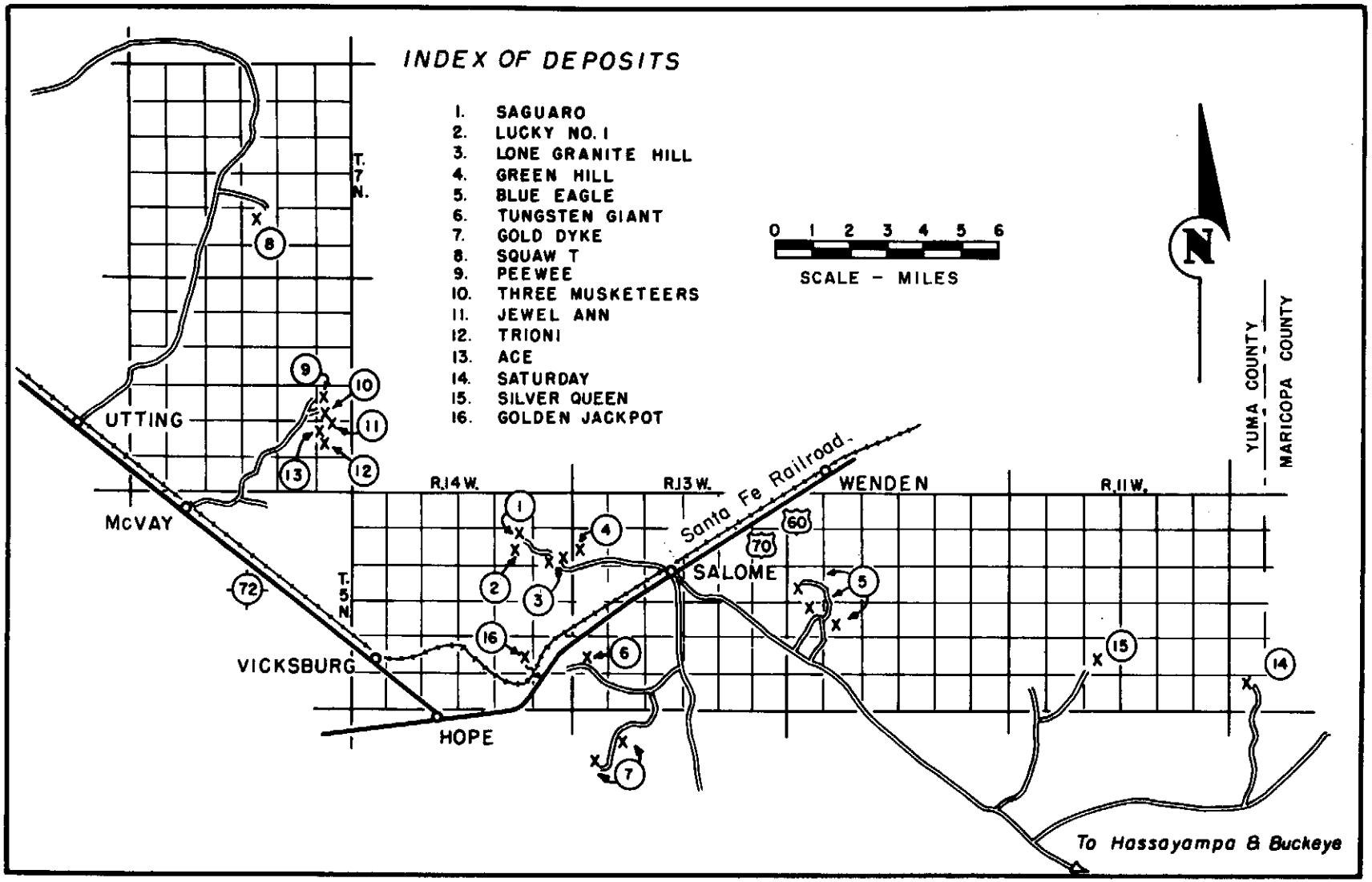

FIGURE 1. - Tungsten Deposits in Salome Area, Yuma County, Ariz.

The scheelite mineralization is associated with structure. It is very sparse and sporadic and occurs near the intersection of fractures striking N. 20° W. and dipping 47° NE. and fractures striking N. 30° E. and dipping 42° SE. The scheelite occurs in stringers about 2 inches wide, which cut the schistose formation. Three lenses of ore have been exposed on the property.

About 100 feet west of these occurrences is a schist-granite contact that strikes N. 30° E. and dips 40° SE. The mineralized zone appears to parallel the contact and is probably 20 to 40 feet wide by 500 feet long (measurements based upon surface float). The float is very sparse and sporadic, as are the lenses. It is doubtful if handpicked ore exposed thus far will assay more than 1 percent WO_3.

About 1,000 feet south of the scheelite occurrence is a fissure approximately 12 inches wide, which strikes N. 65° W. and dips 75° SW. The fissure is filled with calcite, galena, fluorspar, and manganese and iron oxides.

Silver Queen (Bimbo) Claim

The Silver Queen claim is in sec. 28, T. 5 N., R. 11 W., on the south side of the Harquahala Mountains at an altitude of 2,200 feet. The property is 11.8 miles southeasterly from Salome on the Buckeye Road, 3.5 miles northeasterly on a graded road to a dim trail that leads to the right, or easterly, and then northeasterly on this trail 3.5 miles to the claims (fig. 1).

This property has had numerous locators, probably dating back to the 1920's and 30's. The author found seven location papers on the property dating back to 1948. The current valid location was made by George Campbell, Jr., and Jack R. Irwin November 3, 1955. They called their claim the Bimbo, and discovery work was done on a narrow, scheelite-bearing quartz stringer.

Workings on the claim consist of an adit 40 feet long, five shallow opencuts, and three inclined shafts from 10 to 20 feet deep.

Sparse, sporadic scheelite occurs in quartz filled fissures, which strike N. 60° E. and dip 40° SW., N. 40° E., dip indeterminable, and N. 60° W., dip 35° SW. The quartz fissures are discontinuous and occur at random in parallel structure. The quartz is shattered and easily broken.

The quartz fissures cut a series of marbleized limestone and schist, which in turn have been intruded by both acid and basic dikes, probably rhyolite and diorite. Both are fine-grained rocks. The limestone is buff on weathered surfaces and can be seen from several miles south of the mountain range. The limestone is about 1.5 miles long and several hundred feet wide. Abundant scheelite float is noted at several places along the strike of the limestone.

On the Bimbo claim the scheelite, where exposed, occurs in quartz stringers as wide as 6 inches. Some mineralization has penetrated the schist and limestone, but it is very sparse and low grade. Some of the quartz ore will

assay more than 1 percent WO_3. Some of the quartz fissures are 3 or 4 feet wide, but they do not seem to carry scheelite where they are wide. The quartz does contain low-grade galena and chalcopyrite, but it seems not to occur with the scheelite.

No tungsten ore has been produced from the property.

Blue Eagle and Four Winds Claims

The Blue Eagle group of nine unpatented lode claims lies in secs. 19 and 20, T. 5 N., R. 12 W., and the Four Winds group of two unpatented claims lies in sec. 18, T. 5 N., R. 12 W. The claims are in the extreme western end of the Harquahala Mountains at an altitude of about 2,000 feet. The central part of the Blue Eagle claims is reached by driving southeast from Salome on the Buckeye Road for 4.5 miles to a graded road going northeast and, on this road, 1.5 miles to the workings (fig. 1).

These claims probably were worked in the early 1900's on gold showings. In 1933 Geo. W. and Annie E. Campbell relocated a few claims and in 1937 located additional claims. Nineteen carloads of gold ore containing 98 percent SiO_2 were shipped from the property between 1937 and 1944. In 1944 F. M. Stephens, a mining engineer from Tucson, discovered scheelite on the property. About 1,000 units of WO_3 has been produced since that time. Concentrates have averaged 70 percent WO_3. There has been a total gross gold and tungsten production of about $165,000 from the property, according to George Campbell.

The workings consist of numerous shallow opencuts, trenches, adits, and prospect shafts. The deepest workings are on the Four Winds claim in section 18, where a shaft had been sunk about 60 feet.

Schist, gneiss after quartz diorite, and quartzite predominate in this area. The micaceous schist is perhaps of Precambrian age.[5]

Nearly pure scheelite occurs as stringers and blebs in schist and gneiss. Narrow, discontinuous seams of nearly pure scheelite occur along cleavage in the schist, as well as in fractures through schist and gneiss. The scheelite is associated with quartz, which, in addition to scheelite, carries iron oxides and gold.

The general strike of the schist-gneiss-quartzite series is northwest. The mineralized fractures strike N. 15° E. to N. 70° E. and dip 30° to 40° SE. One mineralized fracture was observed striking N. 30° W. and dipping 50° NE.

The seams of nearly pure scheelite open into sporadic, irregular pockets and pods up to 3 feet in cross section. These pods assay as much as 75 percent WO_3. Quartz veinlets generally lead to pods and lenses containing a

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5/ Darton, N. H., A Resume of Arizona Geology: Arizona Bureau of Mines Bull. 119, 1925, p. 223.

few tens of pounds of 10- to 30-percent scheelite ore. Pods and lenses are widely scattered and appear to be localized at the intersections of weak fractures. Other mineralized zones undoubtedly will be found and worked on the surface, but the cost of locating mineralized zones underground will be high. The largest lens mined was about 30 feet long, 10 inches wide, and 30 feet deep.

The ore is concentrated simply. G. W. Campbell crushed the ore to 16-mesh with a 6- by 6-inch crusher, a set of rolls, and a vibrating screen, and then upgraded the scheelite to an average of 70 percent WO_3, with only a Deister table.

Gold Dyke Group

The Gold Dyke group of four claims is in sec. 7, T. 4 N., R. 13 W., unsurveyed, in the Little Harquahala Mountains at an altitude of approximately 2,300 feet. From Salome, drive 2.6 miles south to a trail that branches westerly, and then, on this trail, 3.1 miles southwesterly to the Gold Dyke workings (fig. 1).

These claims were worked in the early 1900's on small gold showings, but the gold production is unknown. George W. Campbell relocated the claims in 1951 on tungsten occurrences. About 100 short-ton units of 60-percent WO_3 has been produced from the property.

The workings consist of several shallow opencuts, trenches, and prospect shafts. No hole was seen that exceeded 15 feet in depth.

Discontinuous quartz veins, striking N. 45° W. and dipping 20° SW., cut a medium-grained gray granite. The quartz ranges in width from a fraction of an inch to 1.5 feet. Cross fractures, striking east and dipping flatly south, cut the quartz veins. The quartz carries sporadic pockets of nearly pure scheelite and minor amounts of iron and manganese oxides. The granite is extensively fractured, and epidote is present in many fractures. Diabase dikes, which strike northwest, also cut the granite.

The largest exposure of quartz observed was 12 to 18 inches wide and could be traced on the surface for about 50 feet and down dip for about 20 feet. High-grade pockets of scheelite had been removed, and only sparse mineralization remained.

Tungsten Giant Group

The Tungsten Giant group of 25 unpatented lode claims is in secs. 25 and 36, R. 14 W., and secs. 30 and 31, R. 13 W., T. 5 N. The claims lie at an approximate altitude of 2,000 feet. The property can be reached by road 2.8 miles westerly on U.S. Highway 60-70, from Salome, thence 1.0 mile southerly on a dirt road to the main workings (fig. 1).

The claims were located by Lora and Arthur Matthews of Salome in late 1951. The ore mined from surface pockets yielded 3,349 pounds of concentrate assaying an average 73.04 percent WO_3 to March 1955. The claims at present

are leased to Moses Mirabel of Grants, N. Mex. He sank a shaft to a depth of 50 feet and produced 200 pounds of concentrate assaying 66 percent WO_3.

Workings on the claim consist of numerous shallow pits, opencuts, and prospect holes. One shaft had been sunk to a depth of 50 feet.

Sparse, sporadic scheelite occurs in discontinuous quartz veins that cut a medium-grained gray granite. The scheelite occurs as minute particles to large pods as thick as 12 inches, according to Arthur Matthews. The author observed crystals to 1 inch in cross section.

The quartz carries some iron oxide stain and minor amounts of pyrite and muscovite. The quartz is extensively fractured, and a caliche filling was observed in some fractures. The quartz veins strike N. 10° to 12° E. and dip 80° to 85° SE. The veins are parallel and some appear to be in en echelon pattern. The most persistent vein observed on the Tungsten Giant is the No. 1. It can be traced on the surface for about 600 feet ranging in widths from a few inches to nearly 4 feet. Sparse scheelite was observed in place at the bottom of the 50-foot shaft. Other quartz veins were observed at widely scattered places on the claims, but none was as wide or as long as that on the Tungsten Giant No. 1. All the veins had the same strike and dip; however, scheelite mineralization of the other veins is not so abundant.

The granite is fractured extensively and cut by the quartz veins, by narrow light-color dikes (probably aplite) striking parallel to the quartz, and by dark diabase dikes, which strike N. 55° W. and dip 50° to 60° NE. The scheelite, scattered throughout the quartz, was very low grade, except where pockets and enriched lenses were found.

Golden Jackpot Claim

The Golden Jackpot claim is in sec. 26, T. 5 N., R. 14 W., on the north side of Granite Wash Pass in the Granite Wash Mountains at an altitude of 1,800 feet. The claim is 4.8 miles southwest of Salome on U.S. Highway 60-70, thence 0.5 mile north to the Santa Fe Railroad, and 100 to 300 feet north of the railroad (fig. 1).

The early history of this property is unknown. On July 1, 1949, G. C. Rhodehamel located the Golden Jackpot claim, and his estate retains possession.

The workings on the claim consist of an adit 75 feet long, an inaccessible shaft 30 feet deep, an accessible shaft 25 feet deep, and several opencuts, shallow pits, and trenches.

Granite (probably Precambrian), remnant schists, and gneisses have been intruded by probable andesite and narrow aplite dikes. All formations have been extensively fractured by northeast; northwest; and eastward-trending fractures and fissures. Some of the fissures are filled with narrow bands of quartz, which carry sparse copper, iron, and manganese oxides and very sparse, sporadic scheelite.

About 300 feet southwest of the adit and 150 feet north of the railroad is a shaft, 25 feet deep, containing 12 inches of finely disseminated scheelite in gneiss. The ore is estimated to contain 1 percent WO_3. The scheelite seems to be concentrated along a fault striking N. 70° E., dipping 60° NW., and intersecting fissures striking N. 20° W. and dipping 70° SW. Not more than 15 feet of the mineralized zone has been exposed.

There has been no production from the property.

Saguaro Claim

The Saguaro unpatented lode claim is in the NE1/4 sec. 11, T. 5 N., R. 14 W., at an altitude of 2,000 feet in the southeastern foothills of the Granite Wash Mountains. It is 0.3 mile north on U.S. Highway 60-70, at the west end of Salome, to a crossroad, left 2.8 miles due west along the section line, thence 1.8 miles northwesterly over a winding road to the workings on the claim (fig. 1).

The claim was located July 24, 1954, by Burnett L. Gary of Salome, and he retains ownership today. Gary estimates that he has produced tungsten ore valued at $500 from the property.

The workings consist of two shafts, each about 10 feet deep, several bulldozer strips, and a few shallow hand-dug pits.

Discontinuous quartz veins cut an altered granitic rock. There are many fractures and joints in both the quartz and the granitic rock. The vein on which most of the work has been done can be traced on the surface for about 450 feet in widths ranging from a few inches to 3.5 feet. It strikes S. 30° W. and dips 80° SE.

Sparse, sporadic scheelite occurs throughout the quartz vein. Small concentrations occur at intersections of the vein with vertical fractures striking N. 45° W. The quartz also contains local concentrations of limonite and hematite. According to Gary, samples containing as much as $14 per ton in gold have been taken from the workings.

Lucky No. 1 Claim

The Lucky No. 1 unpatented lode claim is in the SE1/4 sec. 11, T. 5 N., R. 14 W., at an altitude of 2,000 feet in the southeastern foothills of the Granite Wash Mountains. The property is reached 0.3 mile north on U.S. Highway 60-70 from the west end of Salome, thence 2.8 miles west along a section line, 1.6 miles northwesterly over a winding road, and left 0.2 mile southwest to the workings (fig. 1).

The claim was located in October 1954 by Floyd and Kay Passey and R. D. Lippincott. There has been no production.

Workings on the claim consist of one shaft about 12 feet deep, a small bulldozer cut, and a few very shallow pits.

Quartz lenses, a maximum of 5 feet in width, occurring along a fault striking S. 15° W. and dipping 80° SE., carry very sparse, sporadic scheelite grains and masses up to 1 inch in size. Minor amounts of iron oxides are in the quartz, and some muscovite and orthoclase have formed along the extremities of the vein. The quartz lens on which the work was done can be traced by float on the surface for about 100 feet. The host rock for the quartz is an altered granitic type carrying some hornblende and biotite.

Lone Granite Hill Claims

Two unpatented lode claims comprise the Lone Granite Hill group. They are in the S1/2 sec. 12, T. 5 N., R. 14 W. at an altitude of 2,000 feet. The claims are 3.2 miles west of Salome (fig. 1).

The claims were located June 29, 1955, by Rae G. Adams. Production from the property is unknown but is probably 10 to 15 units of WO_3.

Workings on the claims consist of a glory hole, 15 feet across and about 10 feet deep, on top of a lone granite hill, which protrudes about 100 feet above the desert floor; three shallow shafts, ranging from 5 to 12 feet deep; and several shallow pits and trenches.

Pockets of scheelite ore have been mined from the glory hole and from a shaft at the southeast corner of the property. A quartz lens on top of the granite hill strikes about S. 70° W. and dips 40° SE. It is surrounded by an altered, light-color granite. The pocket of scheelite ore at the southeast corner of the property occurred in a quartz vein a few inches to a few feet wide, striking S. 15° W. and dipping 70° SE. The pocket occurred where a cross fracture, striking N. 40° W. and dipping 65° SW., cuts the quartz. This cross fracture is coated with copper oxides. The quartz contains vugs with remnant iron oxides and sparse copper oxides. This concentration of scheelite is similar in occurrence to a pocket found on the Saguaro claim in section 11. The quartz vein can be traced on the surface for 50 feet. Outcrops are covered with alluvium.

Narrow, discontinuous diabase dikes cut the granite on this property, usually near the quartz veins and lenses.

Green Hill Claim

The Green Hill unpatented lode claim is in the SW1/4 sec. 7, T. 5 N., R. 13 W., at an altitude of 2,000 feet. The claim is 2.5 miles due west from Salome and 0.4 mile north to the workings on the property.

B. L. Gary and R. G. Adams located this claim in 1955. According to Gary, 7 tons of scheelite ore, having a net value of $1,170, was shipped to Stetler's mill in Quartzsite.

Workings on the property consist of an area, probably 150 feet in diameter, which had been cleared by a bulldozer. There are two bulldozer pits in the cleared area. The east pit is about 50 by 15 by 12 feet deep, and

the other is dish-shaped, about 25 feet across and 10 feet deep at the center. Little can be seen of the tungsten occurrences. Narrow, discontinuous quartz veins cut an altered granitic rock. Present also are narrow, discontinuous diabase dikes. The scheelite occurs as sparse, sporadic grains and masses as large as 1 inch in the quartz and granitic rock. Copper oxides and stains also occur in the quartz and along fractures through the granitic rock.

According to Gary, a 40-foot shaft, which contained both scheelite and copper ores, was filled by the bulldozer in the east pit.

Three Musketeers Group

The Three Musketeers group of six unpatented lode claims (fig. 2) is in secs. 24 and 25, T. 6 N., R. 15 W., on the southwest slope of the Granite Wash Mountains at an altitude of 2,000 feet. From Hope the property is 9.9 miles northwesterly on State Highway 72 to the McVay Railroad crossing, thence 1.2 miles northeasterly to a road fork, and then left 5.4 miles northeasterly to the main workings on the claims (fig. 1).

The Three Musketeers scheelite deposit was found originally in November 1951 by John Brusco, John Wood, and L. C. Huthmacher. The three partners worked the claims approximately 5 months, mining over $7,000 worth of tungsten ore. The concentrates sold by them are shown in table 1. The ore was milled in a small plant consisting of a crusher, a ball mill, and a concentrating table.

TABLE 1. - Concentrates sold from Three Musketeers Deposit, December 1951-April 1952

Shipment	Date	Ore, tons	Concentrate, pounds	WO_3, percent	Net value
1.....	12/4/51	1	570	73.6	$1,191.77
2.....	-	-	-	-	1,900.00
3.....	-	10	1,523	61.4	2,688,74
4.....	4/2/52	90	870.5	65.2	1,632.31
Total.....	-	-	-	-	7,412.82

In February 1952 the owners gave L. A. Aplington a lease on the Three Musketeers No. 3 claim. His production is unknown. In May 1952 Aplington assigned his lease to A. R. Floreen and associates, of Chicago. Floreen also obtained leases and working agreements on the remaining five claims. Floreen sank shaft 1 to an inclined depth of 65 feet and shaft 2 to about 110 feet. Considerable drifting, raising, and stoping have been done from these two shafts (figs. 3 and 4). Total production from the property was 515.79 units of WO_3.

Other workings on the property include three adits each more than 50 feet long and several shallow prospect holes, adits, opencuts, and trenches.

In 1954 or 1955 Huthmacher sold his interest in the property to Floreen.

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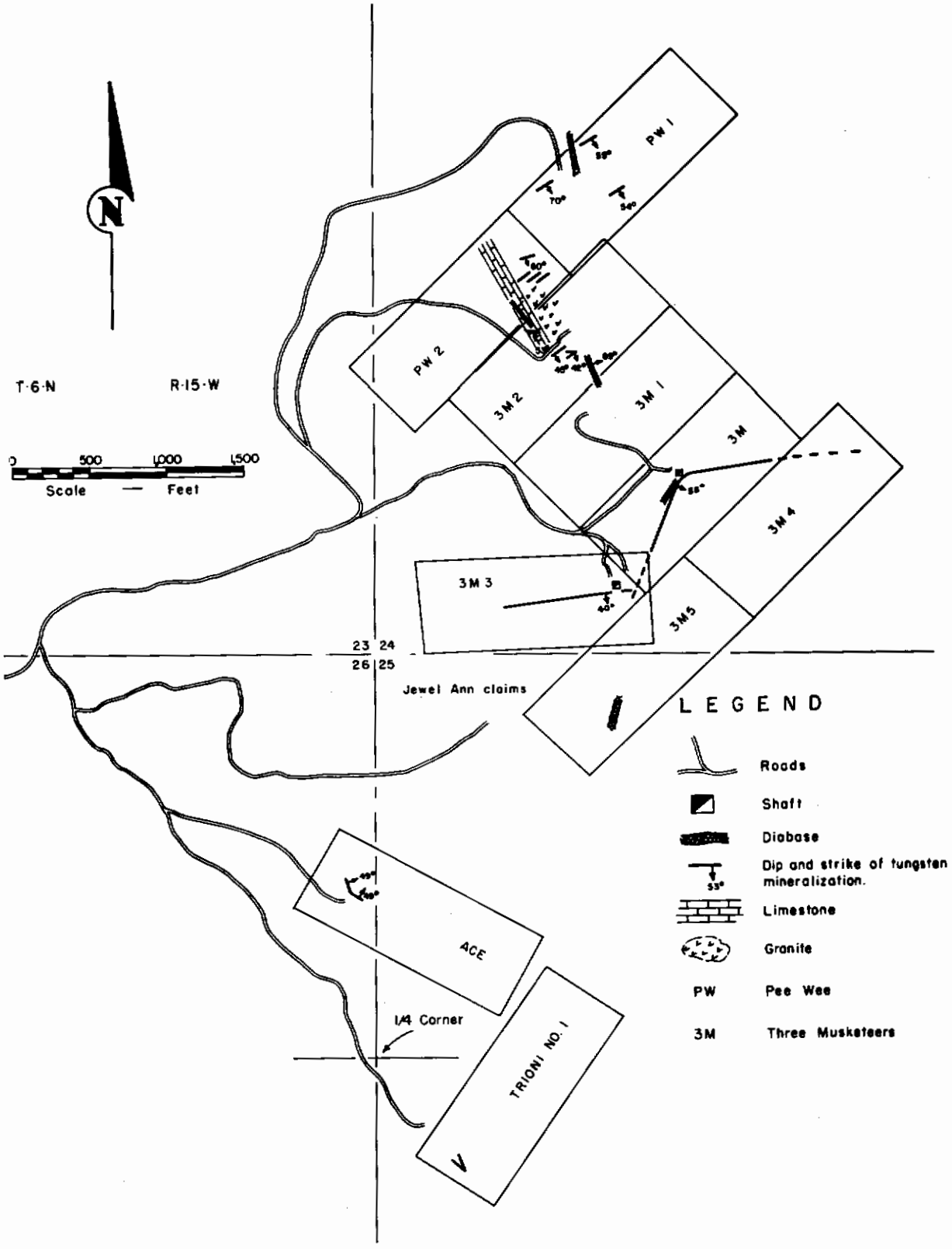

FIGURE 2. - Claim Map, Three Musketeers Area, Yuma County, Ariz.

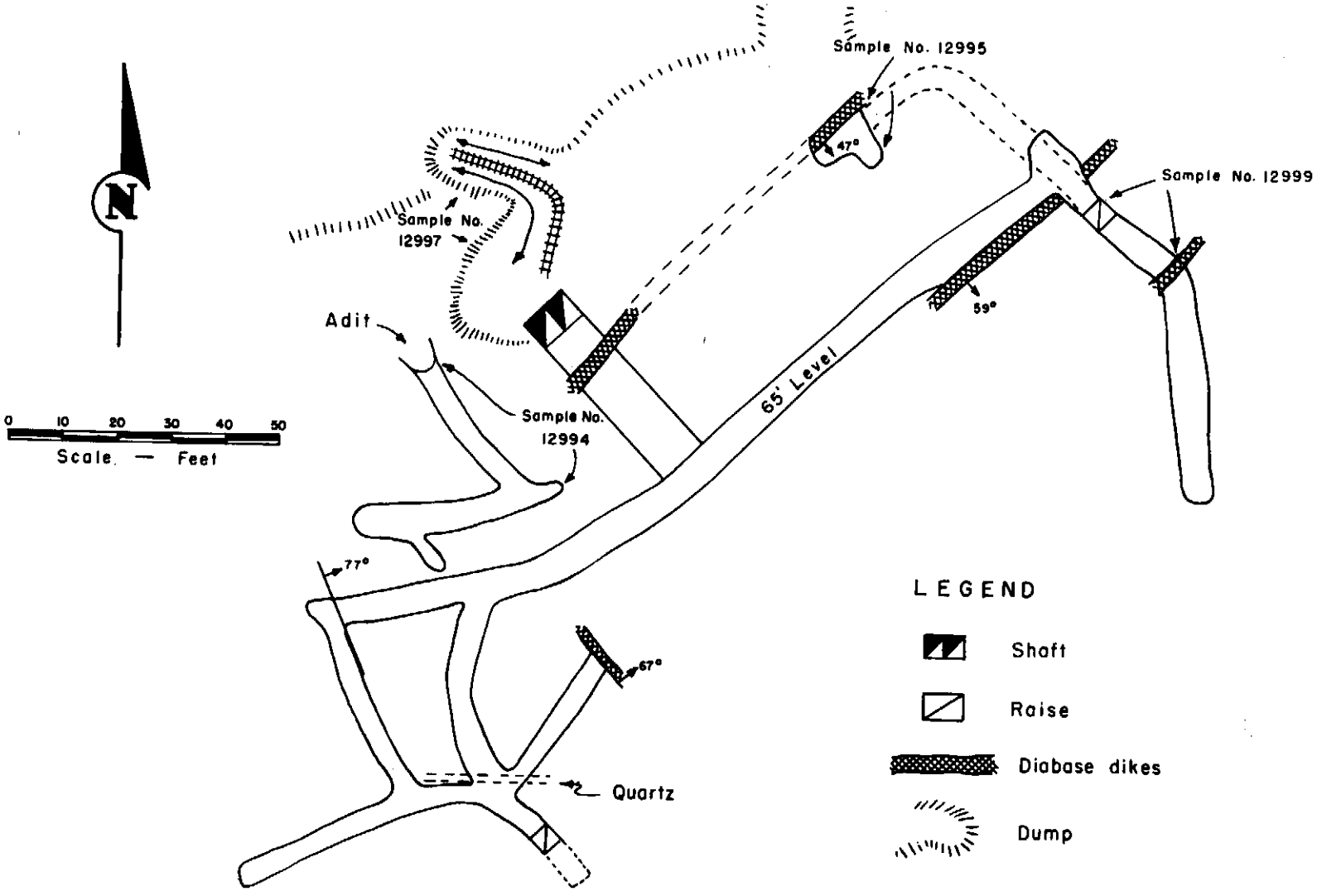

FIGURE 3. - Plan of 65-Foot Level, Shaft 1, Three Musketeers Tungsten Prospect, Yuma County, Ariz.

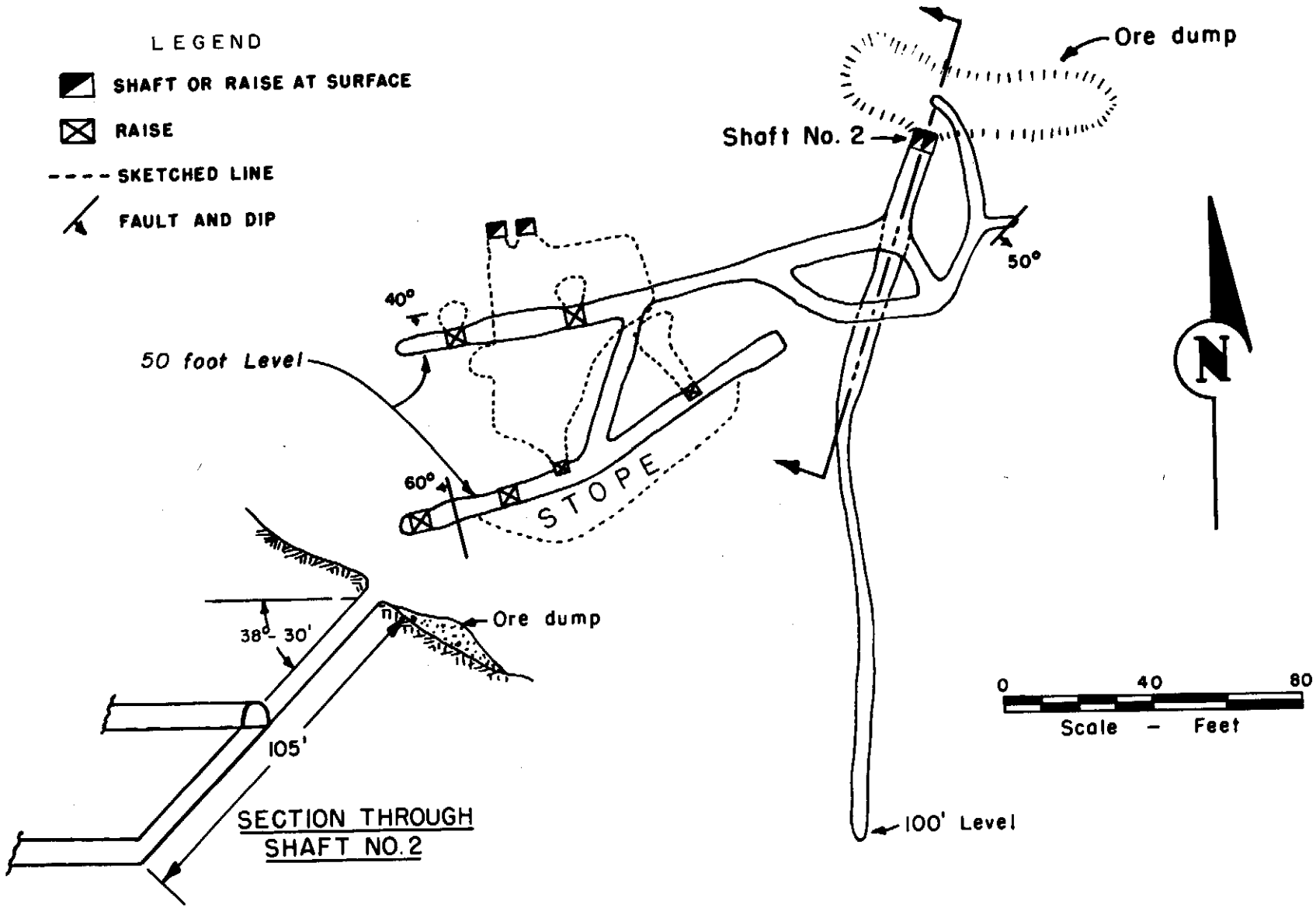

FIGURE 4. - Plan at 50- and 100-Foot Levels, Shaft 2, Three Musketeers Tungsten Prospect, Yuma County, Ariz.

Scheelite occurs as small grains and pods, up to a few inches in size, in quartz lenses and calcareous schist. Crystalline limestone overlies the schist. Scheelite also occurs in quartz-filled fractures in a light-colored medium-grained biotite granite. The ages of the schist, limestone, and granite probably are Precambrian, Paleozoic, and Mesozoic, respectively.6/

The quartz lenses are discontinuous and generally conform to the regional geologic structure. All formations are broken by four predominant sets of fractures. Their respective strikes and dips are: N. 50° to 56° E., 50° to 70° SE.; N. 70° to 75° E., 50° to 60° SE.; E., 40° S.; and N. 80° W., 55° SW. Nearly all the quartz lenses have one or more of the above attitudes, as do the diabase dikes near the quartz occurrences (fig. 2). A few of the quartz lenses have been faulted, but most tend to pinch out within short distances, both horizontally and vertically. Parallel veins are common.

Scheelite is found as grains and pods, both in the quartz and the enclosing schist. In the granite the scheelite is confined to the quartz, but much of the quartz is barren of scheelite. Narrow veinlets of scheelite, about one-eighth to one-half inch wide, occur in both the quartz and the schist. The quartz is brittle and easily broken, which indicates that it has been subjected to stresses after deposition. The scheelite shows little evidence of any crushing or distortion, and this indicates the last phase of mineralization.

The ore is exceptionally free of any penalizing impurities. The nature of the quartz, brittle and easily broken, makes the ore dressing comparatively simple.

The author took six samples near the surface and in the vicinity of shaft 1 and one sample in the north drift of the shaft. These locations are shown on figure 3. Table 2 shows the length of cut and the percentage of WO_3 of each sample.

TABLE 2. - Samples from area of Shaft 1, Three Musketeers deposit

Sample No.	Length of cut, feet	WO_3, percent
12993	16.5	0.67
12994	30.0	.15
12995	7.4	<.01
12996	7.0	.01
12997	(1/)	.04
12998	5.0	.03
12999	17.0	.29

1/ Grab from dump.

Pee Wee Claims

The Pee Wee group of two claims adjoins the Three Musketeers property on the northwest. The claims are in secs. 23 and 24, T. 6 N., R. 15 W., on the

6/ Work cited in footnote 5, p. 6.

southwest side of the Granite Wash Hills at an altitude of 2,000 feet. The property by road from Hope is 9.9 miles northwest on State Highway No. 72 to the McVay Railroad crossing, 1.2 miles northeast to a road fork, and left 4.4 miles northeasterly to the Pee Wee workings (figs. 1 and 2).

The claims were located originally in 1952 by the McVay Mining Co. as the Oliver claims. The ground became delinquent in 1955, and L. C. Huthmacher and James Dilts staked out the two Pee Wee claims over some of the better tungsten showings. The McVay Mining Co. made no production, but Huthmacher produced 3,237 pounds of concentrates at an average grade of 71.56 percent WO_3 to January 1958.

The workings on the property consist of three shallow shafts less than 20 feet deep, two adits about 30 feet long, and numerous small opencuts and trenches.

Sparse, sporadic scheelite occurs as grains, pods, and crystals in quartz veinlets, 2 to 18 inches wide, which cut a light-colored medium-grained biotite granite. The scheelite seems to be concentrated near the endline between the two claims.

The granite is overlain by schist and marbleized limestone. In places the limestone is in direct contact with the granite. Such a limestone-granite contact lies immediately west of the main workings on the Pee Wee No. 2. The ages of the schist, limestone, and granite probably are Precambrian, Paleozoic, and Mesozoic, respectively.7/

The schist and limestone, and the granite near its contact with overlying strata, are extensively fractured. Quartz occupies the fractures erratically. Four sets of fracture planes were noted striking N. 50° to 56° E., dip 50° to 70° SE.; N. 70° to 72° E., dip 50° to 60° SE.; east with south dip; and N. 80° W., dip 55° SW. Small zones of enriched scheelite ore occur along the fractures trending N. 50° E. about 3 or 4 feet southwest of the intersections of east-west fractures. Diabase dikes occur on both claims, as shown on figure 2.

The quartz carries minor amounts of iron oxides and willemite in addition to the scheelite. There are trace amounts of other minerals. The only penalty assessed against the concentrates was for a small amount of zinc. Huthmacher said he had noticed small amounts of sphalerite in the ore.

There is some good placer material on the claims derived from erosion of the outcrops of the quartz veinlets; Huthmacher estimates 10,000 yards, and tests by him indicate that the gravel has as much as 9 pounds of scheelite per yard.

The enriched lode pockets of scheelite have not been removed entirely. Several continue downward in the shallow workings.

7/ Work cited in footnote 5, p. 6.

Jewel Ann Group

The Jewel Ann group of four unpatented lode claims is in secs. 23-26, T. 6 N., R. 15 W. The claims adjoin the Three Musketeers group on the southwest. From the McVay railroad crossing, the property is 1.2 miles northeasterly to a road fork, left northeasterly for 3.3 miles to another road fork, and hard right southeasterly 0.8 mile to the Jewel Ann ore bin (fig. 1).

The Jewel Ann No. 1 claim was located in September 1953 by Lucas L. Contreras, Everett V. Cohoe, and Richard Rowland. Claims 2 and 3 were located later by the three men. The Jewel Ann No. 4 was located in April 1956 by Contreras and Cohoe. They now (1958) are owned by Cohoe. The workings consist of an opencut about 50 feet long by 15 feet wide and 20 feet deep on the high side, an adit about 25 feet long, two small, shallow opencuts, and several small prospect holes and trenches. The opencut is near the crest of a steep rough hillside about 135 feet higher than the ore bin. An overhead tramway was installed to transport the ore to the bin.

The small, narrow stringers of white, glassy quartz on this property cut marbleized limestone. Scheelite occurs sporadically in the quartz and marble in widths ranging from 1 to 15 feet along a strike length of about 200 feet. The mineralized zone strikes generally N. 65° W. and appears to dip flatly north. A hundred tons of ore with a grade estimated at 0.5 to 0.7 percent WO_3 has been removed.

Other small occurrences of tungsten deposition were observed at three points on the claims; at two of these places sparse copper oxides were seen along fractures in the quartz and limestone.

The scheelite here does not seem to be associated with structure to the same extent as on the Pee Wee and Three Musketeers properties.

There is a diabase dike a short distance west of the large opencut.

Ace Claim

The Ace unpatented lode claim is in secs. 25 and 26, T. 6 N., R. 15 W., about 0.25 mile southwest of the Three Musketeers group. Road directions to this property are the same as those to the Jewel Ann group, except for the last quarter of a mile (figs. 1 and 2).

The claim was originally the Pacho No. 2 claim located by Merrill, Merrill and Merrill in 1952, and later, part of a group controlled by the McVay Mining Co. It was relocated a few years later by Glenn and Bolieu, and in October 1955 T. G. Bolieu, of Bouse, Ariz., again relocated the claim.

Nine short-ton units of WO_3 was produced in 1955 and 1956. The workings consist of two shallow prospect holes.

Quartz veins strike N. 10° to 60° W., and dip 40° to 50° NE. The quartz, which has intruded calcareous schist, is discontinuous and ranges from 1 inch to 2.5 feet in width.

Sparse, sporadic scheelite occurs in the schist and quartz. There appear to be remnants of two small pockets near the surface, but the material is very low grade.

Trioni Group

The Trioni group of two unpatented claims is in sec. 25, T. 6 N., R. 15 W., about 0.4 mile south of the Three Musketeers group. The property can be reached, by road, 1.2 miles northeasterly from the McVay railroad crossing to a road fork, left northeasterly 3.3 miles to another road fork, and hard right southerly 1.0 mile to the Trioni No. 1 workings (figs. 1 and 2).

These claims were located originally by Wm. Snyder. He gave them to L. B. Irwin, of Wenden. The claims apparently were forfeited, because in October 1953 L. B. Irwin, D. M. Irwin, and Geo. W. Campbell, Jr., relocated them. Campbell produced about 40 short-ton units of scheelite concentrates from the property to January 1958.

There is a 20-foot shaft on the property and two shallow opencuts.

Narrow stringers of quartz, 2 to 3 inches wide, contain sporadic pockets of scheelite ore. The stringers cut gneiss, shale, schist, and limestone. The stringers strike N. 47° W. and dip nearly vertical. Cross fractures strike N. 25° W. and also dip nearly vertical. The enriched zones of scheelite ore have been removed, and only low-grade material remains.

Squaw T Group

The Squaw T group of three unpatented lode claims is in secs. 26 and 27, T. 7 N., R. 15 W., in the extreme northwest end of the Granite Wash Mountains at an altitude of 1,500 feet. The first claim was located in 1952. Three other claims were located in March 1956 by Lewis Elmer, of Quartzsite. About 125 units of WO_3 has been produced from the property.

The workings consist of several shallow opencuts and prospect holes not exceeding 20 feet deep.

The area is underlain by schist and limestone. The schist is micaceous and calcareous, and the limestone is extensively marbelized. The basement rock is a light-gray, medium- to coarse-grained granite, which contains sparse mafic minerals. The formations are cut by numerous dikes of diabase and rhyolite porphyry. The diabase is fine grained, and the rhyolite contains an appreciable amount of biotite.

Sparse, sporadic scheelite occurs in the schist, limestone, and fractures in the granite. Wide, discontinuous barren quartz veins cut the schist and limestone. The barren quartz strikes generally east and dips flatly north. The strike of the bedding planes is erratic but appears to be generally N. 60° E.; the dip is about 40° NW. A schist bed south of and adjacent to the quartz contains sporadic scheelite. Some of the schist wider than 2 to 3 feet is estimated to carry 0.2 to 0.3 percent WO_3. Pockets or pods of high-grade

scheelite seem to occur near the contact between limestone and schist on the eastern part of the claims. Here also is a bed of sandy limestone that carries sparse, sporadic scheelite. The mineralized zone is about 20 feet wide and can be traced on the surface for about 300 feet.

Near the crest of the mountain range narrow seams of nearly pure scheelite occur in the granite near the intersections of a fault zone, which strikes N. 25° W. and dips 25° SW., with fractures striking northeast. The scheelite here is associated with muscovite and quartz. The average width of the seams is about 1 inch. One seam, or stringer, has been worked along the surface for about 75 feet. A shaft has been sunk about 20 feet.

Little work has been done on the property, and the extent of mineralization is unknown.

Quartzsite Tungsten Mine

The Quartzsite tungsten mine property, locally known as Tung Hill, consists of the Jackpot group of four unpatented lode claims and the Velmaette group of three unpatented placer claims in sec. 27, T. 5 N., R. 20 W., in the north end of the Dome Rock Mountains at an altitude of 850 feet. The property is reached over a desert road from Quartzsite northerly past the schoolhouse 8.4 miles from U. S. Highway 60-70, and westerly on a branch road 2.5 miles to the lower shaft on the claims (fig. 5).

The claims were located by Len Hogue in January 1942 and sold to the Gold Hill Dredging Co. early in 1943. This company owns the claims today.

The workings on the property consist of two shafts, 32 and 85 feet deep, with a connecting drift. About 310 feet of drifts with three winzes have been driven from the two shafts. There is a stope midway on the west side of the 85-foot shaft. A raise to the surface and a winze have been driven from the stope. Two adits, the lower S. 89° W., 443 feet from the main shaft, have been driven 100 feet into high-grade occurrences of scheelite ore. A third, higher adit has stopes to the surface; three raises connect the other two adits. In addition, numerous shallow opencuts, pits, and trenches are on the surface.

In 1943 and 1944, 53 tons of scheelite ore at an average grade of 0.435 percent WO_3 was produced by the Gold Hill Dredging Co. Since that time, the property has been leased to several different parties. Production from 1944 to 1951 is unknown; production from 1952 through 1956 was 4,000 tons averaging 0.416 percent WO_3.

The area is underlain by quartz-biotite schists interbedded with gneiss. Lenticular beds of marble are present locally. Limestone beds from which the marble was metamorphosed form prominent outcrops a short distance northwest of the mine. The beds strike N. 30° to 50° E. and dip 20° to 30° NW. Bodies of garnet-epidote tactite occur along the contact between the schist and limestone. Irregular quartz veins, striking generally N. 70° E., cut the mineralized zones. No granitic rocks are exposed in the area.

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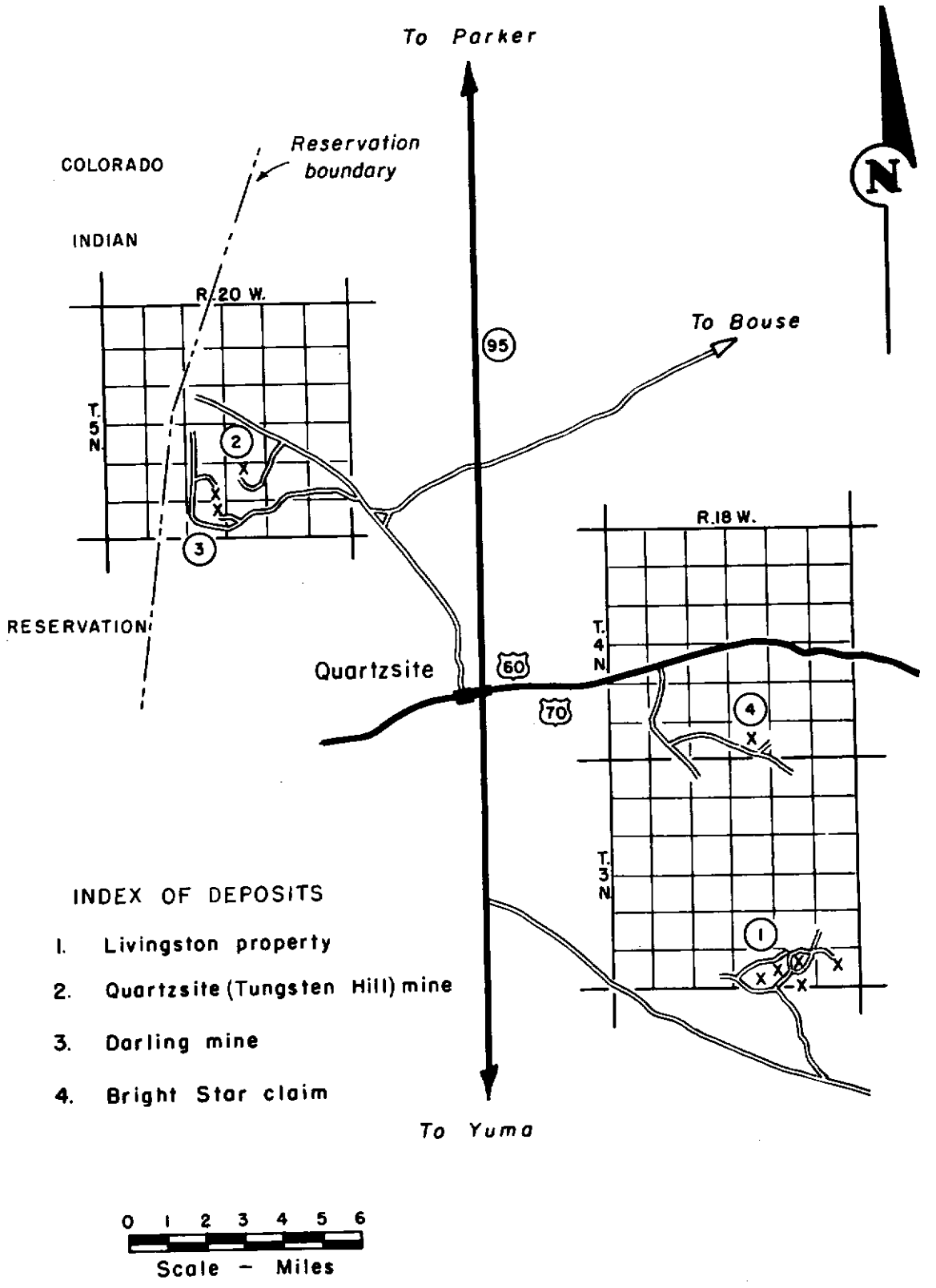


FIGURE 5. - Tungsten Deposits in Vicinity of Quartzsite, Yuma County, Ariz.

Sporadic scheelite mineralization occurs in the tactite and calcareous schist where the quartz veins cut the formation. There are indications, too, that enrichment occurs at intersections of fractures trending N. 20° W. and EW. with quartz veins trending N. 70° E. The northwesterly trending fractures dip 60° SW., and the east-west fractures about 75° N. The quartz-filled fractures are nearly vertical. Widths of the mineralized zones normal to the dip of the beds, both in the lower shaft workings and in the higher adit workings, range from 5 to 30 feet. In the shaft workings, particularly at the east end, can be seen numerous thin beds that have been mineralized in the calcareous schist. Mineralization extends at least 200 feet downdip of the beds.

The highest grade ore has come from the upper adit workings. Scheelite masses up to 3 inches in size were observed here. The upper adit was driven near the nose of an anticline, and pockets of high-grade ore were extracted where quartz veins cut the schist and limestone. The extent of the mineralization in the calcareous schist has not been determined. If the schist beds are mineralized here as they are in the shaft workings below, there should be a considerable tonnage of low-grade ore.

Scheelite float is found for about 2,000 feet along the strike of the mineralized zone.

The author cut five samples in the upper workings. Table 3 shows the length of cut and percentage WO_3 of each sample. Locations of samples are shown in figure 6.

TABLE 3. - Samples from Quartzite tungsten mine property

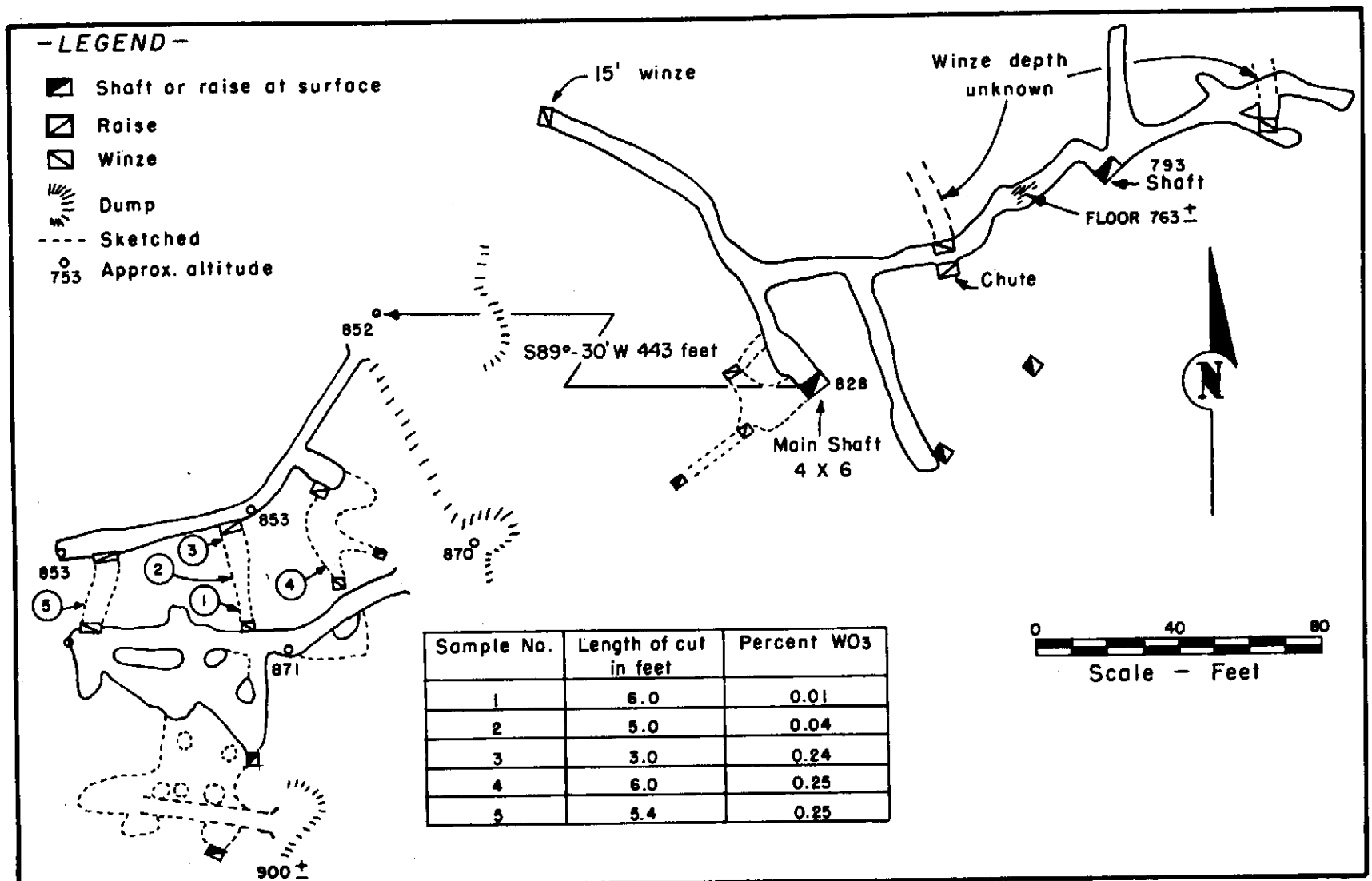
Sample No.	Length of cut, feet	WO_3, percent
1 (12992)	6.0	0.01
2 (12991)	5.0	.04
3 (12990)	3.0	.24
4 (12989)	5.4	.25
5 (12988)	6.0	.25

The mineralized-schist bed is estimated to carry 0.2 to 0.4 percent WO_3.

Darling Mine

Five patented lode claims, four called Mountain Chief, comprise the Darling mine. The property is in secs. 28 and 33, T. 5 N., R. 20 W., on the west slope and near the north end of the Dome Rock Mountains at an altitude of about 950 feet. The property, from Quartzsite, is northerly on the road past the schoolhouse 6.4 miles from U. S. Highway 60-70 to a road that branches westerly through Boyer Gap, 3.7 miles westerly on this branch road to a road fork, and 0.9 mile on the right or north fork over a winding trail to the tungsten deposit on this property (fig. 5).

Little is known of the early history of the claims. It is thought that much work was done on bodies of epidote, which apparently was thought to be



Sample No.	Length of cut in feet	Percent WO_3
1	6.0	0.01
2	5.0	0.04
3	3.0	0.24
4	6.0	0.25
5	5.4	0.25

FIGURE 6. - Brunton Survey of Underground Workings on Jackpot Group, Gold Hill Dredging Co., Yuma County, Ariz.

a copper mineral. Joseph M. Treuer purchased the property in 1952. About 1955 the claims were relocated, and a small amount of work was done before the unknowing parties discovered that the claims were patented. In 1955, 177 pounds of concentrates was sold that contained 73.69 percent WO_3. The concentrates had phosphorus and lead contents of 0.03 percent each.

Sporadic scheelite was found in lenses in epidote deposits along a fault contact between limestone and a dark, micaceous schist. The limestone was marbleized extensively along the contact, and large irregular bodies of epidote had formed in the schist adjacent to the contact. One deposit of scheelite ore has been opened up for a length of 30 feet and a depth of 15 feet. Scheelite mineralization here is about 15 feet wide. The scheelite is concentrated at the intersection of the limestone-schist fault contact, which strikes N. 50° E. and dips 40° NW., and a fault, which strikes N. 15° W. and dips 69° SW. The scheelite occurs as straw-color to white crystals in epidote, with minor amounts of quartz, calcite, and biotite.

Occasional small crystals of scheelite may be seen, both in the schist and marble, for several hundred feet along the contact.

A grab sample of an estimated 4 tons of ore taken from the opencut assayed 0.23 percent WO_3 (appendix, 12987).

Bright Star Claim

The Bright Star unpatented lode claim is in sec. 34, T. 4 N., R. 18 W., on the west side of the Plomosa Mountains at an altitude of 1,500 feet. This claim formerly was part of the Firestone group, discovered and located by L. A. Aplington in October 1943. The claim is 4.6 miles east from Quartzsite on U. S. Highway 60-70, 2.1 miles southerly on a graded road to a dim trail, and 1.9 miles easterly on this rough truck road to a very dim turnout that leads to the east end of the claim, a distance of 0.2 mile northerly from the trail (fig. 5). A footpath up the side of a mountain from the end of the road goes past all the workings.

Elmer Glenn, of Bouse, Ariz., and R. L. Fleming relocated the claim in November 1956. Fleming sold his interest to Jim Sprinkle of Iowa. Glenn carried high-grade ore from the claim on his back. He sold five units of WO_3 and has 90 pounds of concentrates in storage. Aplington sold 12 units of WO_3 from the property in 1955.

The workings on the property consist of three shafts about 12 feet deep, one adit about 30 feet long, and several shallow prospect trenches and pits.

Sporadic scheelite occurs in quartz veinlets and in schist near a schist-limestone contact. The scheelite occurs as fine grains and crystals in the schist and quartz and as large crystals and narrow stringers associated with the quartz. The quartz stringers through the schist range in width from a fraction of an inch to 4 inches. In places nearly all the quartz is replaced by scheelite; in addition, the quartz carries biotite and large amounts of siderite. In other places it has coatings on both walls of what appears to be pyrophyllite.

The schist is approximately 100 feet wide and runs the full length of the claim. The bedding cleavage strikes N. 60° W., and dips 30° to 40° NE. The schist is calcareous and contains biotite, sericite, and siderite. It is gray, overlain by marbleized limestone and underlain by a light-color fine-grained calcareous gneiss.

The schist has been fractured and faulted extensively. The discontinuous quartz veinlets strike N. 40° to 50° E. and dip 38° to 45° NW. Enriched zones occur near the intersections of the quartz veinlets with fractures trending N. 4° to 10° W. Other fractures through the schist strike N. 10° E., S. 20° E., and N. 40° W. There has been movement along the N. 10° E. fractures.

Glenn estimated the grade of ore from the property at 10 percent WO_3. This was handpicked ore and does not represent an average grade. Much of the area is covered with overburden, and very little work has been done on the deposit.

Night Hawk and White Dike Mine
(Livingston Property)

There are 15 unpatented lode claims in what previously has been called the Night Hawk and White Dike mine. There are five Night Hawk claims, five White Dike claims, and five Colorado claims in secs. 34 and 35, T. 3 N., and secs. 2 and 3, T. 2 N., R. 18 W., in the Plomosa Mountains, at an altitude of 1,500 feet. The property is 5.7 miles south from Quartzsite on State Highway No. 95, 9.8 miles southeasterly on the gasoline road, and 3.0 miles northerly to the central part of the property (fig. 5). There is another road to the property--2.7 miles south from Quartzsite and 9.0 miles southeasterly to the mine.

This area was worked for gold in 1943 by Mr. and Mrs. J. R. Livingston, the present owners, who noticed a heavy white mineral that interfered with their dry-washer operation. In May 1942 they saw specimens of scheelite and recognized it as the interfering mineral. Subsequently, the Livingstons and Mrs. Maude Hart located 12 claims on the tungsten occurrences. Since then, the Livingstons have acquired sole ownership of the 12 claims and staked 3 additional claims. I. D. Budd was granted an option to purchase the property in 1945. Livingston foreclosed on his interests in 1947 and regained a clear title. There are no accurate records of production. Livingston estimates a production of scheelite ore and concentrates worth $10,000, all of which was sold to ore buyers in small lots, the largest containing 1,800 pounds. Livingston said the hand-sorted ore and concentrates contained 15 to 60 percent WO_3.

Workings on the property consist of three inclined shafts about 100 feet deep, several shallow shafts less than 50 feet deep, a few short adits, an opencut from which about 100,000 tons of rock has been removed, and numerous shallow opencuts and pits.

White to straw-color crystals of scheelite, ranging from minute particles to crystal masses weighing several pounds, occur in tourmaline, quartz, calcite, and schist along a contact between calcareous tourmalinized schist and

limestone and quartzite. There is also gneiss in the area. The scheelite occurs in small, extremely sporadic, high-grade pockets. There are indications that the pockets occur in quartz and tourmaline at intersections of northwesterly and northeasterly trending fractures. The scheelite appears to be directly associated with black, massive tourmaline. Most of the quartz is barren but carries scheelite where tourmaline is present. Crystals of scheelite were found that contained tourmaline, and much scheelite was observed in the tourmaline, indicating a genetic relationship. Small amounts of siderite were found in the quartz. The tourmaline was checked for lithium and found to carry less than 0.1 percent Li_2O.

The beds strike generally east and dip about 50° S. They are cut by numerous, discontinuous quartz veinlets from a few inches to several feet wide. Some of the quartz has been derived from an igneous source, which does not show in the immediate vicinity of the claims. The mineralized zone in which the scheelite pockets occur is about 1.5 miles long and ranges from 100 to 600 feet in width. As the small shipments indicate, the pockets generally contain less than 1 ton of high-grade ore. Numerous faults were observed throughout the mineralized zone.

Small amounts of copper oxides and minor amounts of silver occur on the claims. Siderite occurs sporadically in the quartz and cuproscheelite in a localized area. About 2 miles east lead ores have been found along the same contact.

Because the pockets of scheelite were removed as they were found, no samples were cut in the workings. One large grab sample of ore was taken from a stockpile estimated to contain 1,000 tons taken from the large opencut. This sample assayed 0.01 percent of WO_3 and 0.01 ounce of gold per ton (appendix, 12986). Small dumps at the west shaft and at an adit driven at the east end of the large opencut contain more scheelite than the stockpile sampled.

Breedon Prospect

The following is information from a Bureau of Mines examination in 1943:

Three unpatented lode claims were owned in 1943 by J. M. Breedon and H. L. Richardson, of Los Angeles, Calif. The claims lie 2.5 miles westerly from Alamo Crossing and 0.5 mile south of the Bill Williams River. Alamo Crossing is 37 miles north from Wenden, which is on U. S. Highway 60-70.

Breedon acquired these claims about 1915 and later optioned them to a stock company. About 500 feet of work was done in adits, shafts, drifts, and opencuts. The property reverted to Breedon when no ore of value was found. There has been no production from this area.

The area is underlain by basic gneiss, on which lies a thin-bedded limestone intercalated with amphibole schist. These beds are overlain by more massive limestones and shales. Seams of specular hematite along the bedding planes are found in the thin limestone and amphibole schist beds. The hematite zones are too small to have any economic value.

One area in the more massive limestone shows some contact-metamorphic material, which has a meager showing of scheelite.

Tungsten Group

The Tungsten group of two unpatented lode claims is in sec. 6, T. 2 S., R. 16 W., on the south side of the Kofa Mountains between the King of Arizona and North Star mines. The altitude is about 1,800 feet. The property is 53.4 miles northeasterly on State Highway 95 from Yuma to the Rob Roy and King of Arizona Road (0.1 mile north of the stone cabin), easterly 14.7 miles to a road fork, left northeasterly 8.1 miles to another road fork, left again, and north 0.5 miles to a trail that turns easterly, and on this trail 1.0 miles to the main workings on Tungsten No. 1 claim (fig. 7).

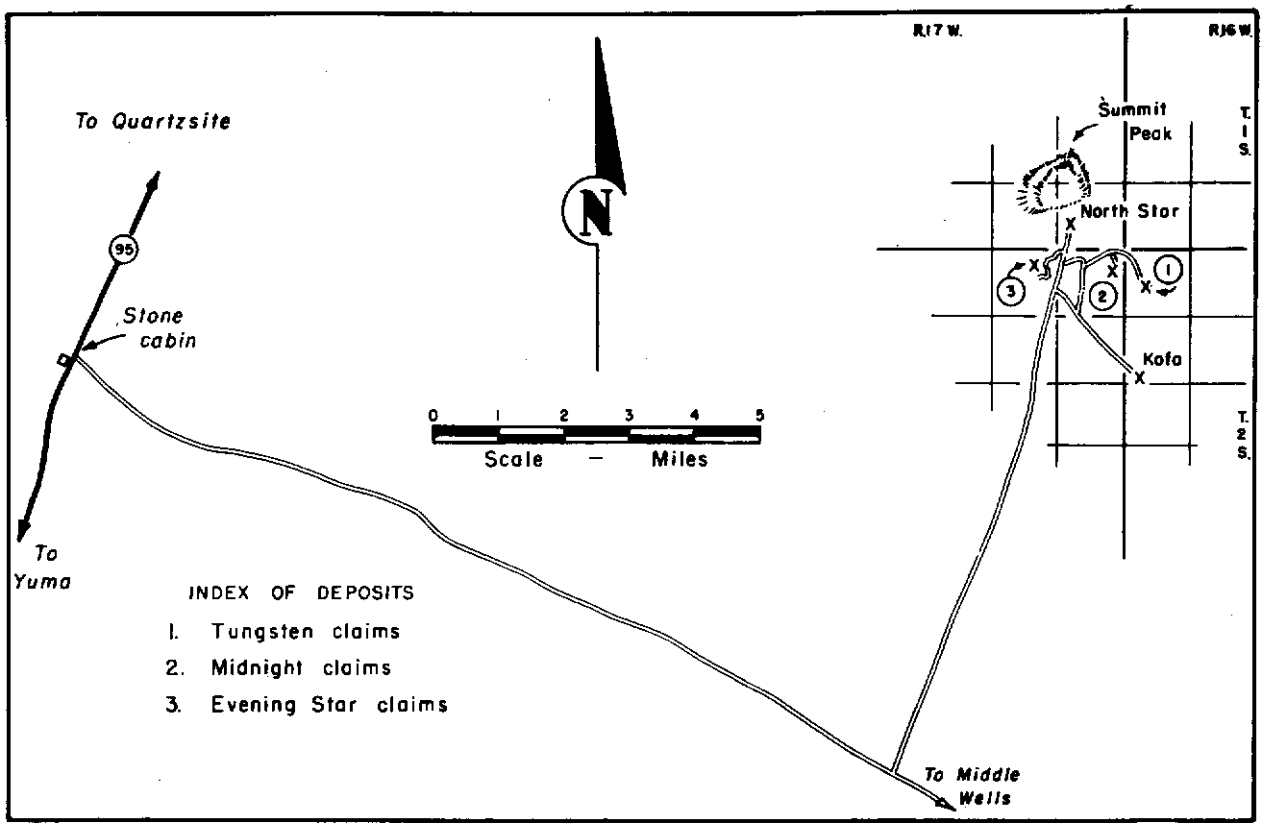


FIGURE 7. - Scheelite Deposits in the Kofa Mountains, Yuma County, Ariz.

These claims were located in the 1920's on sparse gold showings. George E. Meyers relocated the claims October 25, 1954, on tungsten showings. The claims were subsequently leased to A. A. Gibson, who produced 54.4 short-ton units of WO_3. The ore, as mined, was estimated to contain 1 percent WO_3, according to Jack Gibson.

The workings consist of two shafts, 10 and 20 feet deep, an underhand stope from the surface, 25 feet deep by 4 feet wide by 30 feet long, and a few shallow prospect pits.

According to Jones:[8/]

> At the south end of the Kofa Mountains, between the North Star and King of Arizona mines, highly metamorphosed sediments crop out at the base of the lava flows and are the principal rocks of a small ridge between these two points. A dark pyritiferous metamorphosed shale or slate forms the footwall of the North Star vein, and medium-grained quartzose biotite schists crop out on the ridge. Some irregular intrusions of pegmatite occur in these schists.

The bedding cleavage strikes N. 50° W. and dips 38° NE. The schist is cut by east-, northwest-, and northeast-trending fractures and fissures. Many fissures are filled with discontinuous quartz. A fault striking S. 52° E. and dipping 81° SW. contains both quartz and schist, which contain narrow stringers, pods, and small grains of scheelite in widths ranging from 1 to 7 feet. About 100 feet of the vein has been exposed along the strike. The vein is covered with alluvium in many places, but in all probability the vein is continuous to the west endline of the Tungsten No. 1 claim, a distance of about 425 feet from the west end of the exposure.

What is probably a monzonite dike has cut off the mineralization east of the exposure. Float and a few narrow stringers of scheelite ore are east of the dike, but they do not compare with the exposed ore west of the dike.

Settlement sheets for the sale of concentrates show a lead content of about 0.1 percent and a phosphorus content of about 0.1 percent. The copper content in the concentrates was 0.03 percent. The ore carries black to colorless crystals of calcite.

In places the biotite schist carries sporadic scheelite. Hornblende schist carrying scheelite was found in the detritus. It probably is this bed of hornblende schist that lies south of and above the biotite schist.

Midnight Claims

The Midnight group of two unpatented lode claims is in sec. 1, R. 17 W., and sec. 6, R. 16 W., T. 2 S., on the south side of the Kofa Mountains, between the King of Arizona and North Star mines, at an altitude of 1,800 feet. The property is 53.4 miles northeasterly from Yuma on State Highway 95 to the Rob Roy and King of Arizona Road (0.1 mile north of the stone cabin), easterly 14.7 miles to a road fork, left and northeasterly 8.1 miles to another road fork, left and north 0.5 mile to a trail that turns easterly, and, on this trail, 0.7 mile to the principal workings on the Midnight No. 2 claim (fig. 7).

These claims were located in the 1920's on sparse gold showings. On August 2, 1954, W. S. Findley located two claims over scheelite showings. Sometime later the claims were leased to A. A. Gibson, who reportedly produced about $3,000 worth of tungsten ore from the claims. The ore, as mined, was estimated to contain 1 percent WO_3, according to Jack Gibson.

8/ Jones, E. L., Jr. A Reconnaissance in the Kofa Mountains, Arizona: Geol. Survey Bull. 620, 1915, pp. 155-156.

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The workings comprise a shaft 30 feet deep, an opencut 18 feet long by 4 feet wide by 10 feet deep, and several shallow prospect holes and trenches.

According to Jones:9/

> At the south end of the Kofa Mountains, between the North Star and King of Arizona mines, highly metamorphosed sediments crop out at the base of the lava flows and are the principal rocks of a small ridge between these two points. A dark pyritiferous metamorphosed shale on slate forms the footwall of the North Star vein, and medium-grained quartzose-biotite schists crop out on the ridge. Some irregular intrusions of pegmatite occur in these schists.

Bedding cleavage in the schist strikes N. 50° W. and dips 38° NE. The schist is cut by sets of fractures and fissures, which trend east, northwest, and northeast. Many of the fissures are filled with discontinuous quartz. A fault striking N. 53° W. and dipping 77° SW. is filled with quartz, which carries stringers, pods, and small grains of scheelite. The quartz ranges in width from 6 inches to 4 feet. The quartz vein is exposed continuously along the strike for 100 feet in the vicinity of the shaft; it has been exposed in five other places east of the shaft and seems to continue east from the east endline of the Midnight No. 2 claim for approximately 1,100 feet. The same vein seems to extend east into the adjoining Tungsten No. 1 claim for approximately 525 feet. The scheelite mineralization is sporadic throughout the quartz on the Midnight claims.

West of the shaft are numerous discontinuous quartz lenses, all fitting into the pattern of fractures and fissures previously described. Sparse, sporadic scheelite mineralization is scattered throughout the quartz, but much of the quartz is barren. The quartz carries some stains of iron and manganese.

Several dikes of probable monzonite composition have intruded the schist. The dikes strike generally northeast. They have visible displacements along fault planes west of the shaft.

The biotite schist carries a minor amount of scheelite, and a hornblende schist that carries scheelite was found in detrital material on the claims. It is presumed that hornblende schist lies south of and above the biotite schist.

Scheelite concentrates from this property probably will carry 0.1 percent each of phosphorus and lead.

Evening Star Group

The Evening Star group of five unpatented lode claims is in the NE1/4 sec. 2, T. 2 S., R. 17 E., on the south side of the Kofa Mountains about 0.75 mile southwest of the old North Star mine at an altitude of 1,700 feet. (See fig. 7 for road directions to the property.) Road mileages were given from Yuma to the Midnight property, about 1 mile east.

9/ Work cited in footnote 8, p. 27.

The Evening Star property has been worked for a number of years on gold showings. The production of gold is unknown, but it was small. The property was relocated May 5, 1956, by Bill Wayt, Walter E. Parker, and H. E. Linder.

Most of the workings are confined to the Evening Star claim and comprise six or seven inaccessible shafts, 10 to 40 feet deep, an adit 115 feet long with a 40-foot raise and a 10-foot winze, and several shallow trenches and prospect pits.

Rhyolite and pegmatitic dikes cut highly metamorphosed sediments of schists and shales on these claims.

Very fine, sparse scheelite occurs in fractures and fissures through schist. The best showing is in the upper part of a fault, which strikes east and dips 35° N. The upper 12 inches have quartz with sparse scheelite and the lower 3 feet quartz with much hematite and limonite, some massive. This occurrence is exposed for about 50 feet along the strike; it is about 4 feet wide and extends about 35 feet downdip.

There has been no tungsten production from the property, and it is doubtful if a tungsten ore could be handpicked that would carry more than 0.4 percent WO_3.

Gold Reef Claims

The author did not visit these claims. The following description is by Dr. Eldred D. Wilson.10/

> The Gold Reef unpatented claims, held in 1941 by H. Knowles and R. Young, are in T. 4 S., R. 22 W., in the Trigo Mountains. They are accessible by 3-1/2 miles of trail from Knowles camp, on the Colorado River, or by a shorter trail from the Silver District road.
>
> These mountains, although of relatively low altitude, are very rugged and arid. In the vicinity of the Gold Reef claims they are made up of brownish quartz-sericite schist, intruded by rhyolitic and aplitic dikes that may be related to a granitoid stock cropping out about a mile farther north. The schist strikes N. 35° E. and dips 30° NW.
>
> The principal vein occurs within a fault fissure that strikes N. 55° W., dips 80° S., and is traceable on the surface intermittently for about 500 feet. As shown in shallow prospect pits, it consists of irregular masses of sheared grayish-white quartz from less than an inch to 2 feet wide. The quartz contains scattered particles of limonite, hematite, and scheelite. A little scheelite also occurs in the adjacent wall rock, which shows sericitic alteration.

10/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 21.

The author believes that this deposit lies in sec. 21, T. 4 S., R. 22 W.; however, no one could be found who had visited the deposit other than Dr. Wilson, who took a Brunton bearing of N. 33-1/2° E. from a quarter-corner reference (secs. 31 and 32, T. 4 S., R. 22 W.) to the deposit. It is thought that there was a small production from this deposit in 1953, but this could not be established conclusively.

Gila Mountains

Scheelite in epidote-garnet zones occurs in the northern part of the Gila Mountains. The author looked at small deposits in secs. 15 and 22, T. 8 S., R. 21 W., in a schist-gneiss-marble series. Sparse scheelite occurs in epidote and in a fracture through gneiss and marble. The largest mineralized zone observed was on the order of 20 feet long and 10 inches wide, although epidote in zones up to 100 feet long was observed in the area. From observation with the ultraviolet lamp, it is estimated that selected ore will not exceed 1 percent WO_3.

The mineralized fracture strikes east and dips 37° S. Some cross fractures strike N. 50° W. and dip 71° NE.; others strike N. 10° E. and dip nearly vertical. The marbleized beds of limestone strike east and dip flatly south. There is much faulting of beds in evidence here.

The only known production of tungsten from this area was by D. and J. Mining Co., which sold about 125 pounds of tungsten concentrate. It is not known where the ore was extracted.

Marble beds extend for at least 3 miles through the northern part of the Gila Mountains, and they have been described in detail by Wilson.[11/] He describes schist that contains small, granular and tabular masses of epidote, and he states:

> Recrystallization of the original limestone into marble was brought about partly through regional metamorphism and partly, as suggested by the epidote, garnet, and vesuvianite, through contact action of the granitic intrusion.

The granite referred to contacts the metamorphic series on the south.

In all probability the sporadic scheelite mineralization extends throughout this formation.

Stetler Mill

The Stetler mill is owned by Jack Stetler, of Quartzsite, Ariz. It is in the SW1/4 sec. 28, T. 4 N., R. 19 W., about 0.75 mile south of Quartzsite. Operation of the plant was begun in 1952, primarily to treat scheelite ore from the Jackpot group of claims, which are about 8 miles northwest of Quartzsite; however, some custom-ore milling has been done.

11/ Wilson, E. D., Geology and Mineral Deposits of Southern Yuma County, Ariz.: Arizona Bureau of Mines Bull. 134, 1933, pp. 202-208.

Power was obtained from the Central Arizona Light & Power Co., and water from a well at the millsite.

Some 4,000 tons of ore from the Jackpot group of claims, at an average grade of 0.42 percent WO_3, and 400 tons of custom ore were treated.

The mill stopped operating when the Government discontinued purchasing tungsten concentrates.

Figure 8 is a flowsheet of the mill.

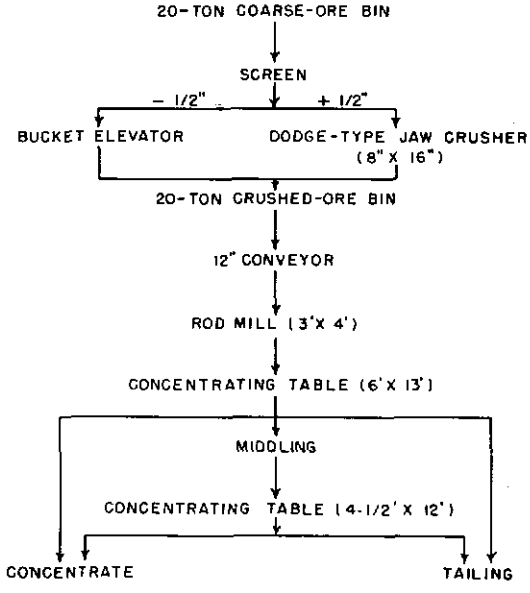


FIGURE 8. - Stetler Mill, Quartzsite, Yuma County, Ariz.

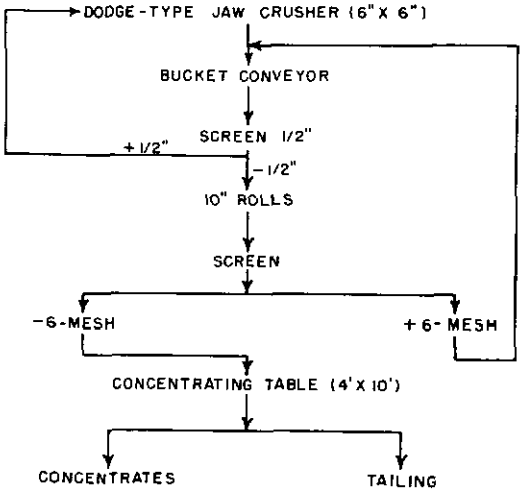


FIGURE 10. - Huthmacher Mill, Wenden, Yuma County, Ariz.

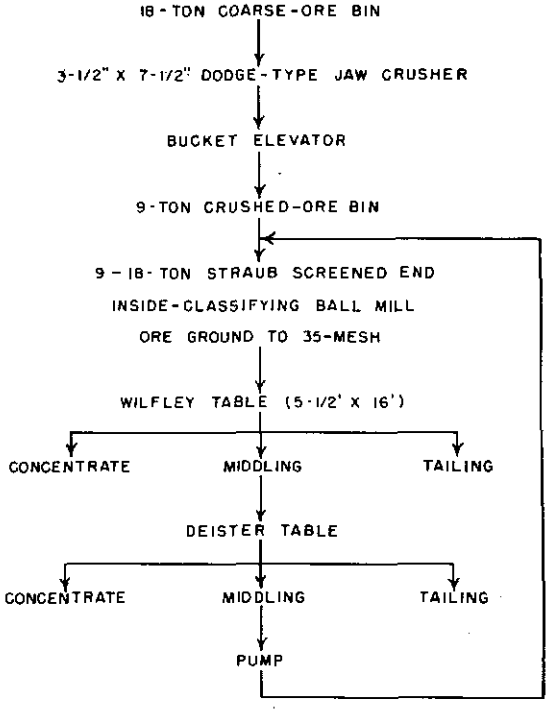


FIGURE 9. - Bouse Custom Mill, Yuma County, Ariz.

Bouse Custom Mill

This mill is owned by J. F. Hicks and associates, Bouse, Ariz., and is in sec. 23, T. 1 N., R. 17 W., about 0.5 mile north of Bouse. It was built to treat scheelite ore from the Jewel Ann property northwest of Vicksburg. Construction of the plant was begun in February 1954 and operation in June 1954. The plant was operated 53 days and closed down temporarily because the mines were involved in litigation. The plant treated ore from six other mining properties late in September 1954.

The property comprises two 5-acre millsites; on one there is a well 120 feet deep and an 8,500-gallon storage tank. Power was obtained from the Central Arizona Light & Power Co.

Approximately 105 tons of Jewel Ann ore was treated with a recovery of 82 percent of the scheelite, and 250 tons was treated from six other mines.

Figure 9 is a flowsheet of the mill.

Huthmacher Mill

L. C. Huthmacher, of Wenden, Ariz., constructed a small mill in 1955 to concentrate high-grade scheelite ore from the Pee Wee property. The mill was on a city lot in Wenden. City water was used, and power was provided by an Arizona Public Service powerline and a Dodge gasoline engine.

An estimated 50 tons of ore has been treated in the mill, from which 3,237 pounds of concentrate at an average grade of 71.56 percent WO_3 was produced. Although small and simple, the mill does a thoroughly adequate job of concentrating the Pee Wee ore.

Figure 10 is a flowsheet of the mill.

Maricopa County

All but one of the Maricopa County tungsten occurrences now known were discovered during the Government purchasing program, May 1951-56. The exception is the ferberite deposit discovered about 1912 on the Gold Cliff group north of Cave Creek.

Except for this deposit, all occurrences lie in typical southwestern desert country. There are no concentrators in the county; however, the Tungsten Refining Co. operates both physical and chemical plants for refining tungsten concentrates in Phoenix.

Scheelite is the principal tungsten mineral and, as in Yuma County, occurs predominantly in fissures through schist. Powellite occurs on the Flying Saucer claims in granitic rocks, and ferberite on the Gold Cliff group associated with both schist and granitics.

The only reported production of tungsten from Maricopa County from 1951 through 1956 is eight short-ton units from the Tough Nut claims. The total production is thought to be 350 short-ton units of WO_3, most of which came from the Gold Cliff deposit before 1946.

There are no measured tungsten-ore reserves in the mines of Maricopa County. The indicated ore reserves are very small; inferred reserves are on the order of 3,400 tons at 0.2 percent WO_3. No estimates of ore were made on the Flying Saucer and Gold Cliff groups.

Tamarack Group

The Tamarack group of 10 unpatented lode claims is in secs. 15, 16, 21, and 22, T. 7 N., R. 3 W., in the north-central part of Maricopa County at an altitude of 2,600 feet. The property is 3.4 miles northerly, by road, from U. S. Highway 60-70 at Morristown on the Castle Hot Springs Road to a road fork, 0.4 mile northwesterly to another fork, right 3.6 miles northerly to another fork, and right 0.4 mile northerly to the central part of the claims (fig. 11).

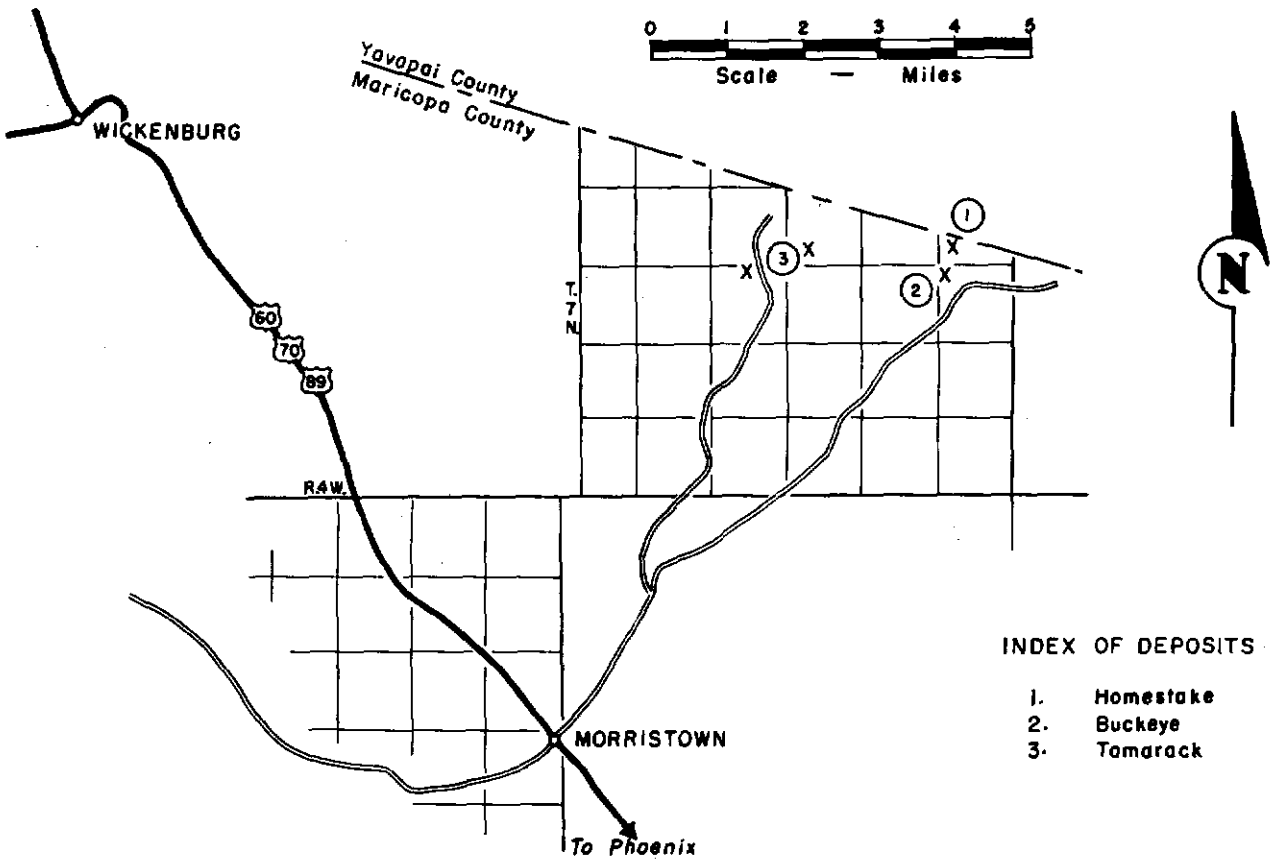


FIGURE 11. - Tungsten Deposits Northeast of Morristown, Maricopa County, Ariz.

D. G. McMillan relocated these claims in 1941 and owns them today. Before McMillan's relocation the claims were worked on meager gold showings. There has been no production of tungsten, and the small production of gold is unknown.

The workings on the property consist of two inclined, inaccessible shafts, each probably 75 feet deep, and numerous shallow prospect shafts and opencuts.

On the Tamarack claims schist and narrow beds of limestone have been intruded by medium-grained, light-gray granite and high-feldspar pegmatite dikes.

Sparse, highly sporadic scheelite occurs in a garnet-epidote rock within the schist and in one place between schist and limestone.

On the southern part of the claims is an epidote-garnet zone, about 4 feet wide, which has been opened for 35 feet along the strike. Scheelite float can be found for 150 feet to the west. Except for the working area, most of the formation is covered with overburden. This occurrence lies between schist and a narrow bed of limestone about 4 feet wide. Grains of white scheelite as large as one-half inch occur sporadically through the tactite, which is about 4 feet wide and strikes N. 55° W. and dips 60° NE. Ore from the cuts, examined by ultraviolet light, has an estimated 0.75 percent WO_3.

About 0.5 mile northeast of the above occurrence, on the north part of the claims, is a parallel tactite zone that can be traced on the surface for some 700 feet. The scheelite is extremely sporadic; cuts have been made on three of the better showings. Ore from these cuts appears to be of lower grade than that previously described. Low-grade mineralization extends into the schist in one place to give an overall width of 18 feet. Most of the epidote and tactite along the 700-foot strike is not mineralized.

The epidote zones conform to the bedding cleavage in the schist; that is, the schist and limestone beds also strike N. 55° W. and dip 55° to 65° NE.

There are other small occurrences of scheelite on the property, which the writer did not examine.

Homestake Group

The Homestake group of four claims is in secs. 13 and 24, T. 7 N., R. 3 W., in the Trilby Wash drainage northeast of Morristown at an altitude of 3,100 feet. The claims, accessible by road from Morristown, are 8.3 miles northeasterly from Morristown on the Castle Hot Springs Road to Trilby Wash, and northerly up Trilby Wash 0.6 mile to a lower scheelite occurrence on the west side of the wash. A second occurrence can be reached 0.8 mile up Trilby Wash, thence left or westerly 0.8 mile to a bulldozer cut (fig. 11).

These claims apparently have been worked on meager gold showings for a number of years. In 1949 George Cook relocated the four claims.

The workings on the tungsten occurrences consist of a dozer cut about 30 by 30 feet by an average depth of 3 feet, a shallow shaft 6 feet deep, and a very small opencut. The extent of the workings on meager gold showings is unknown. There has been virtually no production from the property.

The lower occurrence of scheelite--the one on the west side of Trilby Wash--is in hornblende schist. The scheelite occurs as grains and thin stringers in garnet and epidote. A face about 2 feet wide and 6 feet high is exposed in an opencut. The ore, examined by ultraviolet light, was estimated at more than 1 percent WO_3. The bedding cleavage in the schist strikes east and dips about 40° N.

The upper occurrence of scheelite on these claims is in and along fractures in hornblende gneiss. The mineralized zones strike generally N. 60° E. and dip 45° NW. The larger of two fractures examined showed scheelite mineralization about 4 inches wide for a strike length of 15 feet. Selected ore may run as much as 2 percent WO_3. According to Cook, a diamond-drill hole has been sunk vertically into the gneiss to a depth of 500 feet, and scheelite persisted to the bottom of the hole.

Buckeye Claim

This unpatented lode claim is in sec. 24, T. 7 N., R. 3 W., in the north-central part of Maricopa County at an altitude of approximately 3,000 feet. The prospect is 7.9 miles northeasterly from Morristown on the Castle Hot Springs Road to Trilby Wash, north on Trilby Wash 0.15 mile to a dim truck trail that branches to the left, and, on this trail, northwesterly 0.8 mile to the workings on the Buckeye claim (fig. 11).

The claim, owned by Emmet and Darrell Hamilton and Frank A. Sayre, was located in November 1953 on sparse scheelite showings.

The workings on the claim consist of three shallow shafts (the deepest about 20 feet), a few shallow prospect pits and trenches, and a small amount of dozer stripping.

According to Sayre, about 3.5 units of WO_3 has been produced from 2,000 pounds of ore.

Sparse, sporadic grains of scheelite occur in narrow seams, up to 12 inches wide, in a brown micaceous schist that contains local hornblende, epidote, and calcite. Garnet and traces of copper oxides also occur in the narrow seams. The scheelite mineralization can be traced for about 225 feet. The mineralized zone conforms to the schistosity and strikes N. 83° E. and dips 78° NW.

Andesite or diabase dikes crop out on the claim.

According to Sayre, the average grade of ore is better than 1 percent WO_3.

Tough Nut Group

The Tough Nut group of three unpatented lode claims is in sec. 18, T. 6 N., R. 4 W., at the easterly end of the Vulture Mountains at an altitude of 2,300 feet. The property can be reached by road, 6.5 miles west from Morristown on the unimproved Vulture Mine Road and southerly on a dim trail for 1.2 miles to the central part of the Tough Nut claim (fig. 12).

The claims were located in September and October 1954 by E. G. Savage and C. J. Berry. These men produced six units of WO_3 in 1954 and two units in 1955 from about 1 ton of ore mined from the Tough Nut claim, according to Savage.

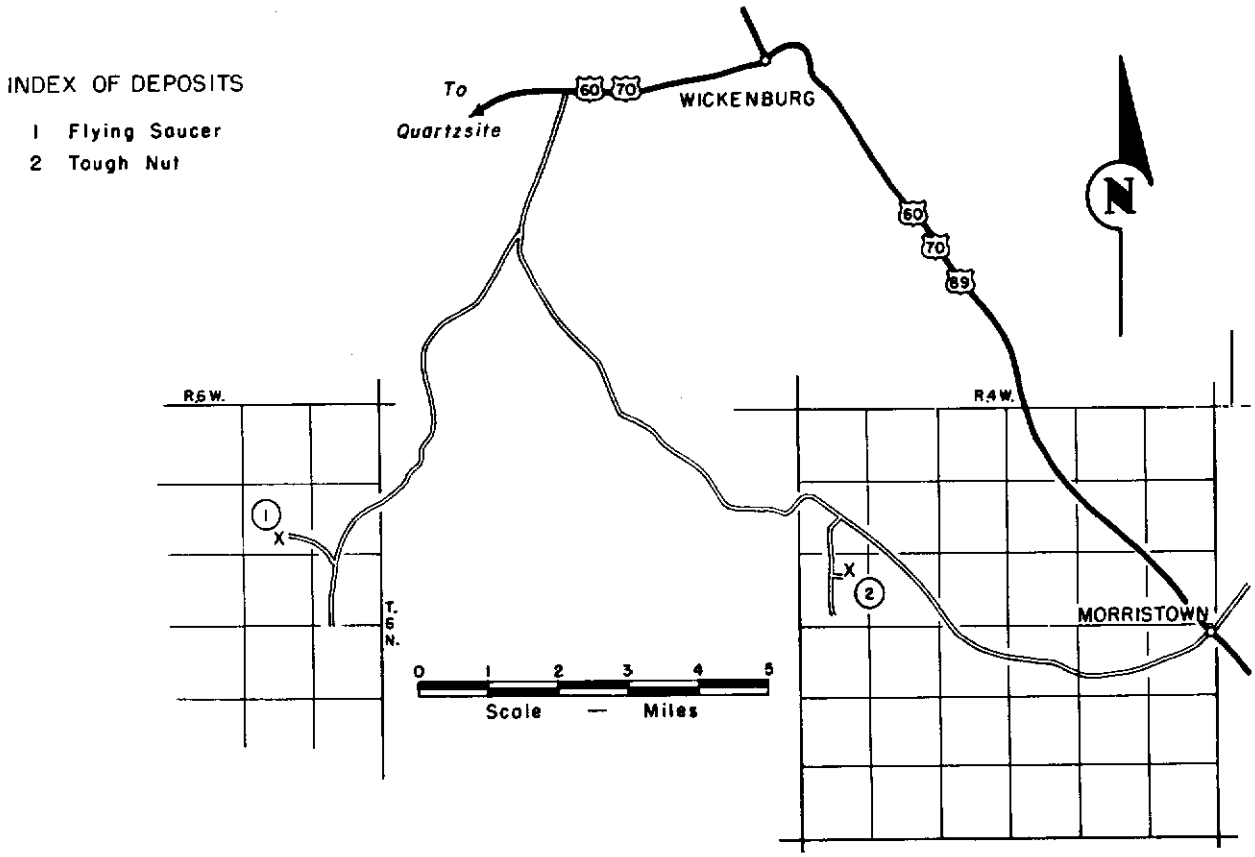


FIGURE 12. - Tungsten Deposits in Wickenburg-Morristown Area, Maricopa County, Ariz.

The workings on the claims consist of one shaft 18 feet deep, an opencut 15 feet long, and six very old shallow shafts. The old shafts were dug many years ago.

Sparse, sporadic scheelite occurs in and along bedding cleavage planes in a gray to brown micaceous schist. Two parallel fractures about 50 feet apart have been worked. The beds strike N. 80° W. and dip 74° SW.

Two lenses of ore, about 125 feet apart, have been worked for scheelite, one on each of the two parallel fractures. The lens in the 18-foot shaft is 4 inches wide and 10 feet long, and the lens in the opencut above the shaft is 8 to 10 inches wide and 15 feet long. Handpicked ore from both places contained about 8 percent WO_3.

The scheelite is in grains and narrow stringers through the schist. Considerable quartz is present locally, with minor amounts of epidote and iron oxides. Scheelite float can be traced sporadically on the surface for about 550 feet along the strike of the fissures.

Some work was done many years ago. Shallow shafts were sunk beside the rhyolite and andesite dikes that cut the schist. No relationship is evident between the dikes and the scheelite mineralization.

Flying Saucer Group

Much of the information on the Flying Saucer Group was gathered by a DMEA team of engineers in 1953.

The Flying Saucer group of six unpatented lode claims is in sec. 12, T. 6 N., R. 6 W., in the Vulture Mountains southwest of Wickenburg at an altitude of approximately 2,600 feet. The property is 2.6 miles west from the center of Wickenburg on U. S. Highway 60-70 to the Vulture-mine road, south 7.8 miles to the dim trail in a canyon bottom, that branches northwesterly from the road, and on this trail, 0.6 mile to the eastern part of the claims (fig. 12).

The claims were owned in 1950 by J. Frank Henderson. The claims now are owned by W. C. Kinnon of Phoenix, Ariz. The workings comprise the discovery shafts and some trenching. There has been no production from the property.

The Flying Saucer group is in an area of medium-grained biotite granite having a number of intrusions of later igneous rocks, which include several kinds of porphyries and some pegmatites and irregular basic intrusives. In some places the granite is fine grained or has been replaced largely by quartz banding. Short and narrow quartz veins and some that are more persistent occur in a few places. These are reported by the owners to contain powellite.

The tungsten mineralization consists of powellite and scheelite, and the deposition of these minerals does not favor any particular kind of rock. Examination of the surface at night showed great areas of brilliant fluorescence, which included granite and all the dike rocks except a late basic dike. In crossing from one formation to another no change is visible in the amount, character, and intensity of the fluorescence. Powellite is more abundant than scheelite.

On Scorpion Hill one area of intense fluorescence is 400 feet long and has a maximum width of nearly 200 feet. There are scores of smaller showings on the other claims of the group.

Most of the powellite and scheelite occurs as disseminations through the rock in roughly rounded forms, which average from pinhead to marble size. Streaks, stringers, and veinlets largely are absent.

The most puzzling features of this occurrence are the low WO_3 content for such brilliant fluorescence and the impossibility of identifying the structural controls that limit its extent.

The eight samples cut during the investigation assayed from less than 0.01 to 0.22 percent WO_3. Sampling indicated that the brilliance and amount of fluorescence were not criteria of the WO_3 content of the material.

Gold Cliff Group (Golden Reef)

The Gold Cliff group of four patented and nine unpatented lode claims is in sec. 11, T. 6 N., R. 4 E., in northeastern Maricopa County at an altitude

of 3,000 feet. The property, by road from Cavecreek, is 27 miles north of Phoenix, 0.4 mile westerly and 1.0 mile northerly to a road fork, right 3.5 miles northeasterly to the Sierra Vista guest ranch, and left at the barn and northeasterly about 1,25 miles to the mine (fig. 13).

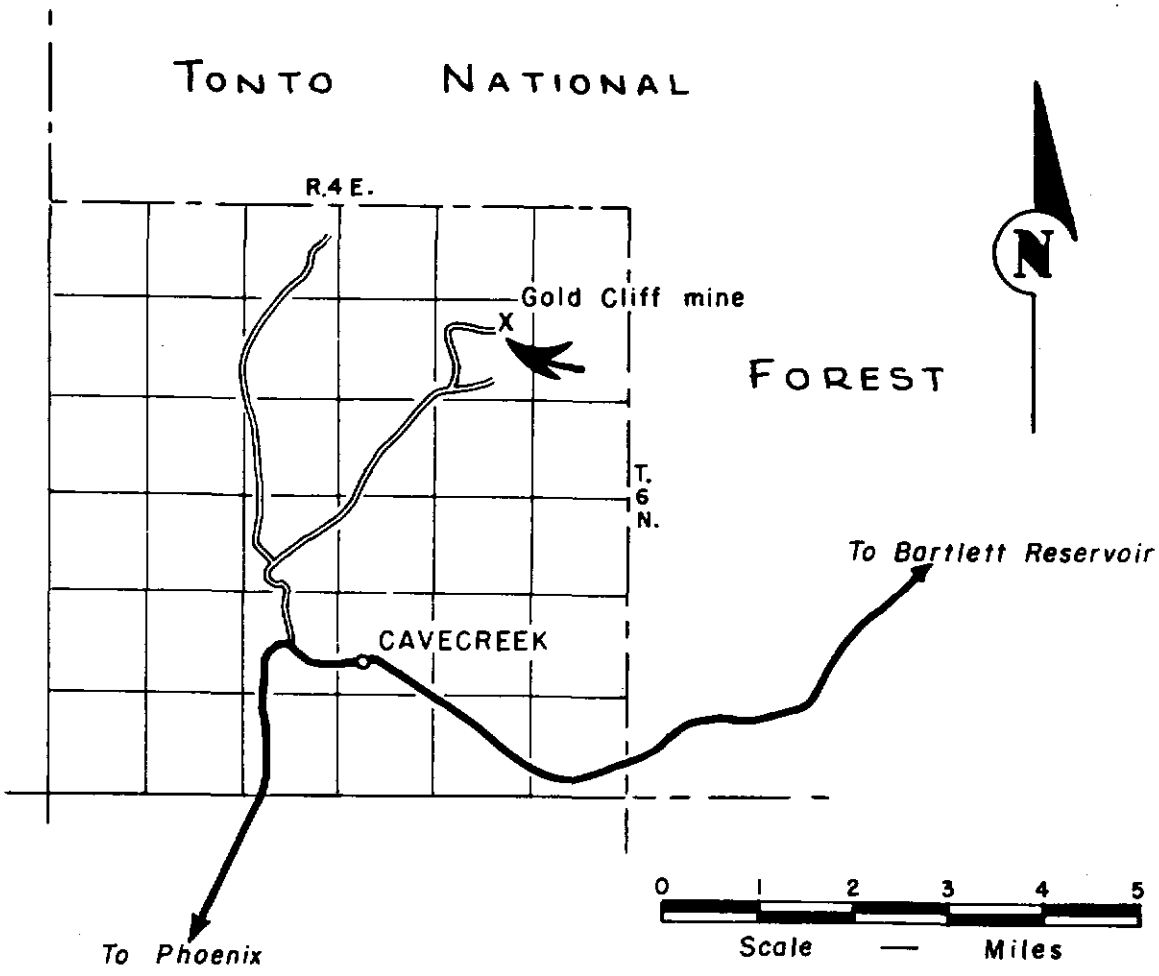


FIGURE 13. - Gold Cliff Group, Maricopa County, Ariz.

A padlocked cable across the road prevented the author from examining these claims; however, several engineers had visited the property, and the following is quoted from one of their reports.[12/]

> The northeastern portion of this property contains quartz veins from which, for many years, gold ore has been mined intermittently and concentrated in a stamp-gravity mill.

12/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 26.

Three claims in the southwestern portion of the group contain the principal tungsten deposits. These deposits, well-known by 1913, were worked during the World War (World War I) by the Pittsburg Tungsten Company, but figures on their production are not available . . . .

In 1936 the property was leased to Jack Lemons, who produced more than 5 tons of ferberite concentrates in a small gravity plant. The concentrates contained 60 to 67 percent WO_3. Lemons quit the property in 1947, and there has been no mineral production since that time.

The property was owned in 1941 by the Gold Cliff Mining Co., and Daniel Steele was the principal stockholder. After his death Mrs. Steele sold the property in 1949 to Russell Talbott, her son-in-law. He obtained patents to four claims and has retained possession of the nine remaining unpatented claims, according to Talbott.

The workings consist of several open stopes, surface cuts, and short adits.

Slaty to sericitic gray Precambrian schist, which strikes northeastward and dips northwestward at moderate angles, is intruded by a granitic stock that crops out over an east-west length of about a mile and a width of 1/4 to 3/4 mile. This granite has been extensively invaded and altered by pegmatite. The alteration consists largely of coarse sericite and quartz.

The area has been broken by several faults of undetermined displacement. Springs important for local water supply, are associated with some of these faults.

Two systems of fissures are prominent; one system, which strikes N. 45° E. and dips about 65° SE. is intersected by the other, which strikes N. 25° to 30° E. and dips about 60° SE.

The N. 45° E. fissures show extensive sericitization and silicification, in places forming zones 30 feet wide. Their outcrops, relatively resistant to erosion, are easily traceable.

The N. 25° to 30° E. fissures generally contain thin veins of quartz up to 3 inches thick, together with iron oxide. Oxidized iron and copper minerals are locally abundant in the walls.

Tungsten deposits are known to occur in six of the N. 45° E. zones, of which four have been productive. The principal mineral is ferberite, locally with auriferous pyrite, chalcopyrite, fluorite, and minor molybdenite. In places near the surface, copper carbonates, iron oxides, tungstite, and cuprotungstite are abundant; Hess[13/] believes that the latter mineral formed through mutual decomposition of

13/ Hess, F. L., Tungsten Minerals and Deposits: Geol. Survey Bull. 652, 1917, pp. 33, 64.

ferberite and copper minerals. He cites one analysis which shows the ferberite to contain 2.20 percent of columbium-tantalum oxide.

> The ore shoots, of which some as much as 2 or 3 feet wide have been mined, clearly seem to be related to the intersections of the fissures, as if the N. 45° E. zones were permeable structures mineralized by the N. 25° to 30° E. fissures. Some of the N. 45° E. zones contain ferberite seams and replacements for tens of feet southwest of these intersections.14/

Lemons stated that the ferberite occurred next to the footwall in lenses containing as much as 600 pounds of nearly pure mineral. He also said that occurrences of pure ferberite up to 8 inches wide had been mined.

Tungsten Refining Co.

The offices and separation plant of the Tungsten Refining Co., an Arizona company, are at 2244 East Henshaw Road, Phoenix, Ariz. The company was formed in April 1957. The separation plant was completed, and full production reached in November 1957. The capacity of the plant is 7,500 units of WO_3 per month.

Both foreign and domestic tungsten concentrates are purchased, and Filament-grade concentrate is sold. Other minerals and elements also are recovered and sold. The company will buy high-molybdenum-content concentrates and table or jig products but no flotation concentrates. It prefers scheelite concentrates but will purchase wolframite concentrates under certain conditions.

About $90,000 has been invested in the chemical-separation plant and $60,000 in the physical-separation plant, which consists of an elaborate sizing plant. Physical separations are effected entirely by dry processes consisting of magnetic, electrostatic, and air-gravity methods. Particle separation is entirely successful on a dry concentrating table when the gravities of the minerals differ by 20 percent, according to E. L. Whipple.

The Colorado Research Foundation developed the processes being used in the chemical plant. The methods are unconventional, and concentrates containing up to 3 percent molybdenum can be processed without losing any WO_3 content.

There is no waste dump at this plant. All minerals associated with tungsten are separated and sold, including oxide, sulfide, phosphate and silicate minerals.

When the author visited the plant in April 1958, it was working at only 20-percent capacity. The company at that time was interested in procuring a constant supply of concentrates from domestic sources.

14/ Work cited in footnote 12 (p. 38), pp. 26-27.

Pinal County

Scheelite was discovered in Pinal County in 1908. There was production from two districts during World War I. With one exception, the 11 deposits included in this report were known before World War II.

About half of the deposits are at altitudes above 4,500 feet, where water is ample for mining and milling and some timber is available for mining purposes. There are no tungsten concentrators in the county now; however, in the past there have been small concentrators on or near four of the deposits.

The predominant tungsten mineral is scheelite; it is found in silicated limestones and schists and in quartz veins through granitic rocks. Wolframite minerals predominate in one area and are found in the quartz veins cutting quartz monzonite. The deposits are undeveloped. Development work has been done in only one area. Measurable ore reserves were found in only one deposit, and these were very small.

Total production has been about 21,200 short-ton units of WO_3; most came from the Mogul fault area in the Santa Catalina Mountains.

Indicated and inferred Pinal County ore reserves total about 51,000 tons, containing about 1 percent WO_3, and most of them are in the Mogul fault area. There are no measurable ore reserves.

Mammoth Mines

Wilson[15/] noted tungsten mineralization in the Mammoth mines.

According to Hess,[16/] concentrates of wulfenite and vanadinite from the Mammoth mines, 21 miles south of Winkelman, contain as much as 2 percent WO_3.

In 1938 the mill concentrates reportedly[17/] contained 0.4 to 0.5 percent WO_3. No tungsten mineral has been identified in these deposits.

Tarr Property

The Tarr property was not examined by the author; tungsten was reported by Wilson.[18/]

The claims, owned by M. G. Tarr, of Mammoth, Ariz., are in the northeastern part of the Black Hills. They are 11 miles from Mammoth by the road that leaves the Mammoth to Winkelman Highway near the bridge, 2 miles north of Mammoth.

15/ Work cited in footnote 12 (p. 38), p. 34.
16/ Hess, F. L., Molybdenum Deposits: Geol. Survey Bull. 761, 1924, pp. 6-7.
17/ Peterson, N. P., Geology and Ore Deposits of the Mammoth Mining Camp Area, Pinal County, Arizona: Arizona Bureau of Mines Bull. 144, 1938, p. 43.
18/ Work cited in footnote 12 (p. 38), pp. 34-35.

According to Wilson:

> This eastern foothill portion of the Black Hills has been sharply dissected by northeastward-draining ravines. The principal rock exposed is fine-grained gneissic to schistose brown porphyry that has undergone considerable hydrothermal and surface alteration. Cutting this formation are numerous north to northeast fissures, of which some contain quartz veins that range from thin seams to 6 inches in width.
>
> When visited in March 1940, a small production had been made from two shallow pits sunk on a brecciated zone several feet wide that strikes N. 70° E. and dips about 80° SE. Its quartz stringers carry wolframite and scheelite. A short distance farther west are six parallel stringers of almost flat dip which show a little scheelite. The possible intersection of them with the brecciated zone had not been prospected.

To February 1943 the total production was 25 pounds of selected ore and concentrates.

Upshaw Tungsten Mines Group

The Tungsten Mines group, formerly the Gold Circle, of six unpatented lode claims is in sec. 11, T. 7 S., R. 14 E., in the south end of the Tortilla Mountains at an altitude of 3,750 feet. The property may be reached from several directions, as may be seen on the Winkelman-quadrangle sheet. The road directions from Tucson are as follows: 21.4 miles north on U. S. Highway 80-89 to Oracle Junction; easterly 5 miles on State Highway 88 to an improved dirt road; left, or northerly, 20.8 miles to the Barkerville Road; right, or northeasterly, 4.5 miles to the Whitehead Well Road; south on the well road 2.4 miles to a pipeline road; and left, or southeasterly, on the pipeline road 0.7 mile to the claims. A cabin and the main workings are a few hundred feet east of the pipeline. State Highway 77 is 13.1 miles easterly on the Barkerville Road from Whitehead Well Road (fig. 14).

The claims were located first in 1925 by C. B. Upshaw, G. E. Upshaw, and Robert Gill and afterward were leased to several different parties. C. B. Upshaw relocated the claims in 1941. Virtually no production has come from the property.

The workings comprise the following: 1 inclined shaft 75 feet deep, with 50 feet of drifts; 2 vertical shafts 25 and 18 feet deep; 1 adit about 25 feet long; and 10 shallow opencuts.

Pink porphyritic granite is cut by veinlets of quartz, which contains sparse, sporadic scheelite, wolframite, and gold.

A short distance east of the cabin a narrow quartz vein, which strikes N. 70° E. and dips vertically, has been opened by six shallow pits over a

strike length of about 250 feet. The vein ranges from 6 to 16 inches in width. All the pits show traces of scheelite.

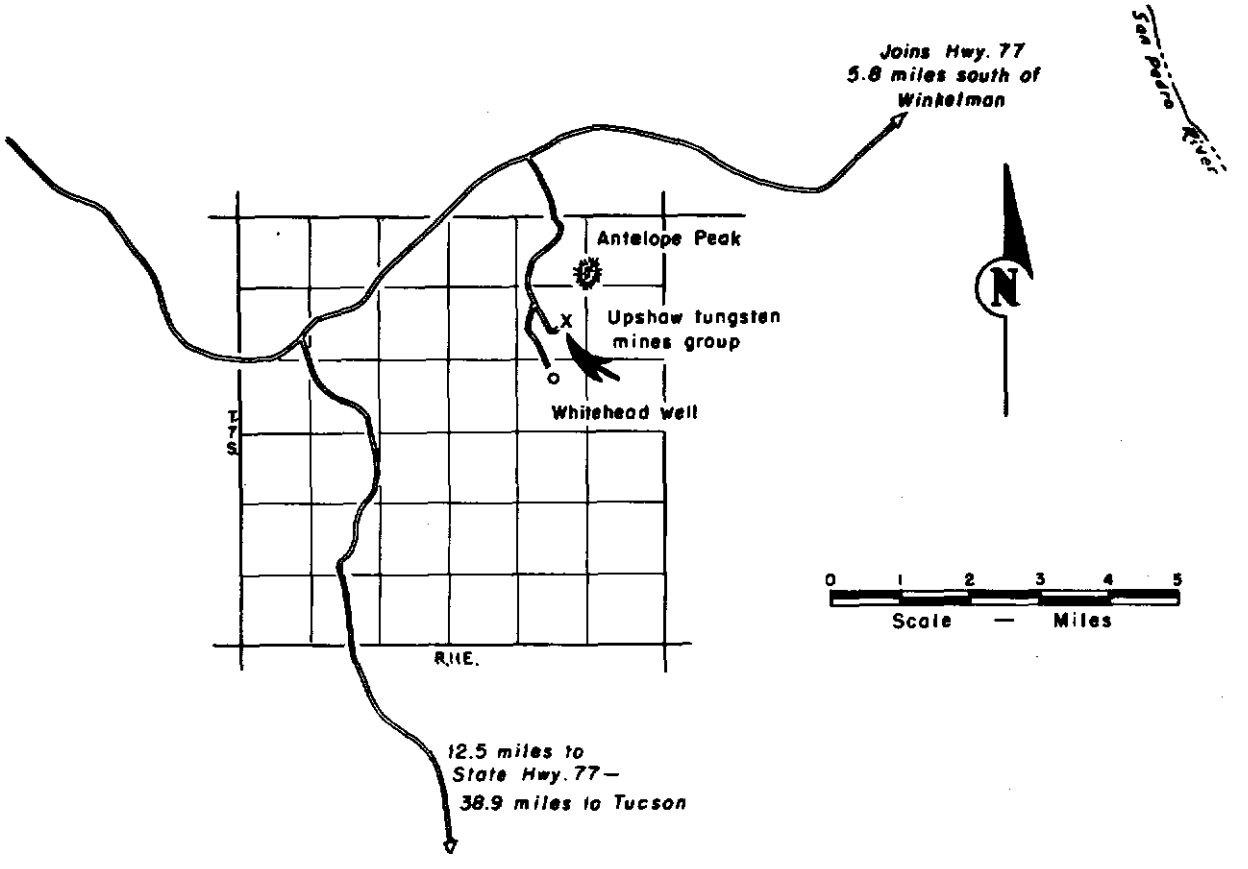


FIGURE 14. - Upshaw Tungsten Mines Group, Pinal County, Ariz.

Wilson[19/] described another occurrence:

About 1/2 mile farther northeast, a fissure zone of irregular eastward trend and steep southward dip is traceable for some 2,000 feet. Its outcrop is marked by iron stain and in places by lenticular bodies of coarsely crystalline, cellular, dull-white quartz. At one place, where this zone contains a quartz vein striking N. 75° E. and dipping 45° to 60° SE., it has been prospected by a 70-foot inclined shaft with 50 feet of drifts. As exposed by these workings, the quartz vein ranges from 6 to 12 inches in width and in places carries small particles of powellite together with irregular bunches of scheelite and some wolframite.

19/ Work cited in footnote 12 (p. 38), p. 35.

According to the Arizona State Department of Mineral Resources, 5 tons of ore taken from a dump on the property in 1942 yielded 123 pounds of concentrate. The concentrate contained the following:

WO_3	percent	33.1
Copper	do.	.28
Lead	do.	9.82
Gold	ounces	2.53
Silver	do.	6.28

Wall Tungsten Claims

The author did not examine these claims. Inquiries at Ray, Ariz., disclosed that the claims had been purchased by the Kennecott Copper Corp., Ray Mines Division, presumably for a dump area.

The following information comes from an old, unpublished report at the Southwest Experiment Station: The tungsten group is on the easterly slope of the Tortilla Mountains about 1 mile west of Sonora, Ariz. The claims can be reached only by a steep trail from Sonora.

In 1942 the property was owned by Leo Wall, who located the ground in that year. Wall sold his group of six tungsten claims to the Kennecott Copper Corp. in 1956. There is no knowledge of any ore having been shipped from the property. According to Wall, the Tungsten Nos. 1, 2, and 3 claims have been patented.

There is a tunnel 75 feet long with a drift on a vein 40 feet long.

The prevailing country rock is granite. The ore occurs in a small feldspar vein, 0.2 to 0.8 foot wide for a length of about 30 feet. The strike is approximately north-south and the dip approximately vertical.

The mineral is scheelite. There was a similar small vein, in a small cut, several hundred feet easterly from the tunnel.

One sample of the vein material in the tunnel assayed 0.20 percent WO_3.

Cole Tungsten Prospect

The Cole Tungsten group of two unpatented lode claims is in sec. 12, T. 1 S., R. 13 E., in the Crook National Forest at an altitude of 4,300 feet. The claims are accessible from Superior or Miami. From Superior, they are 8.4 miles northerly on U. S. Highway 60-70 to the Clark Ranch Road, thence 1.5 miles northerly past the Clark Ranch over a winding unimproved road to the Tungsten claim (fig. 15). Two adits, other openings, and the access road are shown on the Pinal Ranch-quadrangle sheet, 7.5-minute series.

These claims were worked for tungsten in 1917. Faulkner and Messner (partners) did some prospecting on the property, known locally as the Old Swede mine. Helen Marie Cole acquired the group in 1941 and is still the

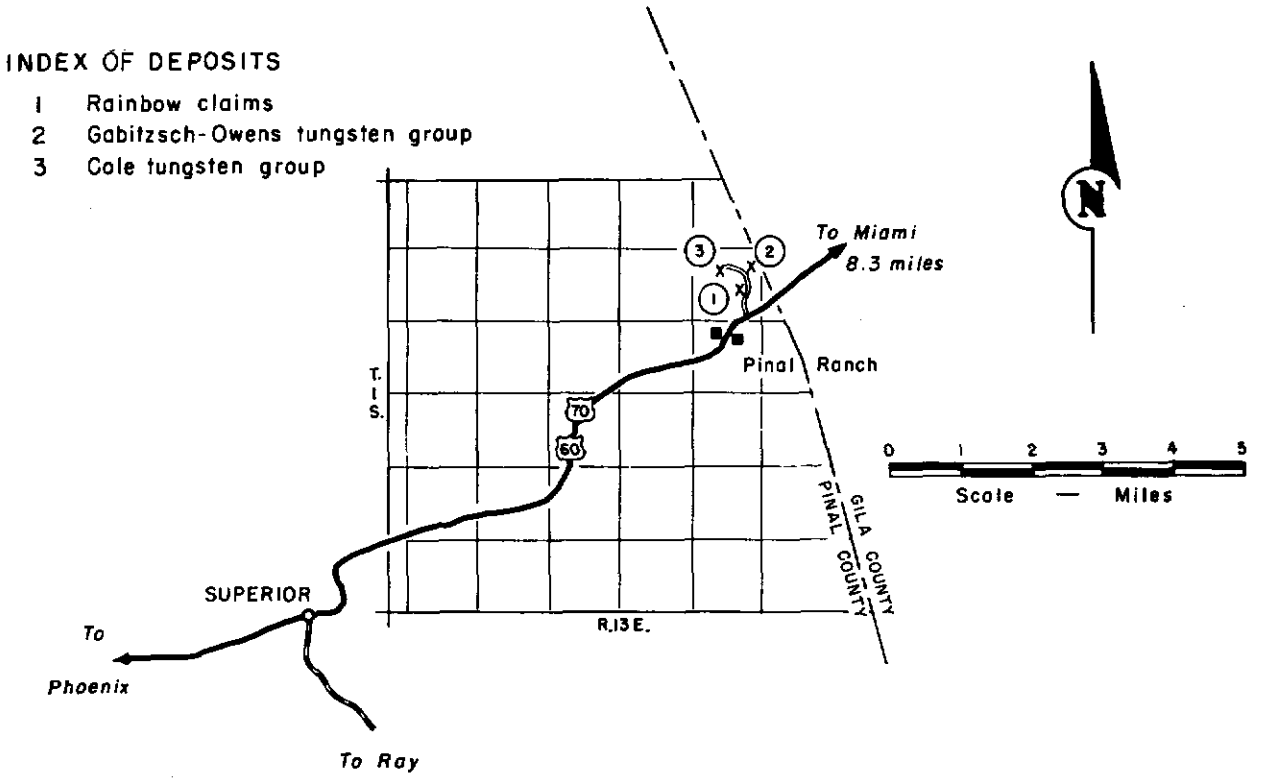


FIGURE 15. - Tungsten Deposits in Pinal Ranch Area, Pinal County, Ariz.

owner. The claims were worked in 1942 by R. A. Keller and associates. G. A. Gabitzsch built a small concentrator at Summit Lodge to concentrate the ore, which was packed on burros about 1 mile. The Arizona State Department of Mines Resources reported in 1942 that 0.5 ton of ore from a drift 75 feet south of the fault was crushed, ground, and tabled. The ore yielded 60 pounds of concentrate, which assayed 32.4 percent WO_3. Total production from the property is unknown but was very small.

The workings include an adit about 100 feet long, with an 85-foot crosscut, an inaccessible raise to the surface from the crosscut, and an inaccessible adit of unknown length (probably 150 feet), two small opencuts, and several small pits and prospect holes.

The country rock is granitic. Prominent pressure fractures strike N. 30° to 35° E. and dip 65° SE. and N. 50° E. and dip about 60° SE. The N. 30° to 35° E. fissures are extensively mineralized here and elsewhere in the vicinity. The granitic rock is thought to be quartz monzonite with considerable biotite.

Considerable surface work has been done on a discontinuous quartz vein ranging in width from a fraction of an inch to 8 feet. A fault displaced the vein for about 20 feet. South of the fault the vein can be traced for 150 feet, and most of the ore has come from there. In the adit crosscut the quartz is 2 and 3 feet wide, except at its southwest end, where the quartz has cut out entirely.

The outcrop of the vein can be traced for at least 600 feet northeast of the fault, but there the quartz does not seem to contain as much tungsten mineralization as that south of the fault.

The quartz carries wolframite and pyrite, with minor amounts of chalcopyrite, galena, sphalerite, jarosite, limonite, and hematite. Only an occasional crystal of scheelite can be found. Most of the wolframite is confined to a 10-inch streak on the hanging wall at the surface and on the foot wall in the adit crosscut. There are indications that enrichment occurs at or near the intersections of the N. 50° E. fractures with the N. 30° to 35° E. fracture.

Rainbow Group

The Rainbow group of 12 unpatented lode claims is in sec. 12, T. 1 S., R. 13 E., in the Crook National Forest at an altitude of 4,600 feet. The claims are readily accessible from Superior by driving 8.4 miles northeasterly on U. S. Highway No. 60-70 to the Clark Ranch Road, and northerly 0.4 mile to the Clark Ranch, shown on the Pinal Ranch quadrangle, 7.5-minute series (fig. 15). The main workings are 100 yards northwest of the house.

These claims, as was the Cole Tungsten group, were worked by the partners Faulkner and Messner. Some float was gathered from the surface of Rainbow No. 3 claim and sold during World War I. Yulee S. Clark relocated part of the claims as early as 1938 on sparse copper showings. Little work was done on the tungsten occurrence until April 1953 when Clark leased the property to John A. Morrow.

The workings on the property consist of a 100-foot shaft with 50 feet of drift, three opencuts all 10 feet deep, and several small pits and shallow prospect shafts.

Mineralized quartz veins through quartz monzonite carry wolframite, scheelite, pyrite, and muscovite, with minor chalcopyrite, bornite, and molybdenite. The wolframite-scheelite ratio is estimated (by eye) to be 1:1. All minerals occur in the monzonite as well as in the quartz. The veins strike N. 70° E. to N. 45° E. with steep northwest dips. On the surface the quartz is 1 to 2 feet wide; it is vuggy and carries much iron oxide.

Morrow sank a 100-foot shaft near the intersection of quartz fissures striking N. 45° E. and N. 70° E. The shaft was sunk vertically into the footwall, and a drift was driven on the 100-foot level to cut the vein. Unfortunately the shaft had 25 to 35 feet of water when the author visited the property in April 1958. According to Clark, an ore zone, 6 feet wide, was penetrated on the 100-foot level, and about 30 feet of drifing was done on the ore. The ore on the dump substantiates Clark's statement.

The quartz fissure striking N. 70° E. from the shaft has been exposed on the surface for about 200 feet. The fissure striking S. 45° W. from the shaft has been exposed for about 150 feet.

The author collected three samples from the dump at the shaft. Sample 12864 was a trench sample from the top of the dump and 12866 a grab sample from approximately 3 feet above the toe of the dump. The two samples represent an estimated 110 tons of ore. Sample 12865 was a grab sample from an estimated 3 to 4 tons of ore said to have come from the south drift. Assay results are shown in table 4.

TABLE 4. - Assay results of three samples from Rainbow group

Sample No.	WO_3, percent	Cu, percent
12864.....	0.08	0.16
12865.....	.25	.08
12866.....	.06	.13

Gabitzsch-Owens Tungsten Group

The Gabitzsch-Owens group of four unpatented lode claims, three in Pinal County and one in Gila County, is in sec. 12, T. 1 S., R. 13 E., in the Crook National Forest at an altitude of 4,400 feet. The claims adjoin the Cole Tungsten group on the north and east.

Little is known of the early history of these claims. Probably they were part of the group worked by the partners Faulkner and Messner. The claims were relocated in 1950 and 1951 by B. A. Gabitzsch and James Owens. There has been no production from the property.

The workings comprise a 25-foot adit and about 11 shallow opencuts, none exceeding 10 feet in depth.

This group lies between the Cole Tungsten and the Rainbow groups, and the geology is virtually the same.

A discontinuous quartz vein cuts quartz monzonite. The vein has formed along a pressure fracture, which strikes N. 25° to 35° E. and dips 62° NW. At least one enriched zone formed at the intersection of the above vein with another quartz-filled fracture, which strikes N. 70° E. and dips 64° SE. There is minor faulting on these claims. The vein ranges in width from a few inches to 3 or 4 feet.

The quartz is vuggy and contains considerable limonite, sporadic wolframite, and fine plates of muscovite. A minor amount of pyrite is present. Scheelite is very scarce.

Elephant Butte Group

The Elephant Butte group of four unpatented lode claims is in sec. 24, T. 1 S., R. 10 E., at an altitude of about 2,600 feet. The claims are accessible from the old Queen Creek Road: From Superior they are 4.5 miles west on U. S. Highway 60-70 to the Queen Creek Road, right 6.0 miles to a road fork, right 1.7 miles down Queen Creek to the Milk Ranch Road, northwestward 2.3 miles to a dim trail that turns eastward, thence 0.6 mile to a fork; and left 0.4 mile to the central part of the Elephant Butte claims (fig. 16).

These claims were located in February 1951 by Jesse and Hart Mullins.

The workings on the property comprise an inaccessible 40-foot shaft, several pits 10 feet deep, and several trenches and opencuts.

The only production from the property has been 0.5 ton of ore of a grade estimated at 10 percent WO_3, which was given as specimens to "rock hounds."

Discontinuous parallel veins of quartz cut a schist--probably Pinal schist--conformable to the bedding cleavage. The quartz strikes N. 50° E. and dips 75° NW. and can be traced intermittently along a strike length of about 3,000 feet in width, ranging from a few inches to 3 feet.

The quartz carries very sparse, sporadic molybdenum-bearing scheelite, also muscovite, chlorite, feldspar, minor amounts of copper carbonates and silicates, and chalcocite.

Only one pocket of ore had been worked and this to a depth of only 10 feet. The ore had been removed, and the hole had caved to cover the ore in place. According to Hart Mullins high-grade tungsten ore was in the bottom of this hole.

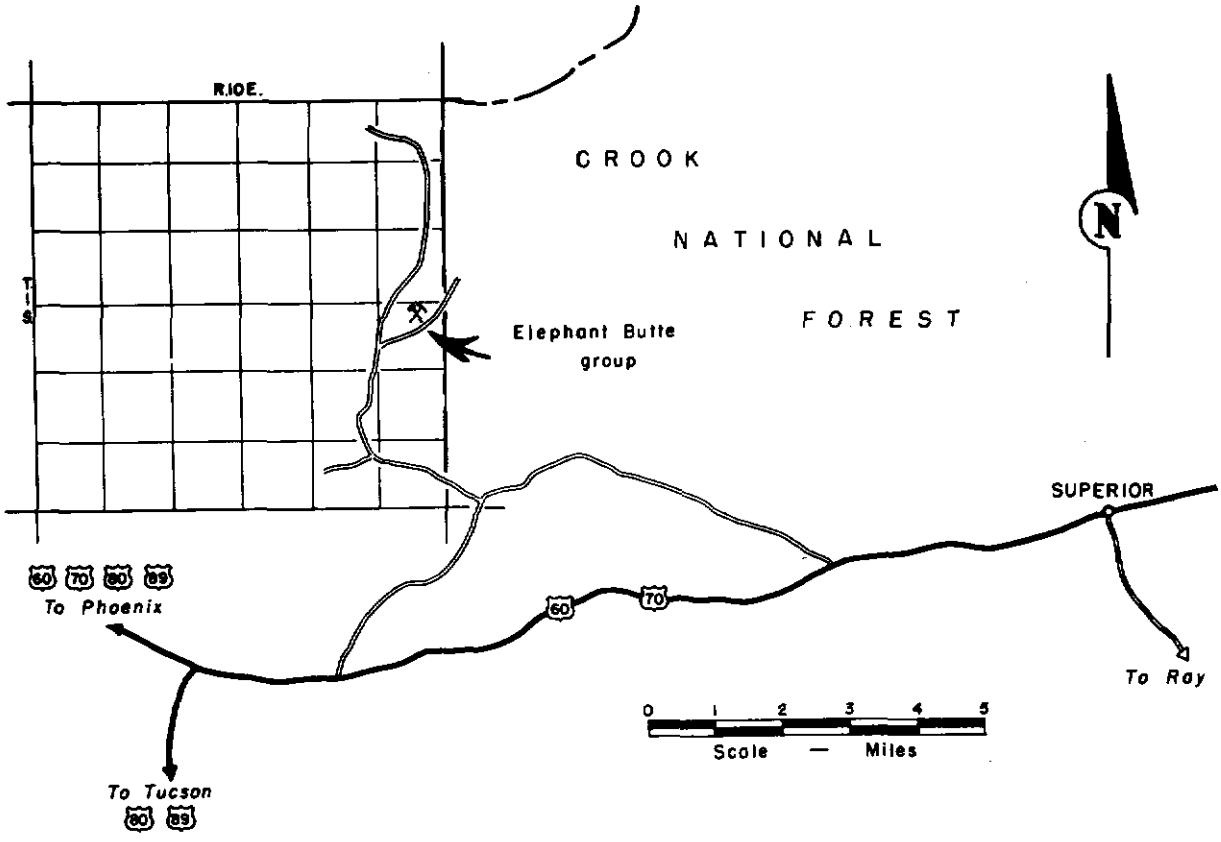


FIGURE 16. - Elephant Butte Group, Pinal County, Ariz.

Bear Cat Group (Madre Del Oro)

The Bear Cat group of eight unpatented lode claims is in sec. 8, T. 10 S., R. 16 E., on the northeast side of the Santa Catalina Mountains at an altitude of approximately 4,475 feet. Access is from Oracle, 4.3 miles southeasterly on the Mount Lemmon Road from its junction with the new San Manuel Road in Oracle to the American Flag Wash, thence 0.2 mile southwesterly up the wash to the camp (fig. 17).

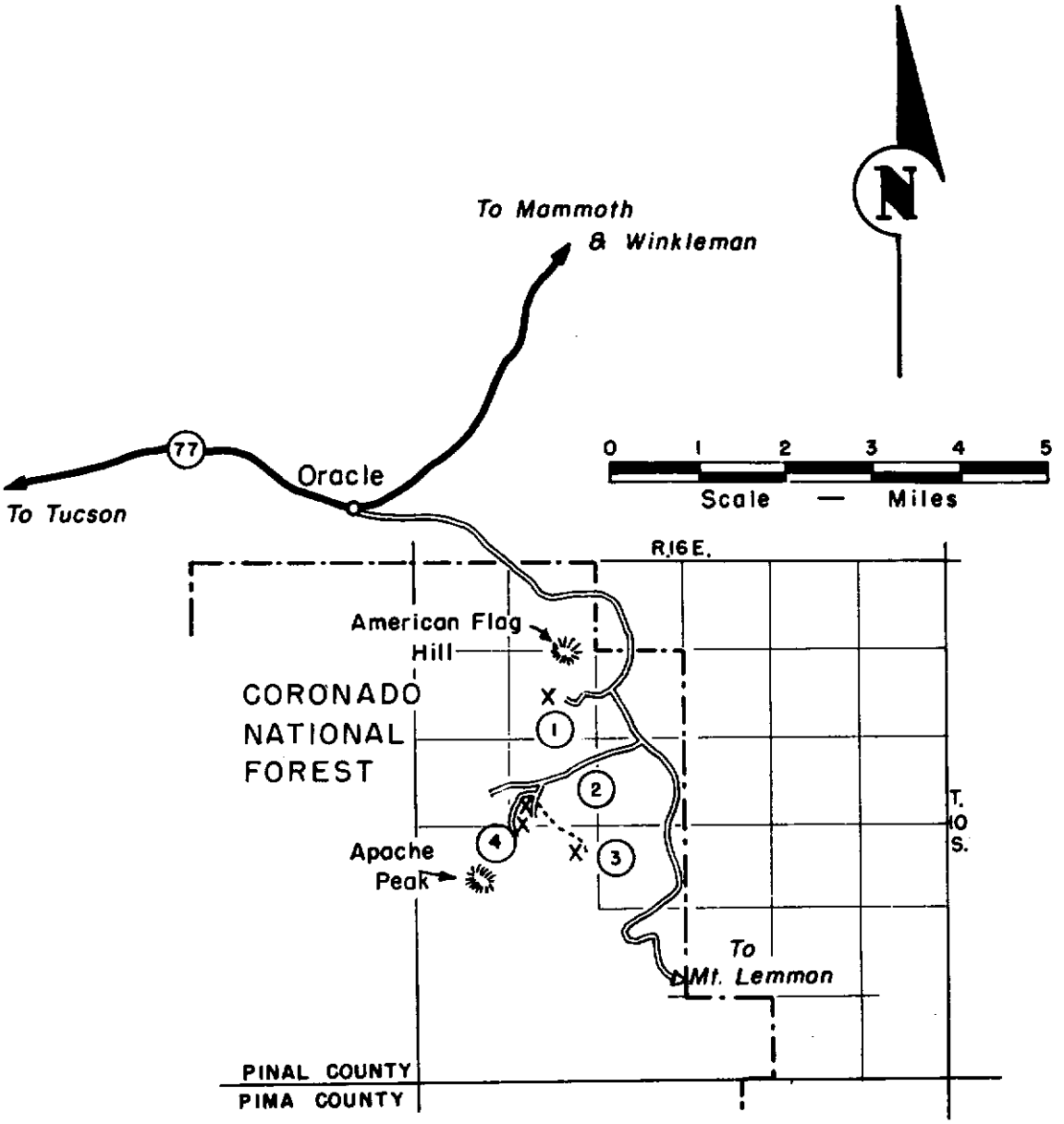
Most of the claims were located in 1938 and 1939 by E. B. Lovejoy. A small production of tungsten is said to have been made during World War I. Langley and Hodgkins, lessees in 1941, produced 600 pounds of concentrates containing 64 to 67 percent WO_3 from a vein on the Bear Cat No. 6 claim (fig. 18). These concentrates came from ore treated in a small, simple concentrator consisting of a hammer mill, a rod mill, a homemade concentrating table, and a tailing launder fitted with bar riffles. Lovejoy sold the claims to a man named Marshall, who in turn sold the property to a Mr. Muller. In 1946 Dr. Paul H. M. P. Brinton purchased the claims from Muller. According to Dr. Brinton there has been no production since Lovejoy sold the property.

The principal workings are on the Bear Cat No. 6 claim and consist of a 90-foot adit with a 10-foot winze, a 40-foot adit, an opencut 50 feet long with an underhand stope of unknown depth, and several small, shallow opencuts and pits. The Bear Cat No. 5 claim has several caved pits, said to have been excavated in 1917 on scheelite occurrences by a man named Castro. On the Silver Cliff claim an adit had been driven 150 feet toward a deposit of copper and silver with a small amount of gold. On the Madre Del Oro,which Dr. Brinton said was worked first in 1882, are an 80-foot shaft and a 75-foot adit. According to Brinton, he obtained samples from a very narrow vein on this claim that assayed as much as 100 ounces of silver per ton.

Dr. Brinton has constructed a petrographic laboratory, a hydrometallurgical laboratory, and a fire-assay laboratory--all well equipped. In addition he has laboratory-size grinding and crushing equipment and a small laboratory pilot plant.

On the Bear Cat No. 6 claim granite has been intruded by a diorite porphyry(?) dike ranging from 50 to 60 feet in width, with a 6-inch quartz vein on the hanging wall and a vein ranging from 1 to 2 feet in width on the foot-wall side. The wider portions of the foot-wall vein are nearly barren of scheelite. The dike strikes N. 10° E. and dips 45° to 50° E. The hanging-wall vein consists of coarsely crystalline milky-white quartz containing sparse, sporadic scheelite and disseminated iron oxide and pyrite. The foot-wall vein also carries sparse calcite that fluoresces red under ultraviolet light. Pits have been sunk along the outcrop of the veins for an estimated 1,200 feet.

The scheelite concentrates produced in 1941 were from the hanging-wall vein, which reportedly gave a recovery of more than 1 percent WO_3. While no ore from the foot-wall vein has been treated, it is considered to have more than 0.5 percent WO_3. At the north end of the mineralized zone Dr. Brinton



INDEX OF DEPOSITS

1 Bear Cat group
2 Pure Gold claim, Campo Bonita group
3 Old Maudina mine, Campo Bonito group
4 Morning Star claim

FIGURE 17. - Santa Catalina Deposits, Pinal County, Ariz.

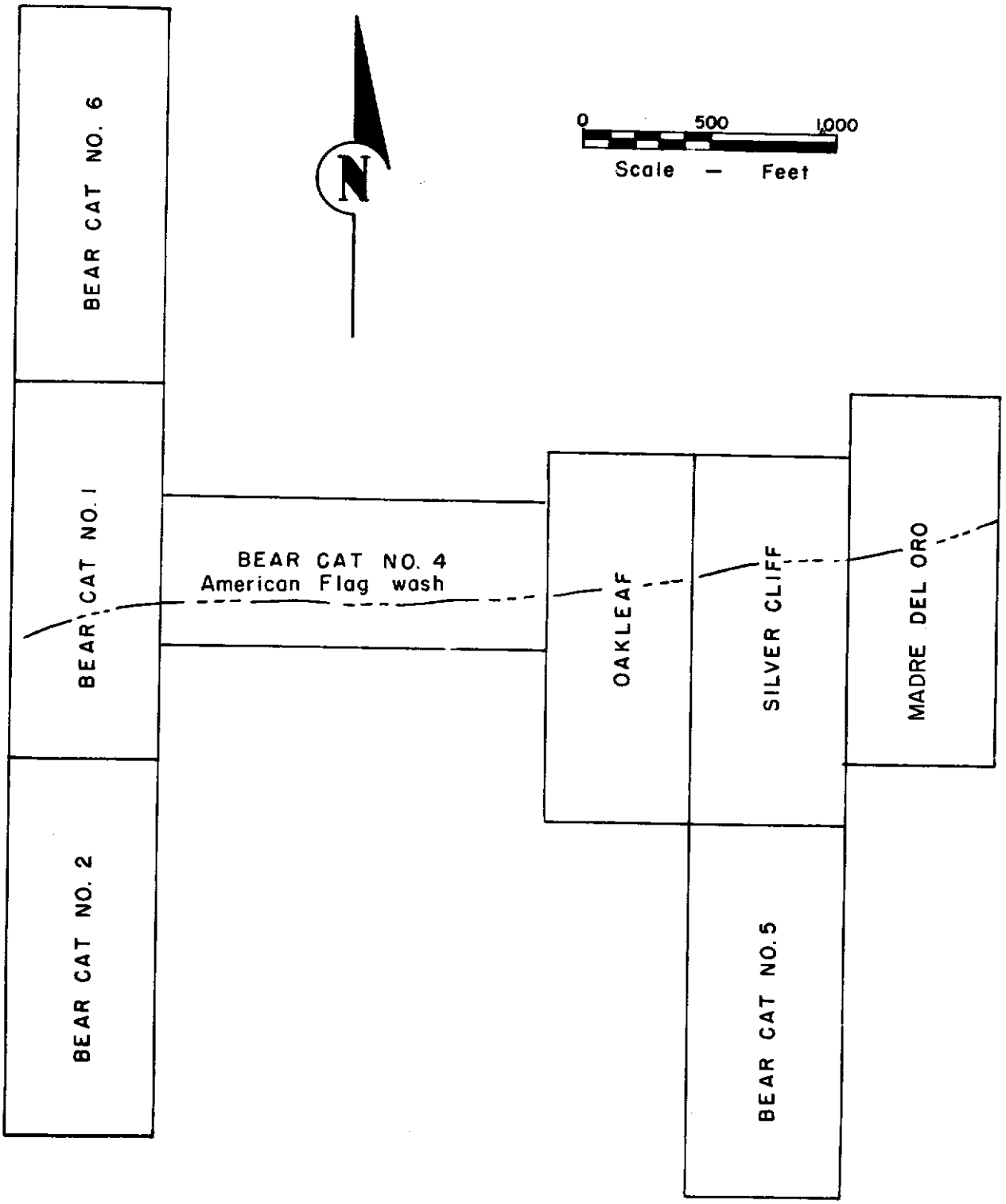


FIGURE 18. - Bear Cat Group, Pinal County, Ariz.

drove a short cut into an occurrence of vanadinite and scheelite near a contact of the granite with shale; the contact strikes east and is nearly vertical. It could not be determined if the diorite porphyry(?) dike had been faulted at this place.

It was reported in 1942 that the old workings on the Bear Cat No. 5 claim had some scheelite-bearing quartz on the dumps. The quartz was crystalline and the scheelite granular. All the small pocket mined must have been milled, as only a few scattered pieces of ore remained on the dump.

Campo Bonito Group (Maudina)

The Campo Bonito group (fig. 19) comprises 29 patented claims in secs. 17, 18, 20 and 21, T. 10 S., R. 16 E., on the northeast slope of the Santa Catalina Mountains. The altitude ranges from 4,600 to 5,500 feet. The property is reached from Oracle 5.2 miles southeastward on the Mount Lemmon Road, thence 1.7 miles to Campo Bonito (fig. 17). The road, *Campo Bonito*, the Maudina mine, Cody tunnel, and the Bonito mine on the Pure Gold claim are shown on the Campo Bonito quadrangle sheet, 7.5-minute series.

The Maudina mine first was worked for gold, then intermittently for tungsten from 1908 to the present. In 1910 the Cody-Dyer Arizona Mining & Milling Co. worked the Maudina as a tungsten mine. The Cody of this company was William Cody, better known as "Buffalo Bill." The company built a small mill, which was operated intermittently for several years. The mine was operated under lease during 1915 and 1916. E. J. Ewing operated the property in 1916. An estimated 50 tons of concentrates containing 60 percent WO_3 was produced during this period. Production from the property was very small and spasmodic until 1943, when E. J. Ewing discovered scheelite of commercial quantity and quality on the Pure Gold claim.

Patent proceedings on the 29 claims were completed in 1943 by Campo Bonito, Inc., of Milwaukee, Wis. In that year Edward H. Molson acquired a controlling interest in the property, which he retains today. Molson and Ewing produced from the Pure Gold claim 7,825 tons of ore containing an average 1.51 percent WO_3. Operations stopped in 1944, and only a very small production has been made since. Total production from the property was 15,000 short-ton units of WO_3.

The workings on the Pure Gold claim consist of a 175-foot aidt, an opencut about 160 feet long by 30 feet wide, an inclined shaft 35 feet wide, an inclined shaft 35 feet deep, an 88-foot adit, and two shallow shafts (fig. 20). The Cody tunnel on the Mogul claims is 830 feet long, with four crosscuts totaling 335 feet. An adit a short distance above the Cody tunnel is 315 feet long and has a 40-foot winze. The Maudina workings consist of a 175-foot vertical shaft with working levels 50, 100, 150, and 175 feet deep. The total drift footage from the shaft is about 1,000 feet. A stoped area 4 to 15 feet wide and about 50 feet long extends from the 150-foot level to the surface (fig. 21).

53-A

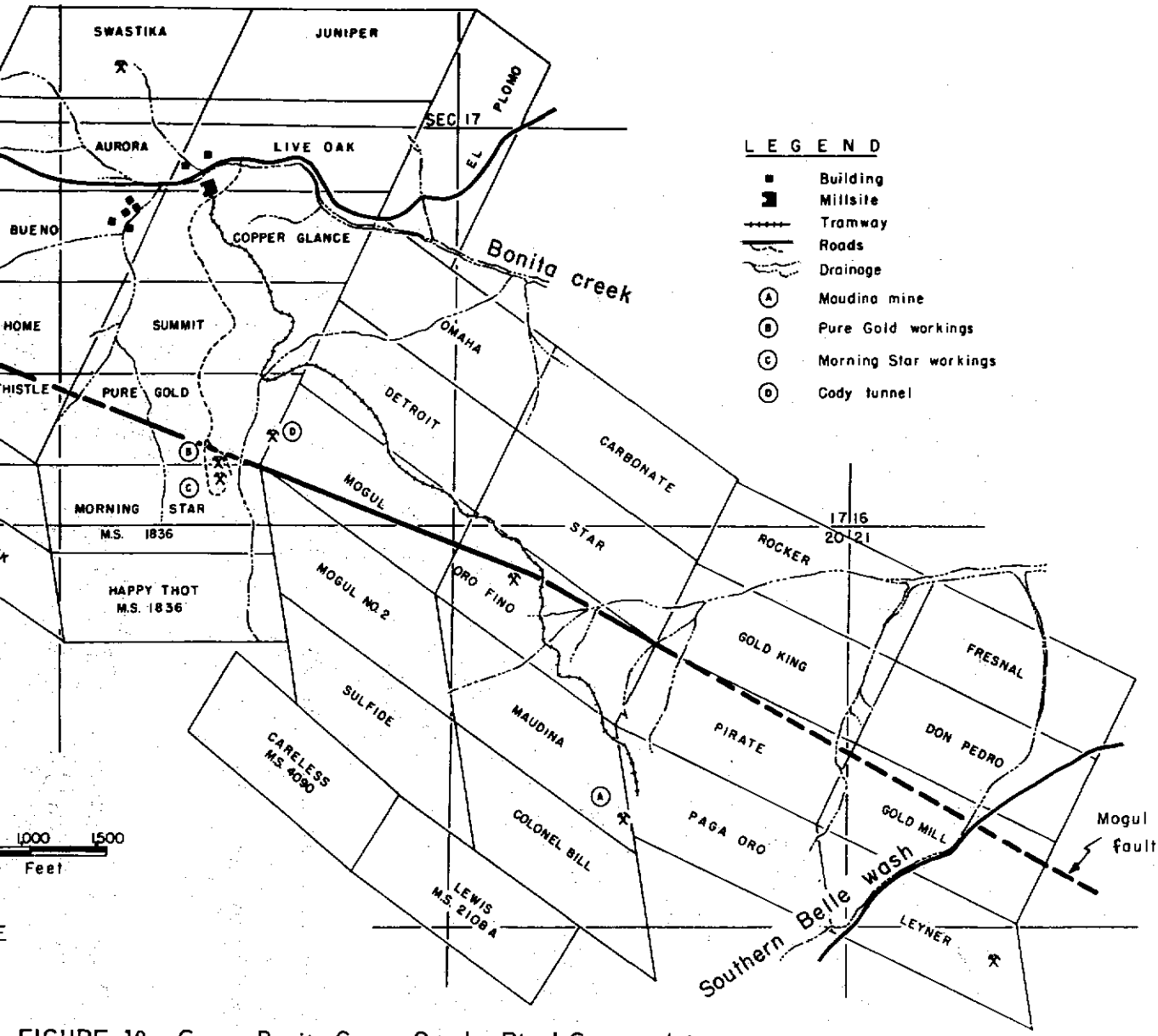
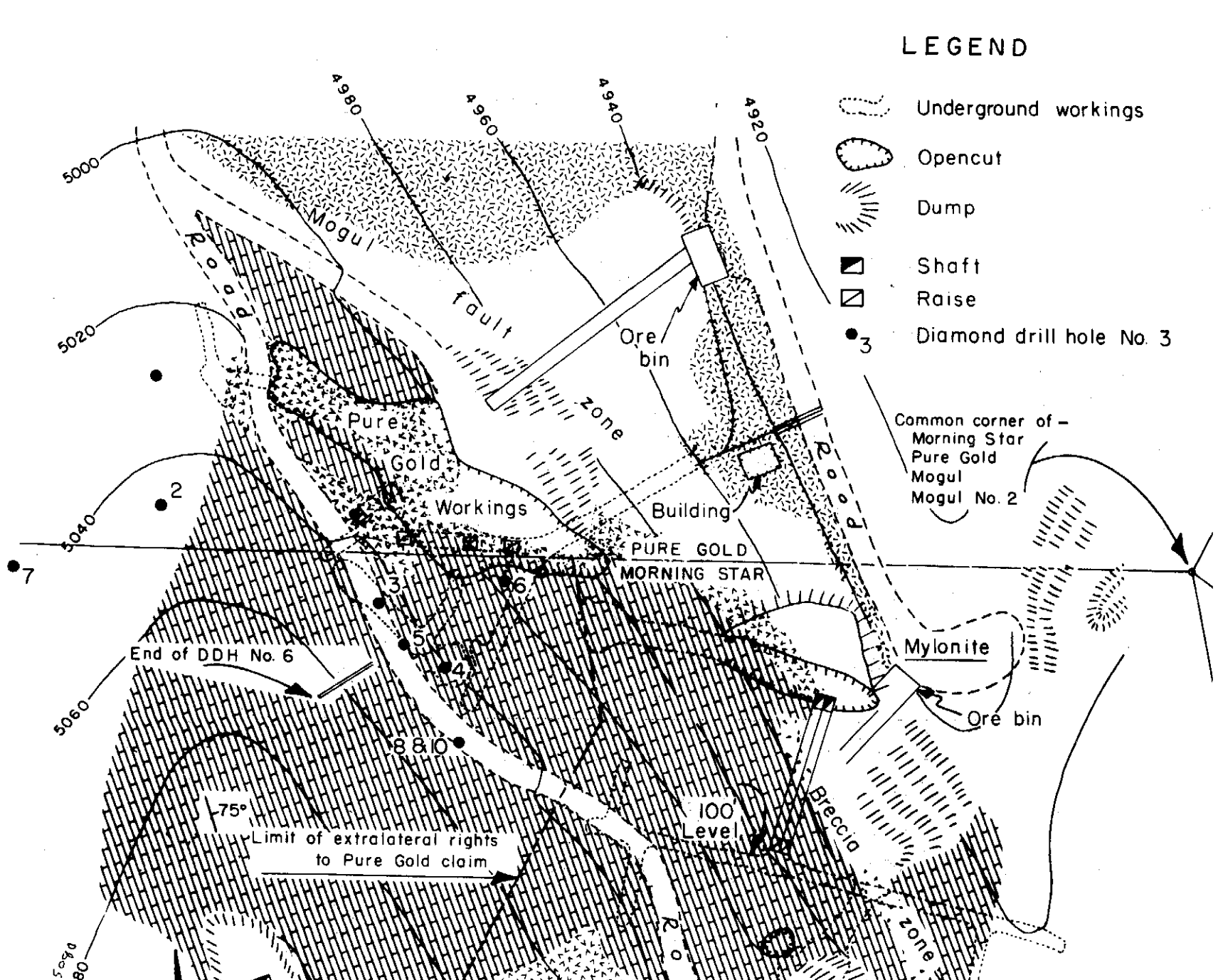


FIGURE 19. - Campo Bonito Group, Oracle, Pinal County, Ariz.


LEGEND
Underground workings
Opencut
Dump
Shaft
Raise
3 Diamond drill hole No. 3
4980
4960
4940
4920
5000
5020
5040
5060
5080
Mogul
fault
zone
Ore bin
Pure Gold
Workings
Building
PURE GOLD
MORNING STAR
Common corner of – Morning Star Pure Gold Mogul Mogul No. 2
Mylonite
Ore bin
End of DDH No. 6
75°
Limit of extralateral rights to Pure Gold claim
100' Level
Breccia zone
1
2
3
4
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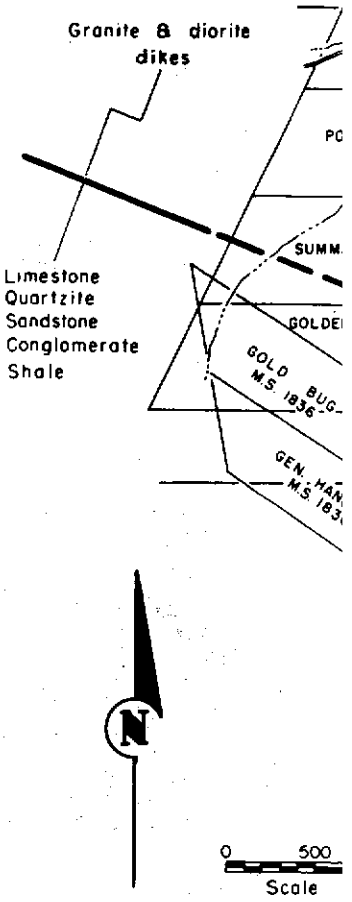

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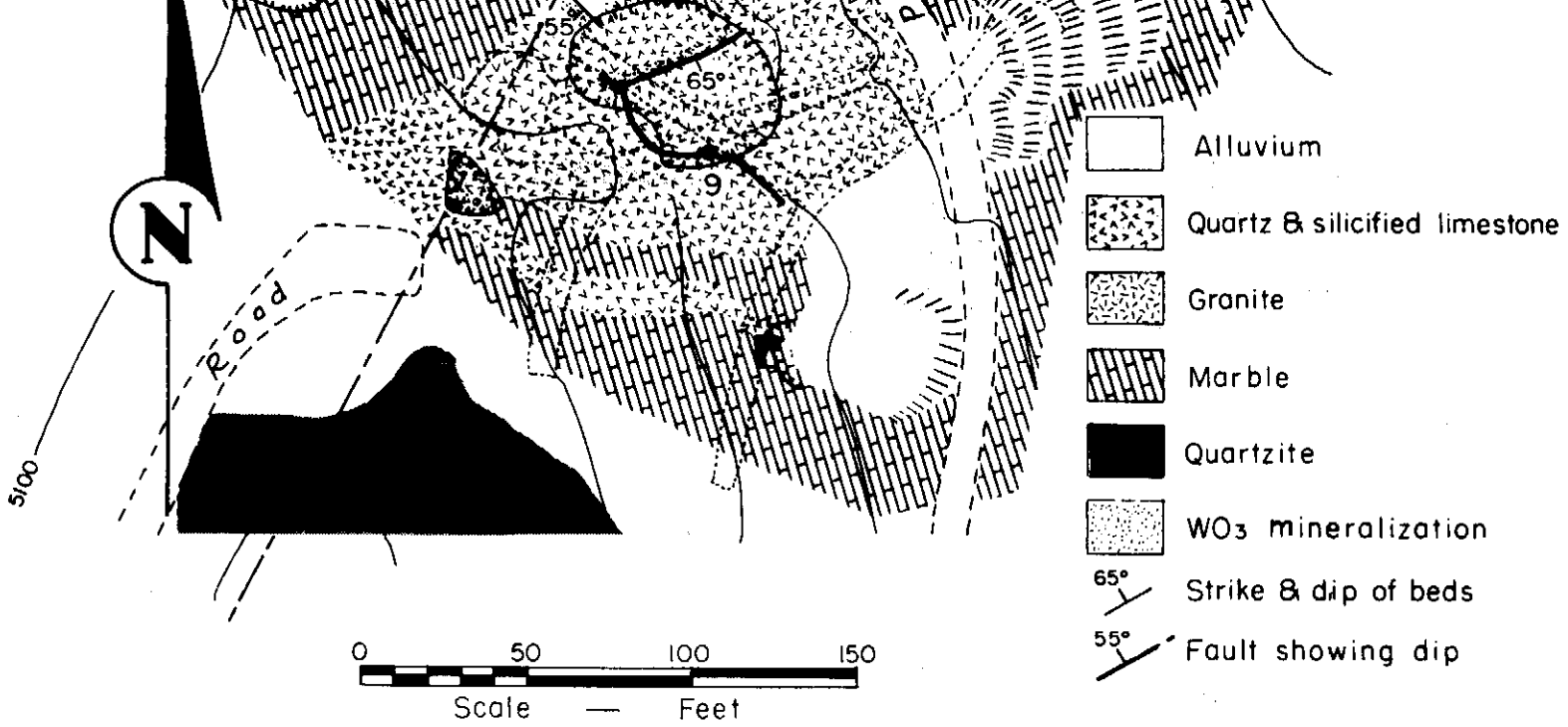


FIGURE 20. - Geological Map Showing Surface Contours, Diamond-drill Holes, and Workings on Pure Gold and Morning Star Claims, Pinal County, Ariz.

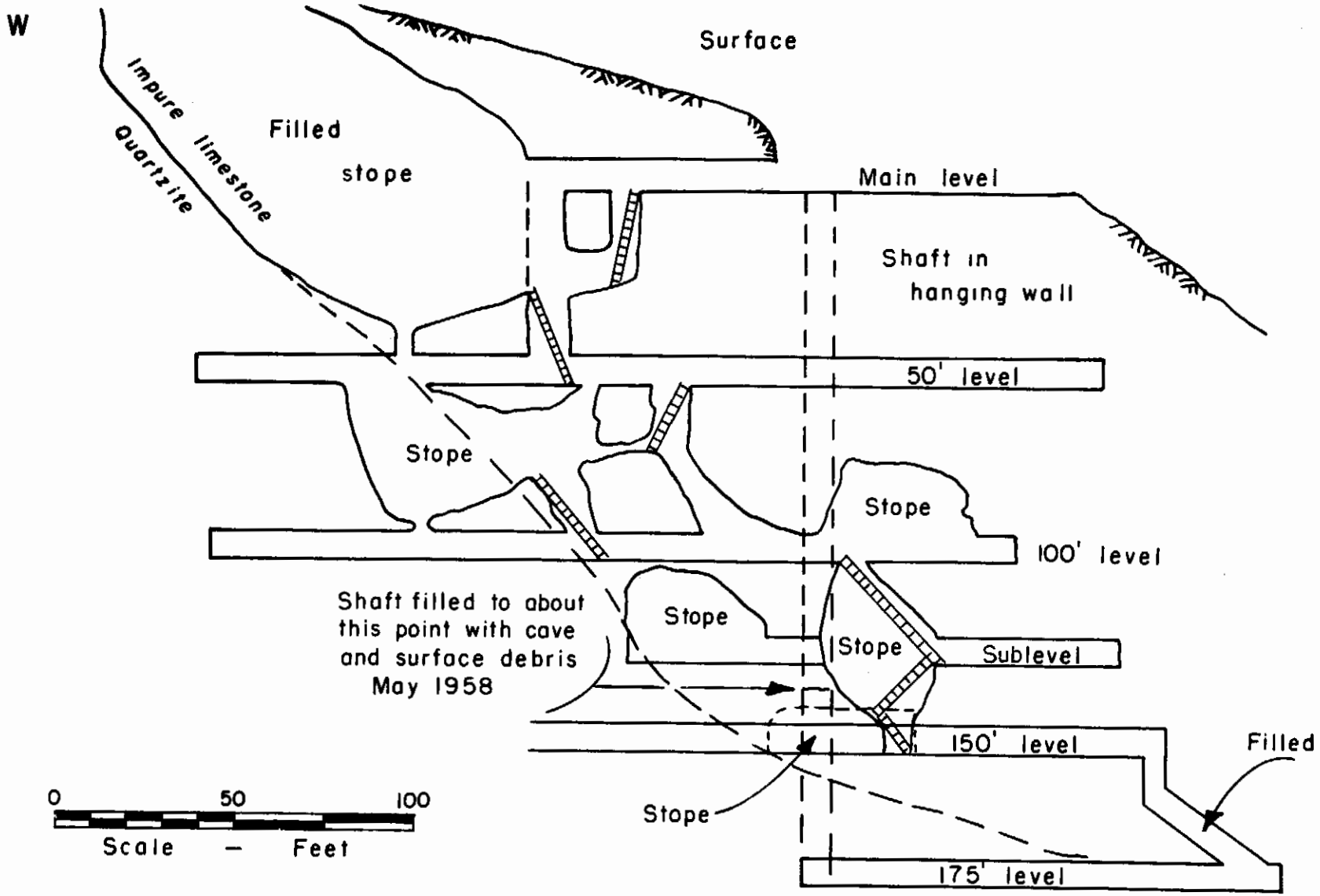


FIGURE 21. - Longitudinal Section in Plane of Vein Maudina Mine, Pinal County, Ariz.

These are the three principal workings on the property. In addition there are 95 opencuts, 28 shallow shafts, 11 adits, 5 winzes, and 6 raises.

The Maudina shaft is filled with surface debris and timber to about the 135-foot level; however, the 150-foot level is open and accessible through open stopes and raises from the surface. The Cody tunnel is caved at 600 feet, where it penetrates loose ground in the Mogul fault. The remainder of the workings generally is accessible, although the opencuts visited by the author contained considerable caved material. Eight diamond-drill holes have been put down on the Pure Gold claim and its extralateral extension.

The following geological information is quoted from a previous report.[20/]

> The principal geological feature of this area is the Mogul fault which trends north of west across the Santa Catalina Range and brings Paleozoic and pre-Cambrian sedimentary and metamorphic rocks on the south into contact with pre-Cambrian granite on the north. The general dip of this fault is from 30° to 60° S. The fault includes many planes of movement over a wide area; the principal zone of brecciation is about 50 feet thick where it is exposed at the Pure Gold workings.
>
> The Pure Gold ore body is localized in silicified breccia in the principal Mogul fault zone. The ore body appears to dip with the fault about 40° to 50° S. The ore zone ranges from 5 to 40 feet in width at the surface where it is exposed for a length of about 200 feet. It may continue under alluvium to the south and connect with a mineralized breccia exposed near the portal of the lower adit on the Morning Star property.
>
> The 120-foot adit barely reached the downward extension of the mineralized zone, 50 feet below the level of the open cut-----. Only a trace of scheelite appears under ultraviolet light in the face of the adit, and samples taken by B. R. Frisbie of the Reconstruction Finance Corporation contained only 0.14 and 0.05 percent of WO_3. The adit, however, does not penetrate the mineralized zone far enough to permit adequate sampling on this level.

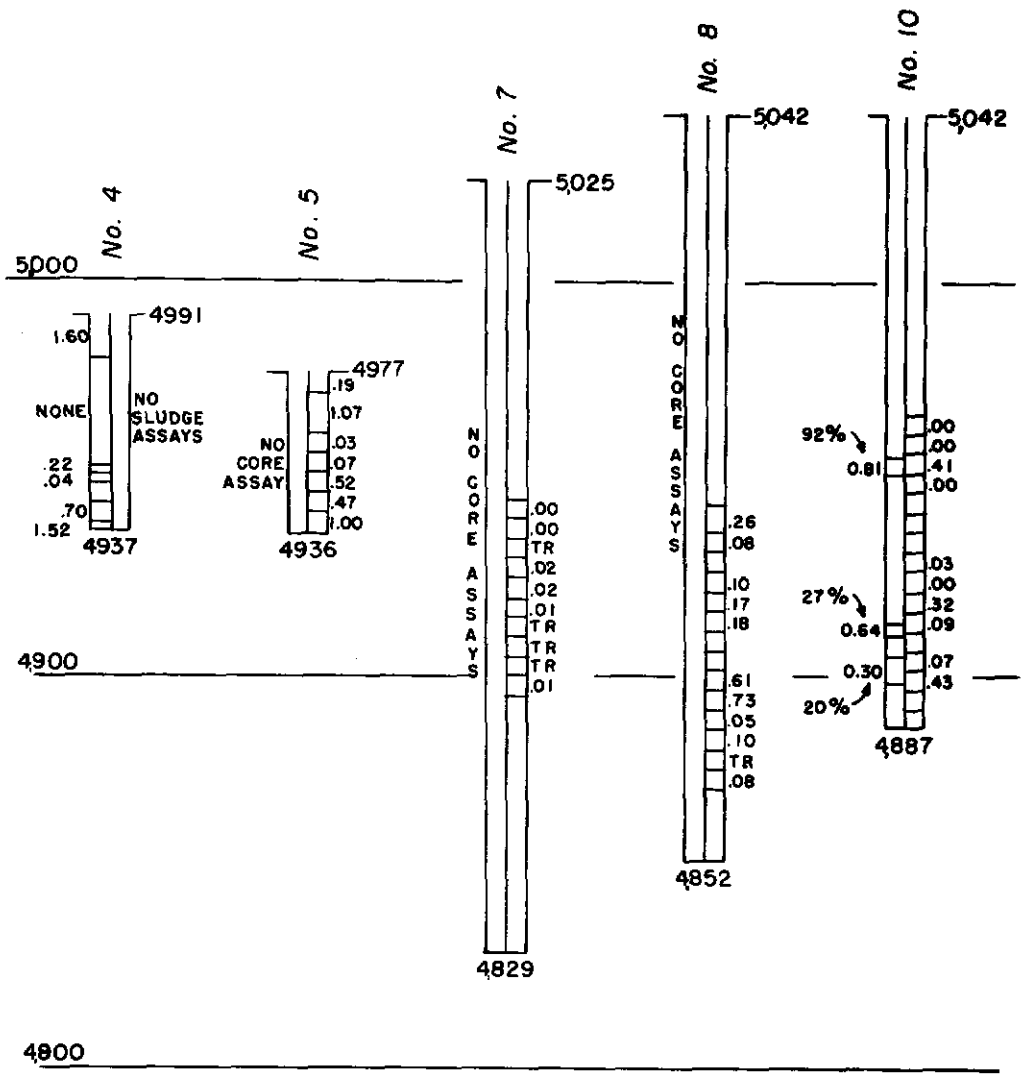
Both the Pure Gold and Morning Star tungsten deposits occur in Escabrosa limestone, which was identified by A. A. Stoyanow.[21/]

In 1944 the Morning Star Mining Co., which was mining on the extension of the Pure Gold vein on the Morning Star claim, brought an extralateral-rights suit against Molson. Extralateral rights were granted to the Pure Gold claim to the extent shown on figure 20.

20/ Maudina and Morning Star Tungsten Mines, Pinal County, Arizona: Geol. Survey Strategic Minerals Investigation, July 1944, 2 sheets.

21/ Ludden, R. W., Jr., Geology of the Campo Bonito Area, Oracle, Arizona: Univ. of Arizona (Tucson) M. S. Thesis, 1950, p. 49.

Six diamond-drill holes were put down on the Pure Gold claim and its extralateral extension some time during 1944, and some ore was found. Hole locations are shown on figures 20, 22, 23, and 24. In 1949 the Mount Lemmon Mining Co. drilled four additional holes and completed a sampling project. Pertinent information obtained from holes 3 and 6 is illustrated in figures 23 and 24, and the results of sampling by the Mt. Lemmon Mining Co. are shown on figure 25.



First number to left of section is core assay in percent WO3.
Second number to left is pecentage core recovery - 20% at 0.30.
Number to right of section is sludge assay.

FIGURE 22. - Drill-Hole Cross Section, Pure Gold Claim, Pinal County, Ariz.

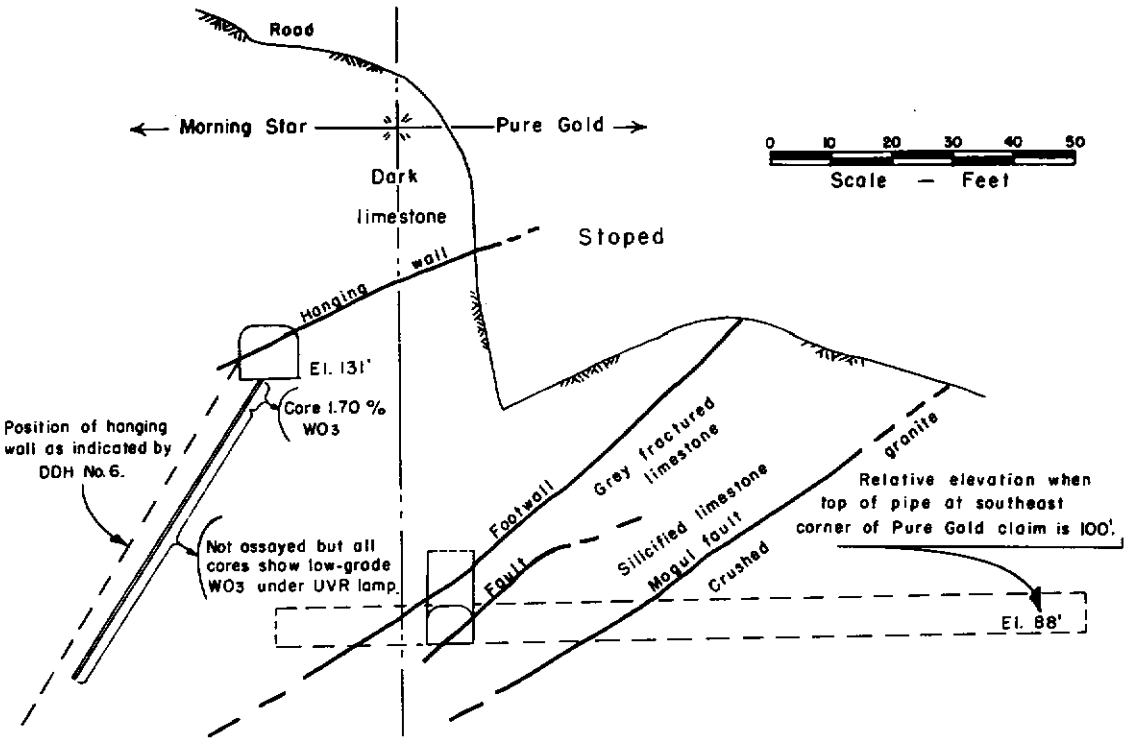


FIGURE 23. - Section Through Diamond-Drill Hole 3 at S. 36° W., Looking Northwest, Pure Gold Deposit, Pinal County, Ariz.

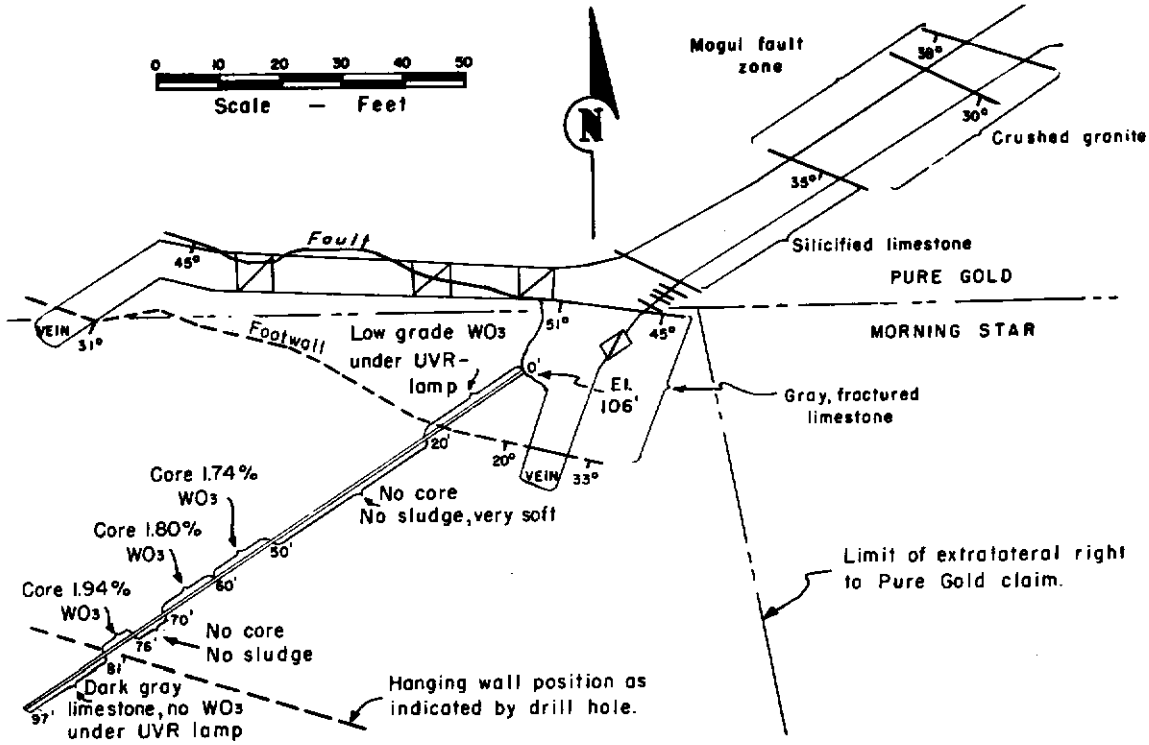
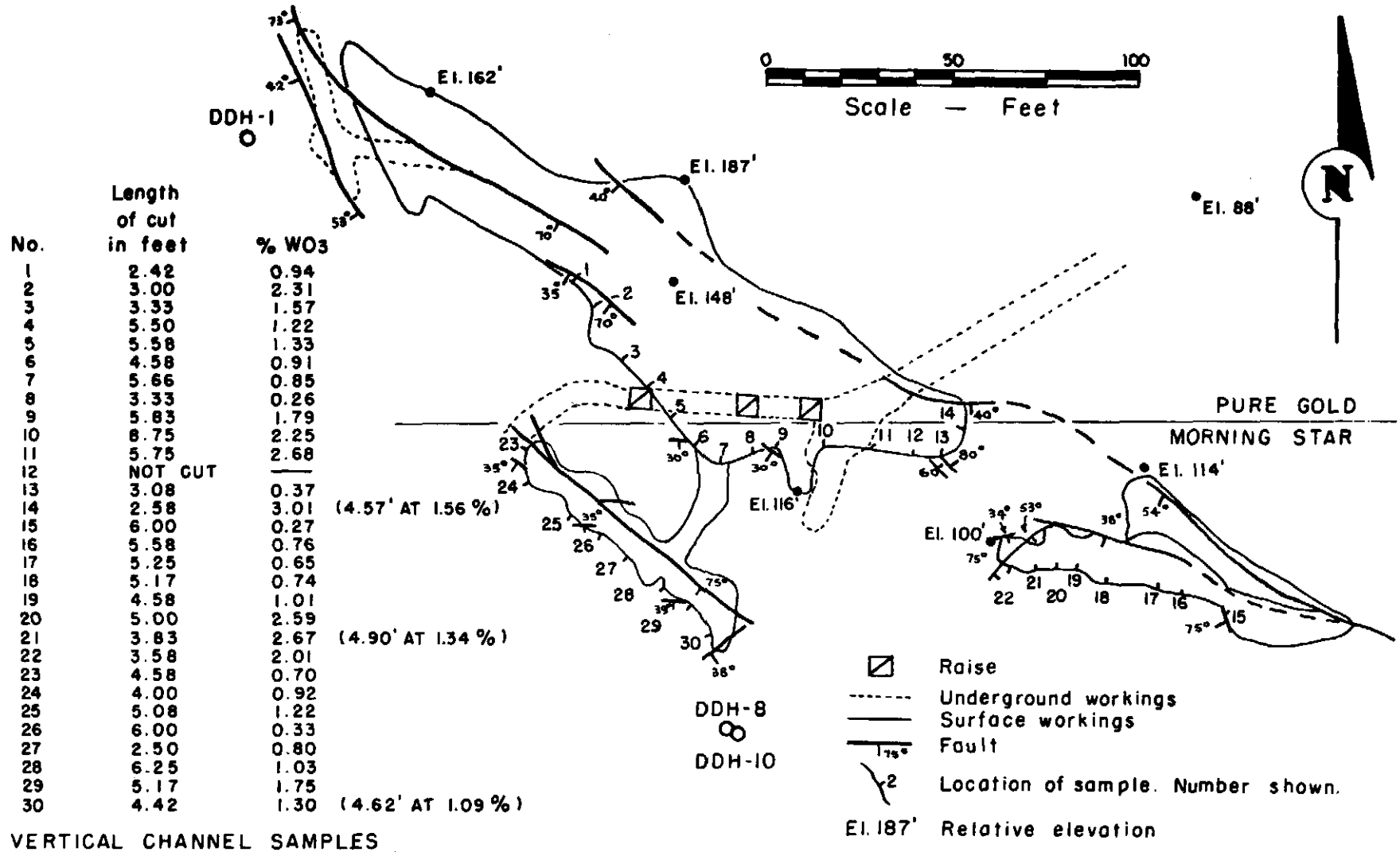


FIGURE 24. - Diamond-Drill Hole 6, Pure Gold Claim, Pinal County, Ariz.



No.	Length of cut in feet	% WO3	
1	2.42	0.94	
2	3.00	2.31	
3	3.33	1.57	
4	5.50	1.22	
5	5.58	1.33	
6	4.58	0.91	
7	5.66	0.85	
8	3.33	0.26	
9	5.83	1.79	
10	8.75	2.25	
11	5.75	2.68	
12	NOT CUT	—	
13	3.08	0.37	
14	2.58	3.01	(4.57' AT 1.56 %)
15	6.00	0.27	
16	5.58	0.76	
17	5.25	0.65	
18	5.17	0.74	
19	4.58	1.01	
20	5.00	2.59	
21	3.83	2.67	(4.90' AT 1.34 %)
22	3.58	2.01	
23	4.58	0.70	
24	4.00	0.92	
25	5.08	1.22	
26	6.00	0.33	
27	2.50	0.80	
28	6.25	1.03	
29	5.17	1.75	
30	4.42	1.30	(4.62' AT 1.09 %)

VERTICAL CHANNEL SAMPLES

FIGURE 25. - Assay Map of Workings on Pure Gold Claim, Pinal County, Ariz.

TABLE 5. - Diamond-drill-hole information

Hole No.	Dip and strike	Relative elevation,[1] feet	Collar elevation, feet	Depth of hole, feet	Elevation of bottom of hole, feet
1	Vertical.....	169	5,029	83	4,946
2	do.....	187	5,047	100	4,947
3	50°, S. 36° W.	131	4,991	57	4,944
4	Vertical.....	131	4,991	54	4,937
5	do.....	117	4,977	41	4,936
6	Horizontal, S.58° 30' W.	106	4,966	97	4,966
7	Vertical.....	165	5,025	196	4,829
8	do.....	182	5,042	190	4,852
9	do.....	177	5,037	255	4,782
10	do.....	182	5,042	155	4,887

1/ Elevation of top of pipe at southeast corner of Pure Gold claim arbitrarily set at 100 feet. Altitude of top of pipe is approximately 4,960 feet.

Figure 19 has been traced from a patent survey map. On it are the main workings and the trace of the Mogul fault across the property.

The Pure Gold workings are at an altitude of 5,000 feet.

The Maudina mine is about 1 mile southeast of Campo Bonito camp at an altitude of 4,976 feet. A tramway was constructed of 18-inch-gage track from the Maudina shaft to a mill on Bonito Creek (fig. 19). The following description of the geology and the ore deposit is from a previous report.[22]

> In this vicinity the prevailing rocks consist of eastward-dipping sandstone, quartzite, impure limestone and shale of the Apache group. Some 1,200 feet farther north is the Mogul fault which strikes west to northwest, dips steeply southward, and brings Apache and Paleozoic beds on the south in contact with pre-Cambrian granite on the north. Earlier than this fault are diorite-porphyry dikes of northward strike and eastward dip. Associated with them in the granite area are quartz veins in which scheelite has recently been found on claims held by E. J. Ewing. Other quartz veins in the granite strike west to northwest.
>
> The principal ore shoot of the Maudina mine was found in the southern portion of a vertical fault zone that strikes parallel to the Mogul fault. As shown by a 175-foot vertical shaft, an adit tunnel, and several hundred feet of drifts, this ore shoot plunged 45° E. and ranged from 4 to 15 feet in width by 50 or more feet in stope length. It has been largely stoped from its outcrop to the 175-foot level. The ore consists of scheelite veinlets and replacement masses, generally free of gangue but locally associated with

22/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, April 1941, pp. 32-33.

quartz. The veinlets range from a fraction of an inch to several inches in width, and the masses from about 1/4 inch to several inches in diameter; according to Mr. Ewing, one solid mass of scheelite weighing 90 pounds was mined. The best ore is reported to have occurred below the 100-foot level, in impure limestone beneath the sandstone and quartzite of the upper workings. Some lead carbonate and wulfenite are reported to have occurred in the upper 50 feet of this ore shoot and in its honeycombed, siliceous outcrop.

A few feet north of the main ore shoot on the 150-foot level, a body of scheelite ore approximately 20 feet long by 12 feet high and 4 feet wide was encountered. Its occurrence suggests the need for further exploration in this fault zone.

Two gold-quartz veins cross the Campo Bonito property in the vicinity of the Old Gold pit, and gold was found in the Cody tunnel, according to E. H. Molson.

Morning Star Claim

The Morning Star patented claim is in secs. 17-20, T. 10 S., R. 16 E., on the northeast slope of the Santa Catalina Mountains at an altitude of 5,000 feet. It lies at the north end of a group of 4 patented and 13 unpatented lode claims owned by the Y.M.C.A. of Tucson, Ariz. The claim may be reached by automobile from Oracle 5.5 miles to the southeast on the Mount Lemmon Road, 1.5 miles westward on the Campo Bonito Road, and 0.5 mile southward to the Morning Star workings (figs. 17 and 19).

The Morning Star claim was worked first in 1913 by E. J. Ewing, who produced about 335 units of WO_3. Some of the ore was relatively high grade.[23/] Production during World War I is unknown. Near the end of World War I, or shortly afterward, Mrs. Elizabeth Wood purchased the property. The Fortuna Mining Co. (Rivera Bros.) leased the property from April 1939 to August 30, 1943. Concentrates from a small mill, consisting of a set of rolls and two concentrating tables, were said to contain 65 to 75 percent WO_3 during this period. The Morning Star Mining Co. acquired the lease from the Fortuna Mining Co. August 30, 1943, and operated the property through 1944 into 1945. In 1949 Mrs. Wood deeded the property, as a memorial, to the Y.M.C.A., of Tucson, Ariz.

In 1951 the Nikas Mining Co. leased the claim. This company obtained a DMEA exploratory contract in July 1952, sank a 110-foot inclined shaft, and did 205 feet of drifting and 88 feet of crosscutting on the 100-foot level. The mine was shut down in July 1953 and subsequently subleased to several parties.

Total production from the property exceeded 6,000 units of WO_3.

23/ Work cited in footnote 22 (p. 60), p. 33.

Workings on the claim comprise a 65- by 45-foot opencut (glory hole) 12 to 50 feet deep, with a stope to the west; a haulage adit leading into the bottom of the cut; a shaft 110 feet deep on a 45° inclination, with 205 feet of drifts and 88 feet of crosscuts; two short adits; a 20-foot shaft; and several shallow pits (fig. 20). The inclined shaft was full of water when the author examined the property.

Tungsten ore from the Morning Star claim has come principally from the northeast corner of the property.

The following description is from a previous investigation.[24/]

> The principal geologic feature of this area is the Mogul fault which trends north of west across the Santa Catalina Range and brings Paleozoic and pre-Cambrian sedimentary and metamorphic rocks on the south into contact with pre-Cambrian granite on the north. The general dip of this fault is from 30° to 60° S. The fault includes many planes of movement over a wide area; the principal zone of brecciation is about 50 feet thick where it is exposed at the Pure Gold workings.
>
> Scheelite mineralization occurs in silicified zones in a small body of limestone just south of the main fault zone. The limestone is bordered by pink quartzite on all sides except the northeast where it is cut off by the fault. Although the contact between the limestone and the quartzite is nowhere exposed, it seems probable that parts of it are faulted, especially to the south. The limestone is fine-grained and locally dolomitic. In most places bedding is not recognizable, but on the ridge southwest of the Pure Gold workings traces of bedding appear to strike N. 20° W. and dip 75° E.
>
> All the ore produced was mined from a glory hole and some small stopes west of the glory hole.... Scheelite in the glory hole and stopes is erratically distributed in an irregular, elongate body of silicified limestone that trends northeast. Large crystals of scheelite are concentrated along two faults which strike at right angles to each other, cutting the silicified limestone.... The northwest-trending fault, along which some postmineral movement took place, offsets the southwest-trending fault about 10 feet. Under ultraviolet light, the ore along the fault appears in places to contain as much as 10 percent of WO_3 across widths of from 0.5 to 2.0 feet, although in most places the grade is not over 1 percent of WO_3. In the remainder of the silicified zone, scheelite is sparsely disseminated.
>
> A 5-foot layer of silicified limestone breccia near the portal of the lower adit also contains substantial amounts of scheelite so fine-grained that the WO_3 content is difficult to estimate

---

24/ Work cited in toofnote 20 (p. 56).

under ultraviolet light. This zone may be a continuation of the ore zone on the Pure Gold claims. The first 60 feet of the adit is also in silicified limestone that contains little scheelite.

Both the Pure Gold and Morning Star tungsten deposits occur in Escabrosa limestone, as identified by A. A. Stoyanow.[25/]

The exploratory project in which the Government assisted was successful. Figure 26 is an assay map of the inclined shaft workings.

Some diamond drilling has been done on the property. Figures 20 and 27 show the location and log of hole 9 on the Morning Star. The upper and lower adits on the claim are shown also on figure 20.

This is only one of several occurrences of scheelite in faulted and fractured zones along the Mogul fault. There is evidence that mineralization occurs at and near the intersections of northwest- and northeast-trending fractures.

On file at the Bureau of Mines Tucson (Ariz.) Laboratory is correspondence giving results of Bureau metallurgical tests on a tailing sample from the Rivera Bros. mill, which then consisted of a crusher, a 50-ton screen-discharge ball mill, and two concentrating tables. The chemical character of the sample follows:

	Assay, percent
Mn	0.15
Insol	91.9
SiO_2	85.8
Fe	1.4
CaO	2.3
S	.15
Al_2O_3	5.1
MgO	.6
WO_3	.42
Co	.01
Pb	.05
Zn	Nil

	Assay, ounce per ton
Au	Tr.
Ag	0.11

Examination of the tailings showed that 50 percent of the weight and 30 percent of the WO_3 occurred locked in plus-65-mesh sizes too coarse for flotation. Microscopic examination indicated that the scheelite grains from minus-48- to plus 200-mesh had quartz as inclusions. Some of the quartz grains within this size range were coated with scheelite, and to recover the scheelite it would be necessary to grind to minus-200-mesh.

25/ Work cited in footnote 21, p. 56.

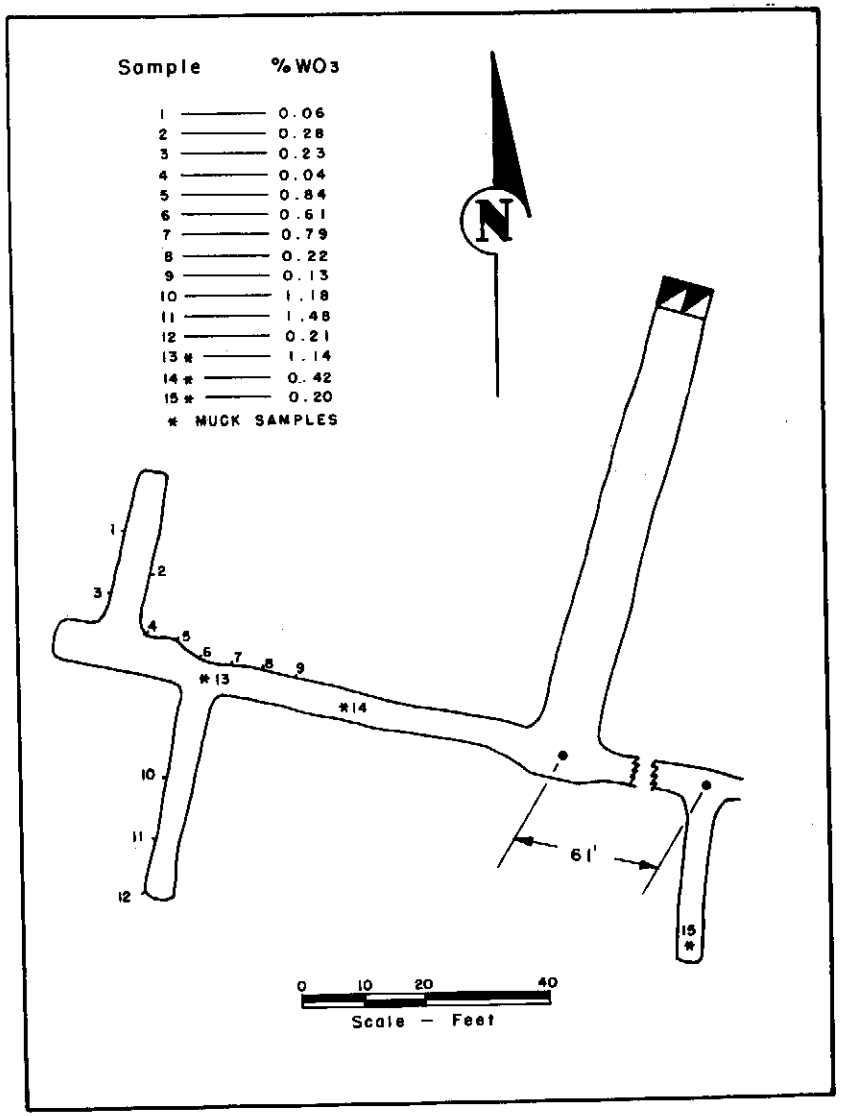


FIGURE 26. - Assay Map, 100-Foot Level, Morning Star Tungsten Mine, Pinal County, Ariz.

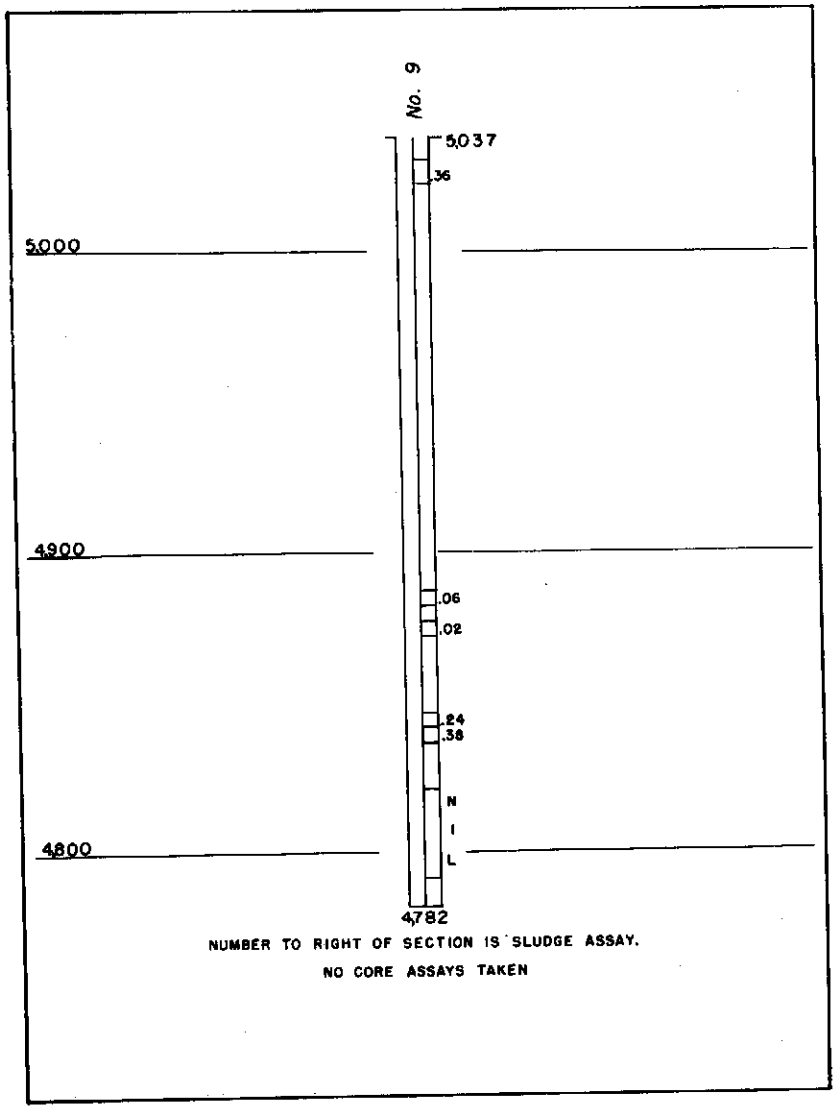


FIGURE 27. - Drill-Hole Cross Section, Morning Star Claim, Pinal County, Ariz.

By flotation of a minus-48-mesh fraction containing 64 percent of the weight and 75 percent of the tungsten, the following results were obtained: Based upon the fraction treated, 68.3 percent of the tungsten was recovered in a product assaying 10.5 percent WO_3, or 80.7 percent was recovered in a product assaying 4.53 percent WO_3. The latter product represents a recovery of approximately 60 percent of the tungsten content of the original tailings.

Six flotation tests were made of a minus-200-mesh fraction containing 31 percent of the weight and 62 percent of the tungsten. The concentrate assayed 5.34 to 21.35 percent WO_3. Recovery from the fraction treated ranged from 48 to 90 percent, and recovery from the original tailing sample ranged from 30 to 57 percent.

By flotation of the original tailing (all ground to minus-65-mesh) an overall recovery of 80 percent plus was obtained in a product assaying 5 to 10 percent WO_3.

The Rivera Bros. mill was estimated to have made a 75-percent recovery of the scheelite.

Graham County

Black Beauty Group

The Black Beauty group of three unpatented lode claims is in the SE1/4 sec. 35 and the SW1/4 sec. 36, T. 8 S., R. 22 E., near the southwest end of the Graham (Pinaleno) Mountains at an altitude of 5,150 feet. The property, from Bonito, is west on a graded road 5.7 miles to a trail that branches north, 2.6 miles on this trail to a windmill and corral, westerly on the old Cedar Spring to Camp Grant Road (shown on the Sierra Bonito Ranch quadrangle) 2.5 miles to a truck trail that branches northerly, and 0.5 mile on this trail to the workings (fig. 28).

This property was in possession of the Lee family for many years. It was located first in 1916 to prospect for gold and relocated later by Van Lee, son of the original locator. Robert G. Lee and Lee Bartlett located the property again August 5, 1946. W. L. Woodrow bought Bartlett's interest, and later Marvin Johnston purchased the R. G. Lee interest.

The only production was made by Johnston and Woodrow in 1955. From 4.5 tons of ore, 12 short-ton units of WO_3 was sold.

The workings on the claim consist of an opencut 12 feet wide by 15 feet deep by 50 feet long, two smaller cuts, a shaft of unknown depth, and a prospect trench about 150 feet long.

Precambrian schists are the host rocks for quartz veins that carry sporadic scheelite. The schists range from brown to gray; the brown contains much muscovite, and the gray has predominant biotite. The schist on the surface is about 1 mile wide and at least 4 miles long. The scheelite mineralization occurs near the eastern edge of the schist, where it contacts Precambrian granite.

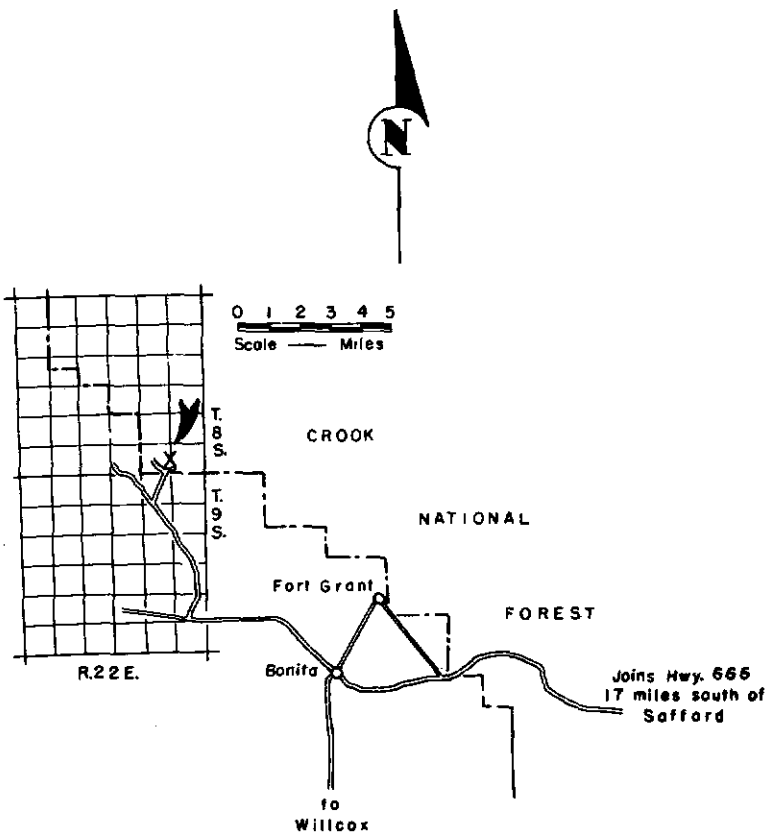


FIGURE 28. - Black Beauty Deposit, Graham County, Ariz.

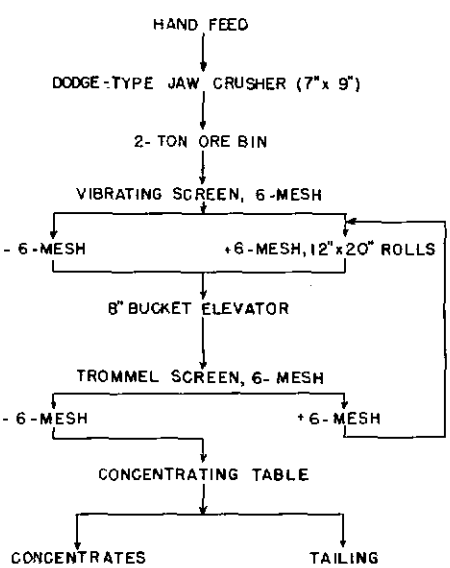


FIGURE 29. - Flowsheet, Black Beauty Mill, Graham County, Ariz.

Quartz veins with much tourmaline formed along fractures through the schist. These veins strike N. 53° E. and dip vertically; strike N. 80° E., dip 85° SE.; strike N. 40° W., dip 55° NE.; or strike east and dip flatly north. The schist strikes N. 50° to 55° E. and dips steeply southeast. The vein with the heaviest mineralization strikes N. 53° E. and is 3 to 4 feet wide. The scheelite is very sporadic but is abundant locally in masses up to 4 inches in cross section. On the west side of the opencut, mineralization extends for 20 feet horizontally. The scheelite occurs in schist to a minor extent, adjacent to the opencut. There is evidence that enrichment occurs at or near the northeast- and northwest-trending fractures. The quartz, in addition to tourmaline and scheelite, contains clays from altered feldspars, pyrite, and iron and manganese oxides. According to Woodrow the quartz also contains sparse, sporadic beryl and lithium minerals.

At the southwest corner of the opencut is a narrow dike of altered andesite. Lime has been deposited on the fractures through the andesite. This was the only formation observed to have any amount of lime.

The zone containing the scheelite is 25 feet wide, has been explored to a depth of 40 feet, and can be traced on the surface for at least 200 feet. According to Woodrow, the scheelite extends sporadically through the schist for 3 miles north of the opencut. There are irregular discontinuous veins of quartz over an area at least one-half mile wide, but the quartz carries no scheelite and, as a whole, is sparsely mineralized except at the eastern edge of the schist.

There was considerable equipment on the property when it was visited. In addition to the equipment shown on the mill flowsheet (fig. 29) the following equipment was noted: A 37.5-kw. generator, powered by a 6-cylinder diesel engine; a feeder belt, 8 inches wide with an electromagnetic pulley; a 7.5-kw. pulley; a 7.5-kw. generator, powered by a gasoline engine; a 2-cell Pan American jig, 42 by 42 inches; a horizontal Gardner compressor, 7 by 6 inches and a 10- by 6-foot-diameter water tank.

APPENDIX

Assay Log

Sample No.	Mine	Location	Length of cut, feet	WO_3 percent
12988	Jack Pot..... (Quartzsite tungsten mine).	Sec. 27, T. 5 N., R. 20 W.	6.0	0.25
12989	do.	do.	5.4	.25
12990	do.	do.	3.0	.24
12991	do.	do.	5.0	.04
12992	do.	do.	6.0	.01
12987	Darling.....	Sec. 33, T. 5 N., R. 20 W.	(1/)	.23
12986	White Dike..... (Livingstone property).	Sec. 36, T. 3 N., R. 18 W.	(1/)	.01
12993	Three Musketeers.....	Secs. 24, 25, T. 6 N., R. 15 W.	16.5	.67
12994	do.	do.	30.0	.15
12995	do.	do.	7.4	.01
12996	do.	do.	7.0	.01
12997	do.	do.	(1/)	.04
12998	do.	do.	5.0	.03
12999	do.	do.	17.0	.29
12864	Rainbow.....	Sec. 12, T. 1 S., R. 13 E.	(1/)	.08
12865	do.	do.	(1/)	.25
12866	do.	do.	(1/)	.06

1/ Grab sample.

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