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TUNGSTEN DEPOSITS OF GILA, YAVAPAI, AND MOHAVE COUNTIES, ARIZ.

By V. B. Dale

DEPARTMENT MINERAL RESOURCES
MINERAL BUILDING
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BUREAU OF MINES
1961

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TUNGSTEN DEPOSITS OF GILA, YAVAPAI, AND MOHAVE COUNTIES, ARIZ.[1/]

by

V. B. Dale[2/]

INTRODUCTION AND SUMMARY

This report is one of a series covering the mineral resources of the Nation. It briefly describes most of the known tungsten deposits in Gila, Yavapai, and Mohave Counties, Ariz. Many of the descriptions are taken from the reports of previous examinations by Bureau of Mines engineers, and from Defense Minerals Exploration Administration files. Where a previous examination had been made, and an inquiry disclosed that little or no work had been done since that time, pertinent information from the report was used in this paper with acknowledgment of the source. However, the majority of the descriptions is from field examinations by the author.

In the past 3 years (July 1956-May 1959) only necessary annual assessment work was conducted on nearly all the properties described in this paper. There was no active mining on any of the properties examined.

Production figures are given for each deposit, where known, and for each county. Ore reserve estimates are made for the individual counties. The reader should bear in mind that most of the deposits are raw prospects and that virtually all ores were removed as they were encountered. At only three properties has there been any development work; most of the properties contained only shallow surface diggings.

Tungsten mineralization was very sporadic and discontinuous in all deposits that were examined. Conventional sampling methods, other than bulk mining, often are unreliable; hence, very few samples were taken.

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

1/ Work on manuscript completed May 1959.
2/ Former Bureau of Mines mining engineer, Tucson, Ariz.

Search for new occurrences of tungsten minerals was greatly stimulated in this area by the Government purchasing program announced on 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. By the end of August 1957, the price had dropped to $12.75 per short ton unit, duty extra.[4]

The word "ore" as used throughout this manuscript includes tungsten-bearing material too low in grade for exploitation except at very high prices. A look at the erratic price history will show why it is difficult to classify tungsten-bearing material.

Field work for this report was done from July 1958 to May 1959.

ACKNOWLEDGMENTS

The author acknowledges the willing cooperation of owners and operators in collecting information for this report concerning their properties. Histories of the various deposits were secured partly from present owners and previous operators, partly from previous publications, and partly from unpublished reports of mine investigations in the files at the Bureau of Mines Southwest Experiment Station in Tucson. Acknowledgment is due the Arizona State Department of Mineral Resources for help in locating many of the deposits, and to the Arizona Bureau of Mines for much geological data. Information was also secured from Defense Minerals Exploration Administration files. Permission to publish that information was obtained from the mine owners and others concerned.

DESCRIPTION OF DEPOSITS

Gila County

Tungsten ore mining in Gila County probably began about 1917 in the Pinto Creek vicinity. In 1928, E. C. O'Brien & Co. erected a small mill at Globe, Ariz., to treat tungsten ores of the region. In 1929 Frank Samsel started the construction of a small mill.

Tungsten has been found in the Pinal and Mazatzal Ranges, and in the Sierra Ancha, at altitudes ranging from 3,200 feet to 6,800 feet. The deposits all lie in typical southwestern desert mountains. The claims in the Mazatzal Range and the Sierra Ancha contain sufficient timber for mining activities. With one or perhaps two exceptions, roads to the properties may be classed as mountain trails. The trails are winding, rough, and steep, and sometimes are impassable during the rainy season in July and August. There is a scarcity of water at most of the Gila County deposits.

3/ A short ton unit equals 20 lb. of tungsten trioxide (WO_3) and contains 15.862 lb. of tungsten (W). A short ton of 60 pct. WO_3 (standard-grade concentrate) contains 951.72 lb. of tungsten.

4/ The import duty is $7.93 per short ton unit (May 1959).

Occurrences of tungsten minerals, both scheelite and wolframite, are about equally divided between granitic and metamorphic formations. The minerals are very sporadic, and the ore occurs generally in small pockets and lenses which usually are related to structure.

Accurate production records for Gila County are not available. The author believes that no more than 500 short ton units of tungsten trioxide have been produced. The only recorded production from the county between 1951 and 1956 was 28 units which came from the Mazatzal Range during 1953 and 1954.

Measurable ore reserves are nil. It is extremely difficult to estimate ore reserves of tungsten deposits because of the unreliability of conventional sampling methods. A few high-grade pockets will probably be found in the future, but past production records indicate that production from this source will be small. Indicated and inferred reserves in Gila County are about 5,000 tons at an estimated grade of 0.5 percent tungsten trioxide (WO_3).

Pinal Mountains

Bobtail Group (Mariana Mine)

The Bobtail group of 15 unpatented lode claims, sometimes called the Mariana mine, is in secs. 12 and 13, R. 14 E., and sec. 7, R. 15 E., T. 2 S., on the south side of the Pinal Mountains in the Tonto National Forest at an average altitude of 5,000 feet. Road directions to the property are as follows: In Globe from the southeast end of Broad Street turn southerly on Ice House Canyon road for 1.0 mile to the junction of Ice House Canyon and Six Shooter Canyon roads; turn right on Ice House Canyon road for 1.7 miles to the end of the blacktop; turn sharply right for 2.8 miles to the Miami road junction; keep left 5.3 miles to the junction of the Signal Peak and Madera Peak roads; keep left on the Signal Peak road for 0.3 mile to a truck trail that branches southerly, or to the right; follow this trail 2.6 miles to the Bobtail shaft in the Mineral Creek drainage (fig. 1).

This property was visited on July 8, 1958. No work had been done, and all equipment had been removed. The claims are owned by T. S. Armstrong, Marion Armstrong, and Marion Moon, all of Pensylvania, and Mrs. Grace Finley of Globe, Ariz.

The present underground workings on the Bobtail and Tungsten veins were known as the Mariana mine when examined by the Bureau of Mines in 1945. The report of that examination states:

> The property was located about 1898. J. F. Lund of Globe, Arizona, was interested in the property during this early period and the present shaft is believed to have been sunk at that time. Litigation closed the property in 1904. About 1926 the Rosengartens of New York acquired a clear title to the property and did considerable work. Fifty men were employed at one time. A road was built and a post office established at Doak. The shaft was retimbered,

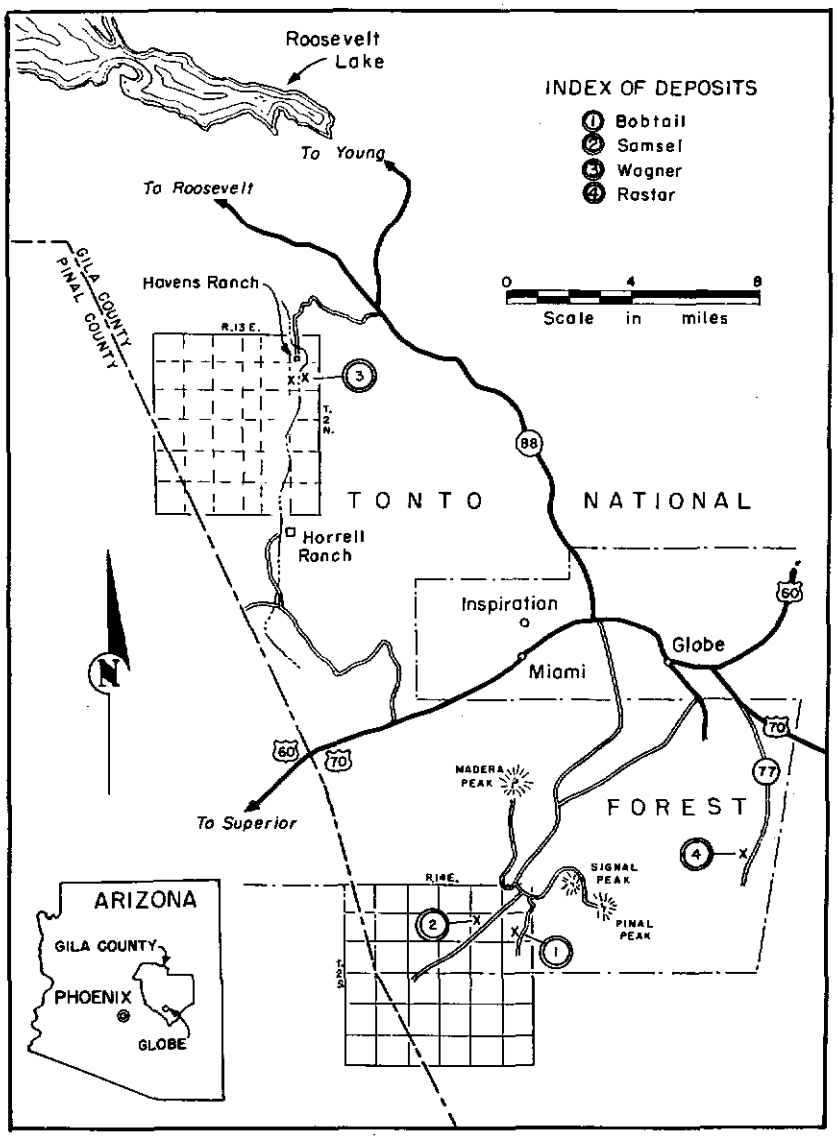


FIGURE 1. - Location Map, Tungsten Deposits in Globe Area, Gila County, Ariz.

an 800-foot water tunnel driven, and a 20,000 gallon storage tank for a mill was installed.

According to a report by John H. Slate, mining engineer of New York, dated November 15, 1929, ore shipments were made which averaged 0.44 ounces per ton gold, 25.6 ounces per ton silver, and 7.51 percent copper. The tonnage is not stated. He estimates the ore reserve at 60,000 tons - 25 percent shipping ore and 75 percent milling ore.

The depression of 1929 stopped all work. Some years later the present owner (T. S. Armstrong) got the property by acquiring all the outstanding stock. A caretaker was placed in charge of the mine, but little or no work was done until the recent lessees started operations.

Old smelter settlement sheets indicate that about 285 tons of ore containing 2.8 percent copper, 0.11 ounce gold, and 12.06 ounces silver per ton was shipped from the property between December 1940 and May 1945. Numerous lessees kept the grade of ore high by selective mining and hand sorting. No tungsten production is known to have been recorded. Little work is believed to have been done from 1945 to 1957 when the claims were leased to Tulsa Minerals Corp., whose activities were confined mainly to prospecting, surveying and mapping, and sampling.

Workings on the property consist of a 218-foot shaft with short drifts on the 20, 50, 60, 100, and 200 levels, an inclined shaft said to be 75 feet

deep, an adit 235 feet long with a 40-foot winze, a water tunnel said to be 800 feet long, several shallow pits and open cuts, and two short adits.

The Bobtail vein (fig. 2) carries little or no tungsten value. The Tungsten vein (fig. 2) contains sparse tungsten minerals as huebnerite and minor scheelite associated with chalcopyrite and pyrite, galena, sphalerite, gold, and silver in a quartz gangue. The veins are conformable with Pinal schist in the area, strike from N. 30° to 55° E., and dip from 37° to 62° NW. Granite, diorite, and diabase intrude the schist and have caused variations in the strike and dip of the planes of schistosity.

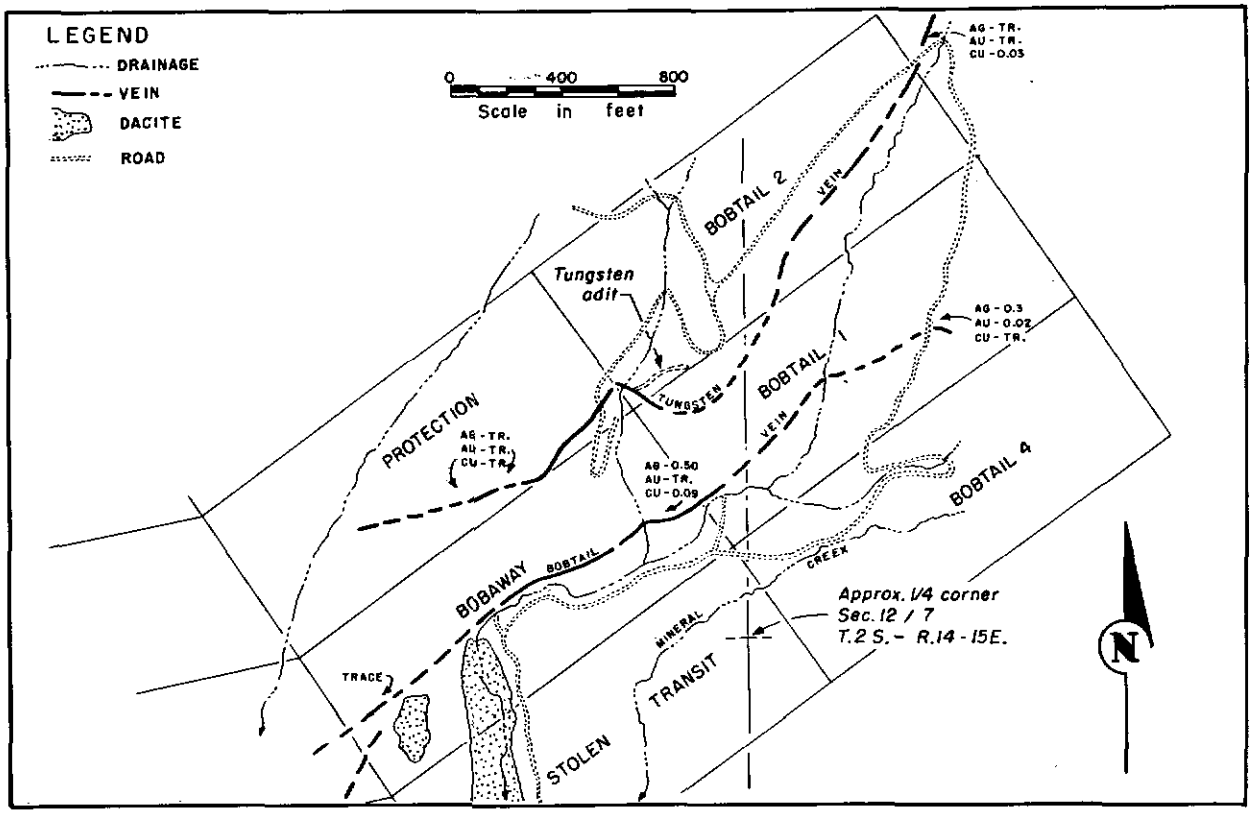
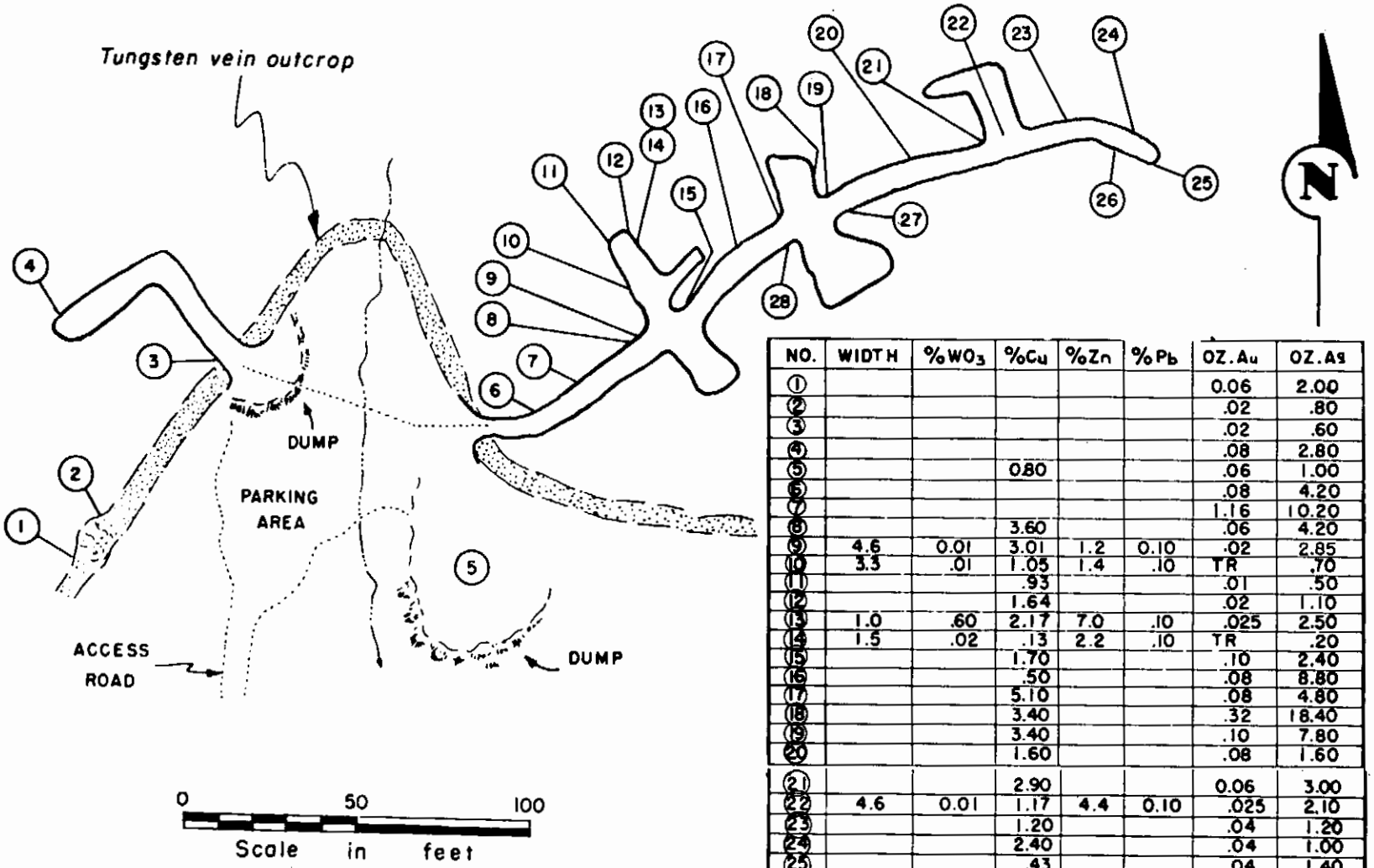


FIGURE 2. - Geologic Map, Bobtail Prospect, Gila County, Ariz.

Figure 3 is an assay map of the Tungsten tunnel furnished by the Tulsa Minerals Corp.

In the files of the Defense Minerals Exploration Administration, the following is stated:

> The sulphide lenses in the Tungsten tunnel range from a knife-edge to locally one foot in thickness. The lenses branch, pinch and swell, and are generally erratic and nonpersistent in continuity. In places the sulphide lenses pinch out completely and have only a sparse showing of the oxides; or, the vein is simply a mineralized zone containing oxides and some disseminated



NO.	WIDTH	%WO_3	%Cu	%Zn	%Pb	OZ. Au	OZ. Ag
1						0.06	2.00
2						.02	.80
3						.02	.60
4						.08	2.80
5			0.80			.06	1.00
6						.08	4.20
7						1.16	10.20
8			3.60			.06	4.20
9	4.6	0.01	3.01	1.2	0.10	.02	2.85
10	3.3	.01	1.05	1.4	.10	TR	.70
11			.93			.01	.50
12			1.64			.02	1.10
13	1.0	.60	2.17	7.0	.10	.025	2.50
14	1.5	.02	.13	2.2	.10	TR	.20
15			1.70			.10	2.40
16			.50			.08	8.80
17			5.10			.08	4.80
18			3.40			.32	18.40
19			3.40			.10	7.80
20			1.60			.08	1.60
21			2.90			0.06	3.00
22	4.6	0.01	1.17	4.4	0.10	.025	2.10
23			1.20			.04	1.20
24			2.40			.04	1.00
25			.43			.04	1.40
26			.80			.02	.80
27			7.40			.08	11.40
28			6.72			.02	3.40

FIGURE 3. - Assay Map, Tungsten Tunnel, Bobtail Group.

pyrite. Also, in places, several thin, widely spaced sulphide lenses and stringers occur in a zone ranging from 5 to 6 feet from floor to back. In the short southwest drift off the incline 70 feet west of the Tungsten tunnel, thin stringers of chalcopyrite and pyrite less than an inch thick occur in a quartz gangue along with oxides. Dip-wise the sulphide lenses in the winzes of the Tungsten tunnel were no better looking than exposed in the drift. The bottom faces of the winzes were not accessible to inspection either because they were under water or were muck-filled.

Samsel Mine

The Samsel mine today comprises 16 unpatented lode claims in sec. 11, T. 2 S., R. 14 E., on the south side of the Pinal Mountains in Tonto National Forest at an average altitude of about 4,800 feet. To reach the property by road from Globe, continue 1.0 mile from the junction at Broad Street and Ice House road to the Junction at Ice House and Six Shooter roads, turn right on Ice House road for 1.7 miles to the end of the blacktop, turn sharply right for 5.3 miles to the junction of the Signal Peak and Madera Peak roads, then turn left on the Signal Peak road for 0.1 mile to the Government Springs road. Follow this road 1.9 miles to the Samsel mine, turn to the right and continue 0.3 mile to the campsite (fig. 1). The mine, as well as the road, is shown on the Geological Survey topographical quadrangle (7.5 minute series) of Pinal Ranch, Ariz.

This property was visited on July 9, 1958, at which time no work was in operation. Only a cursory examination was made. The property is owned by Henry E. Huffman of Globe, Ariz.

Workings on the claims consist of a 300-foot adit with a 25-foot crosscut in the end, a caved underhand stope from the surface 60 feet long by a reported 20 feet deep, a shaft about 25 feet deep, and several short adits and shallow opencuts and pits.

Wilson examined the claims in 1940 and his report[5/] states:

> This ground was located for gold, silver, and lead deposits many years ago. Intermittent work has been done on its tungsten deposits since about 1924, and several tons of concentrates have been produced. Equipment includes a 600-foot aerial tram and a small gravity mill. Water is obtained from a spring and a shallow well.
>
> This part of the Pinal Mountains has been carved into steep-sided, southwestward draining canyons tributary to Mineral Creek. Pre-Cambrian Pinal schist, intruded on the northwest by Madera diorite and granodiorite, is the prevailing formation.

5/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, pp. 28-29.

The principal vein occurs in a fissure that strikes N. 25° to 30° E., dips about 80° NW., and is traceable for some 3,000 feet. It has been complexly faulted and cuts metamorphosed sericitic schist that strikes and dips about parallel to the vein. The vein filling consists of granular, glassy, grayish-white quartz, ranging from a thin seam to 4 or 5 feet in thickness, in which tungsten occurs as rather small particles of wolframite. Other minerals in the quartz include pyrite, galena, and gold and silver in unidentified form. Oxidized iron and lead minerals are locally prominent in the outcrops. This vein has been stoped for a length of 60 feet by a depth of 20 feet from the surface.

Early in 1940 the Pinal Tungsten Mines, Inc., completed a 280-foot adit designed to cut the principal vein at a point northeast of the stope and some distance below the surface workings. This adit penetrates some thin bodies of pyritic molybdenite and terminates at a fault that strikes N. 50° E. and dips 65° to 75° NW.

Since Wilson examined the property, a crosscut has been driven from the adit about 25 feet southwest along this fault. Little else has been done to change the picture.

Rastar Claims

The Rastar group of 12 unpatented lode claims is in secs. 31 and 32, T. 1 S., R. 16 E., unsurveyed, in the northeast corner of the Pinal Mountains at an approximate altitude of 4,500 feet. The property is accessible from Globe as follows: From the intersection of U.S. Highways Nos. 60 and 70 in east Globe, continue 4.6 miles southeasterly on U.S. Highway No. 70 to State Route 77; turn right or southerly on Route 77 for 5.7 miles to a dim trail leading westerly; follow this trail 0.6 mile to an inclined shaft on Rastar No. 2 claim (fig. 1). The property was idle when visited in July 1958. R. M. Grantham of Globe was the owner.

The claims were located on July 31, 1953, by Grantham. Some old workings on the property were dug on gold or silver showings. The workings consist of a 45-foot inclined shaft, an inaccessible vertical shaft of unknown depth, four diamond-drill holes, each reported to be 100 feet deep, and a few shallow pits and opencuts.

Very fine, sparse, sporadic scheelite occurs in a fault zone 4 to 12 inches wide. The scheelite fluoresces blue. The fault appears to be a contact between Pinal schist and a highly altered rock, probably Madera diorite. It strikes S. 60° E. and dips 40° NE., while the schistosity strikes about N. 45° E. and dips steeply southeast.

Within the schist are small granitic intrusions with considerable quartz striking generally with the schistosity. The quartz carries sporadic pyrite, epidote, hematite, and chlorite, but appears to have no connection with the tungsten mineralization. The sparse scheelite in general occurs

within 2 inches of the fault. Although the outcrops are covered, scheelite float can be traced along the strike for about 100 feet, and outcrops 125 feet east from the inclined shaft show sparse scheelite.

It is doubtful if hand-picked ore will exceed 1 percent WO_3.

Other Deposits

Tungsten minerals are reported to occur also on other properties in the vicinity of the Bobtail group and the Samsel mine, but little ore has been produced.

Pinto Creek Region

Wagner Group

The Wagner group of 14 unpatented lode claims was in secs. 11 and 12, T. 2 N., R. 13 E., along lower Pinto Creek in the Tonto National Forest at an altitude of about 3,200 feet. This property was visited on July 11, 1958, at which time the claims had reverted to the public domain.

These workings may be reached by traveling down the bed of Pinto Creek for a distance of 6.1 miles below the Horrell ranch. This route can be traversed only by trucks and jeeps. A better road has been built from the Globe-Young highway. From the junction of the Young and Roosevelt roads on State Route 88 continue 0.4 mile southeasterly to a trail that branches westerly, then turn westerly into Blevins Wash and southerly into Pinto Creek, a distance of 5.8 miles to the Henry Havens ranch (fig. 1). The workings on the Red Bird claims (fig. 4) are about 0.5 mile by trail southwest of Havens' house.

The claims were located by V. E. Wagner in 1938. He held them until 1943, when they were sold to J. A. Keeter. Keeter held the claims until 1955. I. D. Budd leased the property in 1950, built a road into Pinto Creek, and mined on a small scale until his death in 1952. His production is not known. Investigators estimated that approximately 10 tons of ore carrying not more than 3 percent WO_3 has been produced from the property. Wagner shipped 4,800 pounds of hand-sorted ore from which 96 pounds of concentrate that assayed 55 percent WO_3 was produced.

Workings on the property consist of several shallow opencuts and pits, and three short adits, each less than 50 feet long.

Sparse, very sporadic wolframite with small amounts of scheelite occurs in quartz veins which cut a coarse-grained granite. Wilson examined this occurrence in 1940. His report[6] states:

> Here, Pinto Creek, a northward-flowing tributary of Salt River, has carved a canyon several hundred feet deep through

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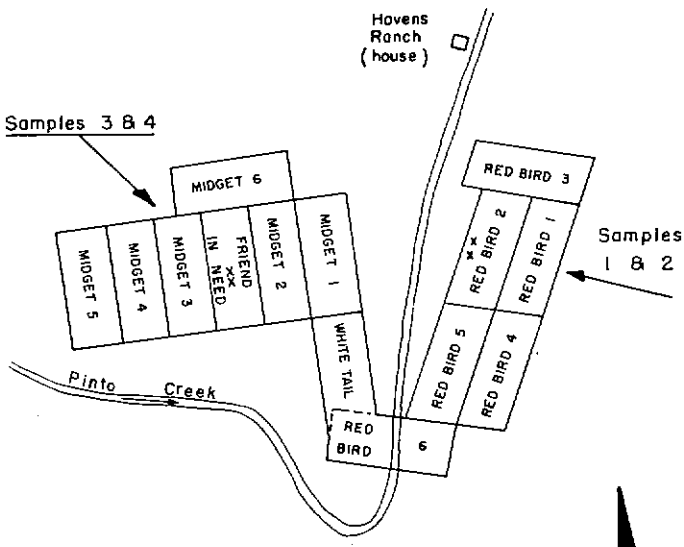
6/ Work cited in footnote 5 (p. 7), p. 30.



No.	Length of cut in inches	% WO3
1	6" at the top of adit 12" at bottom of adit	0.26
2	Hand-sorted ore	5.04
3	24"	.01
4	51"	.32

FIGURE 4. - Claim Map, Wagner Tungsten Prospect, Gila County, Ariz.

pre-Cambrian Apache beds and into underlying coarse-grained granite.

This granite has undergone considerable fissuring and sheeting of northwestward trend. Some of these structures contain pegmatite and aplite dikes, and others are occupied by quartz veins. Along the vein walls it shows alteration to sericite.

This area contains numerous quartz veins of prevailing N. 25° to 45° W. strike and vertical to steep northeast dip. They commonly range from a thin seam to 12 inches, and exceptionally to 32 inches in width. Their filling consists essentially of coarse-grained, glassy, grayish-white quartz with locally abundant tourmaline, scattered particles of wolframite and scheelite, and grains of pyrite. Some of the outcrops show considerable iron oxide.

On the east side of the canyon and a few hundred feet above Pinto Creek, shallow pits or short adits have opened six veins, all generally less than a foot wide. About 1/2 mile farther southwest, on the west side of the canyon, a short tunnel has been driven on a vein 2 to 2-1/2 feet wide. It shows rather abundant wolframite in places adjacent to the walls.

During an examination by the Bureau of Mines in 1942 an outcrop 51 inches wide was sampled on the Friend in Need claim. Twenty-five feet east on this outcrop the vein was only 14 inches wide. See figure 4 for sample locations and assays.

Other Deposits

Tungsten minerals occur in the upper drainage of Pinto Creek along the boundary of Pinal and Gila Counties. One of the occurrences is discussed in a previous work.[7] Tungsten minerals also have been reported 4 miles northwest

7/ Dale, V. B., Tungsten Deposits of Yuma, Maricopa, Pinal, and Graham Counties, Ariz.: Bureau of Mines Rept. of Investigations 5516, 1959, 68 pp.

of Louis Horrell's ranch. No ore has been produced from any of these minor occurrences.

Mazatzal Mountains

El Oso Group

El Oso group of 17 unpatented lode claims is near the crest of the Mazatzal Mountains in secs. 24 and 25, R. 9 E., and sec. 30, R. 10 E., T. 5 N., unsurveyed, at an altitude of about 6,000 feet. The property is accessible from the Globe-Payson road. Continue 13.6 miles northerly from Roosevelt dam up Tonto Creek, then turn left, or northwesterly, on a mountain trail for 11.5 miles to El Oso camp (fig. 5). The claims were not being worked when visited on July 22, 1958. The principal owner was Marvin Harrison of Fresno, Calif.

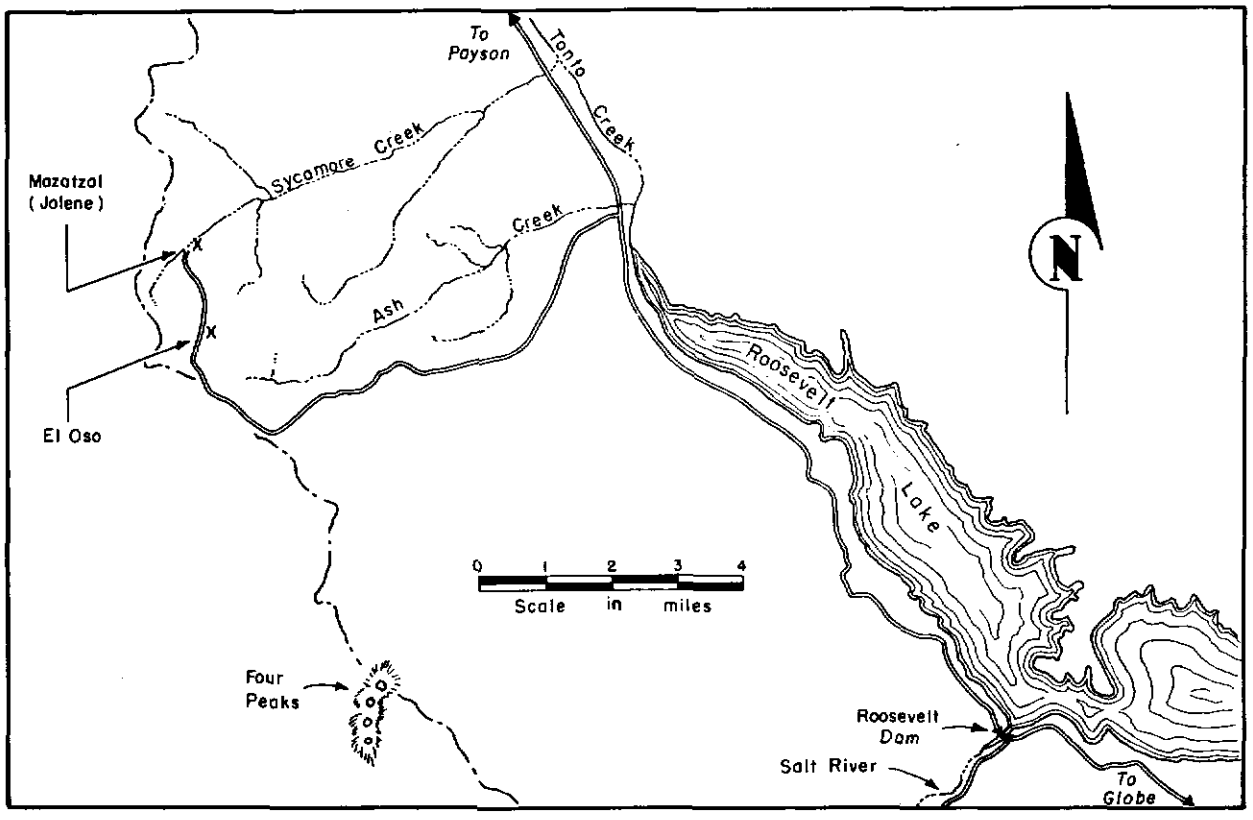


FIGURE 5. - Location Map, Mazatzal Tungsten District, Gila County, Ariz.

The claims were located first in May 1941 by E. R., P. J., and H. G. Harrison, and Bern Swensk, all of Payson. In 1942 a Reconstruction Finance Corporation loan of $20,000 was expended for exploration of the deposit. By July 1951, P. J. and H. G. Harrison were owners, and in 1957 Marvin Harrison became principal owner.

The only record of production is that made by Olin Berry, a lessee, in 1953 and 1954. A total of 24 units of tungsten trioxide was produced. Other production not recorded could have consisted of no more than a few tons of hand-sorted ore. Workings consist of an adit 235 feet long with about 200 feet of crosscuts, several short adits and shallow shafts, opencuts and trenches (fig. 6).

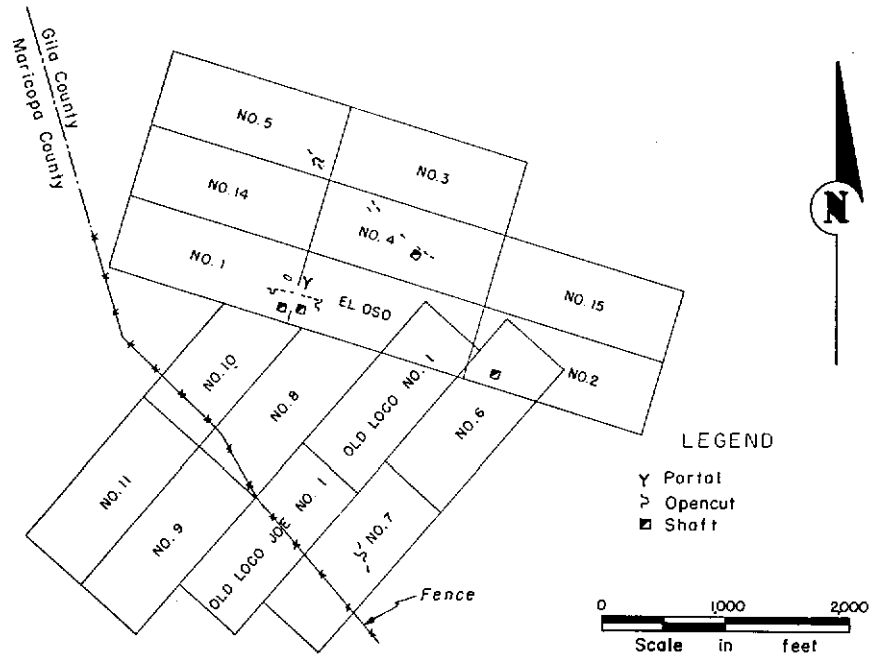


FIGURE 6. - Claim Map, El Oso Group.

Wilson[8/] examined this prospect in 1941. He states:

Coarse-grained, pinkish-gray, pre-Cambrian granite is the predominant rock of this portion of the Mazatzal Range. In the vicinity of the tungsten deposits, it has been intruded by a northeastward-trending belt of granite porphyry about a mile wide. This porphyry is characterized by coarse phenocrysts of pink feldspar within an aplitic, sugary groundmass of feldspar, quartz, and biotite.

Both the granite and granite porphyry are cut by numerous steeply dipping to vertical fissures which may be grouped according to strike as follows: N. to S., N. 20° to 25° E., N. 45° E., and N. 65° W. At many places these fissures have been intruded by aplite or pegmatite dikes, the walls of which are marked by sericitic alteration and iron stain. Some of them are occupied by tungsten-bearing quartz veins. There is considerable suggestion that the deposits of tungsten are associated with intersections of the fissures.

8/ Work cited in footnote 5 (p. 7), pp. 30-31.

Numerous small quartz veins with minor amounts of tungsten minerals were found on several of the claims. In only a few places were the tungsten minerals sufficiently concentrated to constitute ore. The principal ore shoots occur on El Oso and El Oso No. 4 claims, where the major amount of exploration has been done (figs. 7 and 8). Small crystals of wolframite, usually coated with scheelite, are sporadically present in quartz associated with, and in some instances grading into, pegmatite. The quartz bodies are discontinuous and range in width from 6 inches to occasionally 5 feet. None shows a strike length greater than 30 feet, and the majority is much smaller. Their vertical continuity is limited by sharp terminations against flat points within the granite. In addition to the tungsten minerals, the quartz contains considerable pyrite and minor amounts of molybdenite.

Figures 7, 8, 9, and 10 are assay maps made in the course of an examination by the Bureau of Mines in 1943.

Mazatzal Group (Jolene or Cline Group)

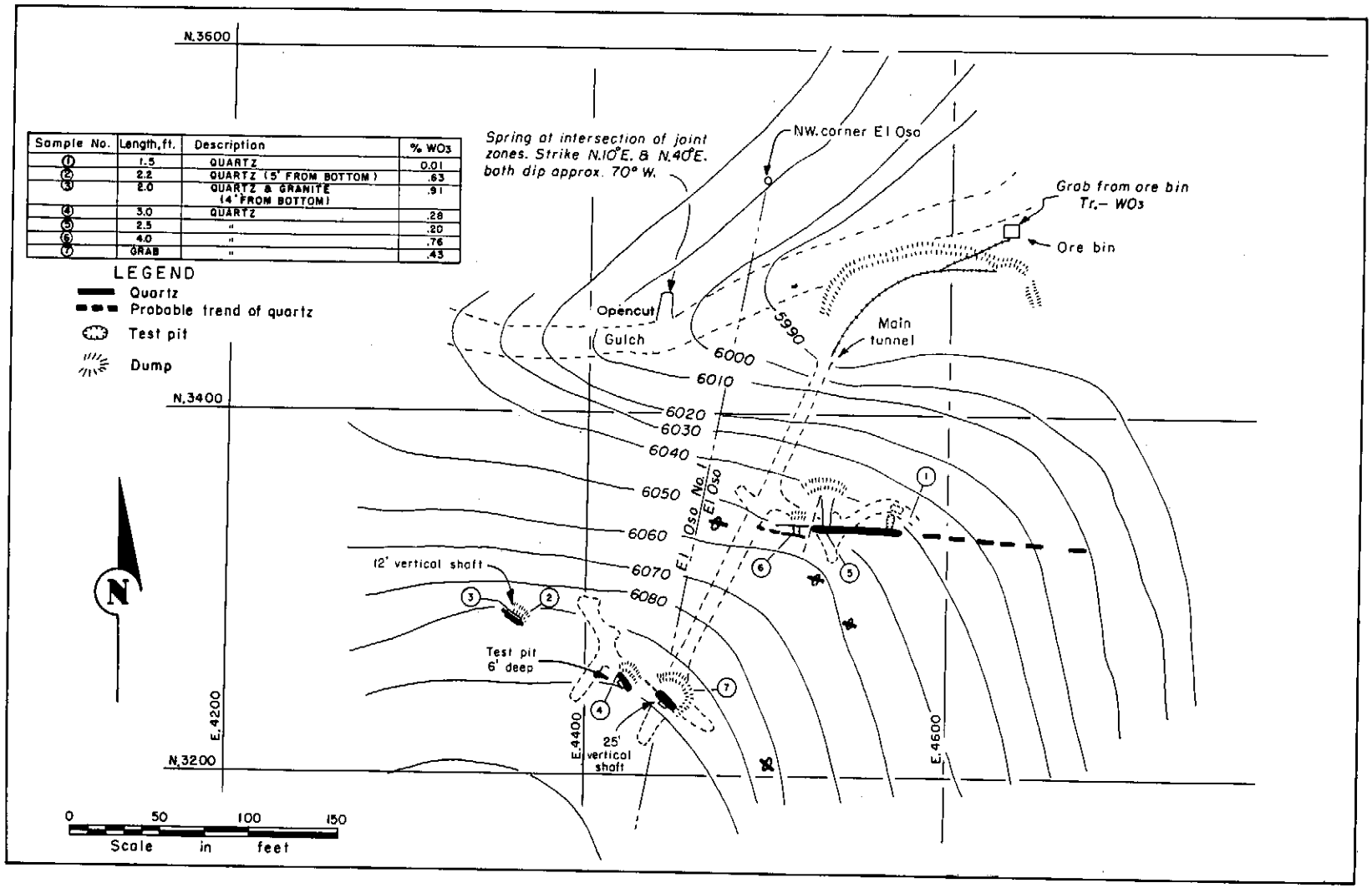
The Mazatzal group (Jolene or Cline) of 11 unpatented lode claims is in sec. 13, R. 9 E. and sec. 18, R. 10 E., T. 5 N., unsurveyed, in the upper drainage of Cline Creek at an altitude of about 5,500 feet. A road has been constructed from El Oso trail to the claims, 2 miles north from El Oso camp (fig. 5). The property was idle in July 1958. Its present owners are Mrs. Ella Lee Owens of Payson, Ariz., and Marvin Harrison of Fresno, Calif.

The Jolene group of five unpatented claims was located first in 1938 by Joe H. and John H. Cline. This group was surveyed and sampled in July 1943 by the Bureau of Mines, and a report was written from which the following excerpt was taken:

> The Jolene Group: This group, situated 2 miles north of El Oso camp, was surveyed and sampled. Large pieces of wolframite occur sparingly in the vein. About one ton of this high-grade ore is piled on the dump. This had been sorted from about 300 tons of rock mined. Assay returns of cut samples of the vein are very low grade.

Figure 11 is a map showing the surveying and sampling done under the above examination.

Records indicate that the Clines held the claims until 1953 when Paul J. Harrison and Keith Owens relocated 11 claims under the names of Mazatzal, Midway Tungsten, and Apache Chief. The only known production from the property has been small lots shipped for metallurgical testing purposes. Two units of tungsten tioxide were sold in 1954 by Keith Owens. Workings consist of a vertical shaft about 75 feet deep (inaccessible at the time of the writer's visit), an inclined shaft 20 feet deep, and several shallow opencuts and trenches.



Sample No.	Length, ft.	Description	% WO3
①	1.5	QUARTZ	0.01
②	2.2	QUARTZ (5' FROM BOTTOM)	.63
③	2.0	QUARTZ & GRANITE (4' FROM BOTTOM)	.91
④	3.0	QUARTZ	.28
⑤	2.5	"	.20
⑥	4.0	"	.76
⑦	GRAB	"	.43

FIGURE 7. - Assay Map, El Oso and El Oso No. 1 Tungsten.

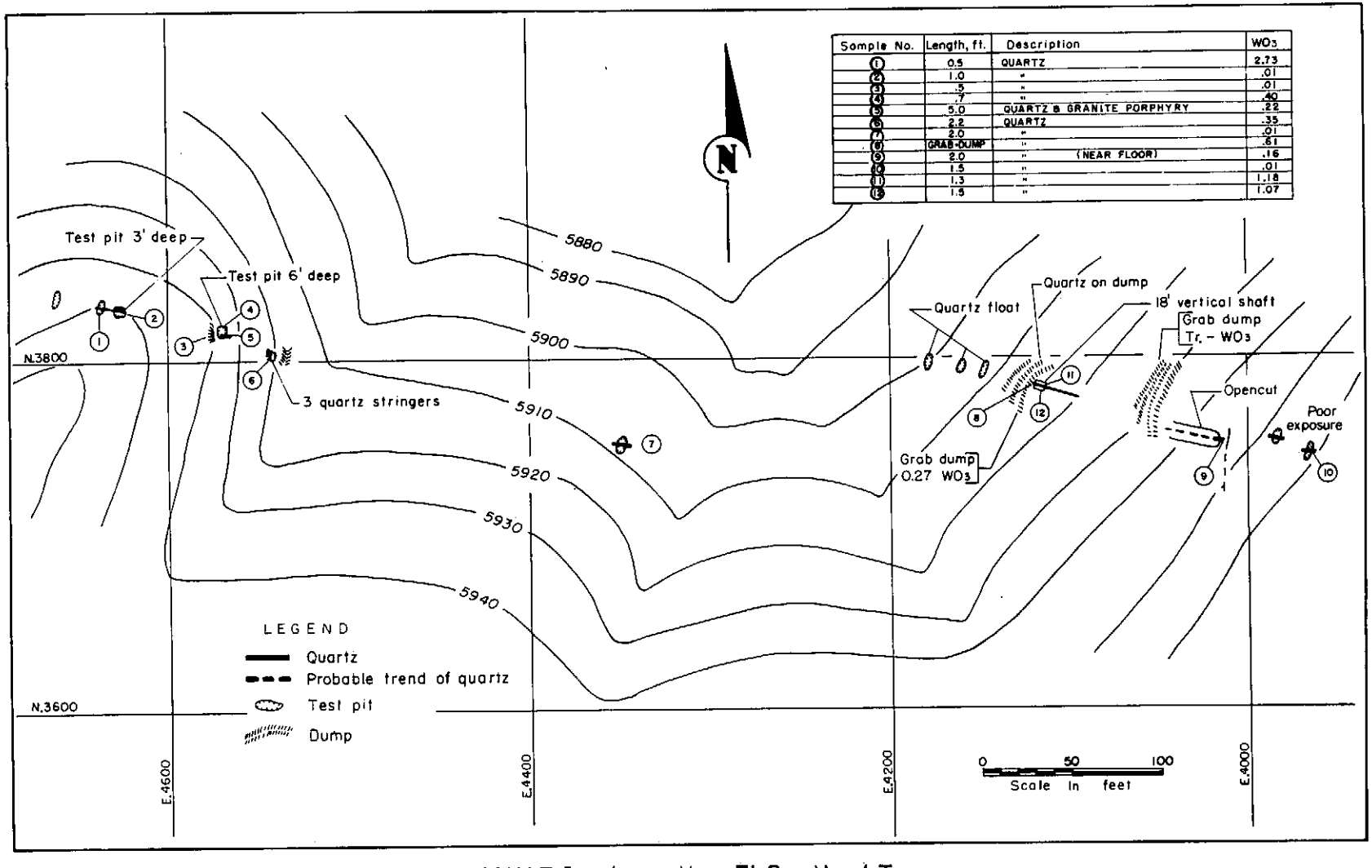
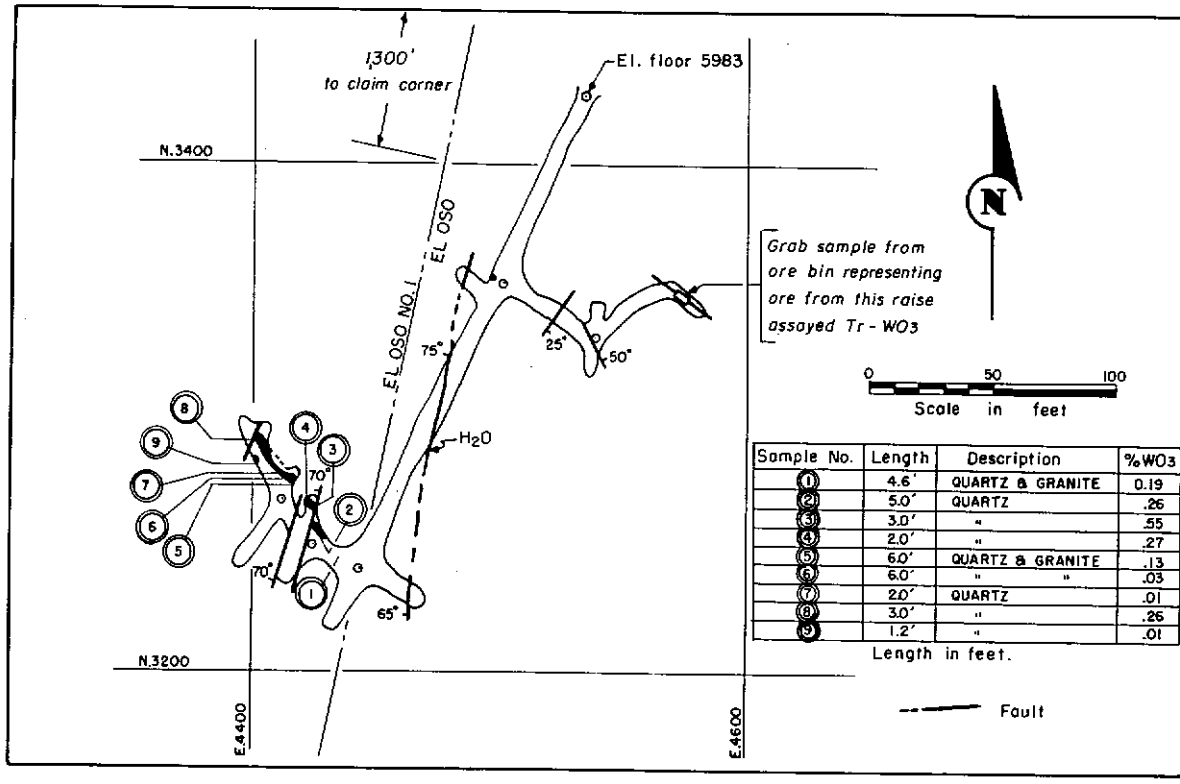
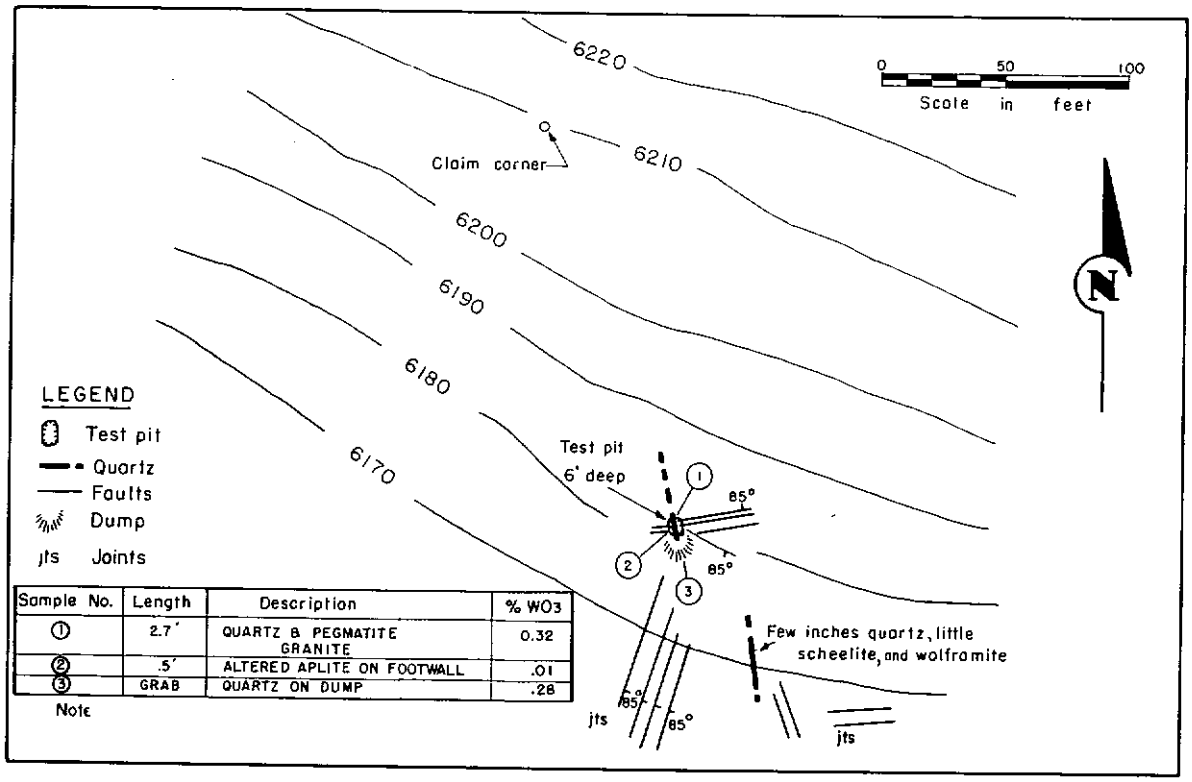


FIGURE 8. - Assay Map, El Oso No. 4 Tungsten.



Sample No.	Length	Description	%WO3
1	4.6'	QUARTZ & GRANITE	0.19
2	5.0'	QUARTZ	.26
3	3.0'	"	.55
4	2.0'	"	.27
5	6.0'	QUARTZ & GRANITE	.13
6	6.0'	" "	.03
7	2.0'	QUARTZ	.01
8	3.0'	"	.26
9	1.2'	"	.01

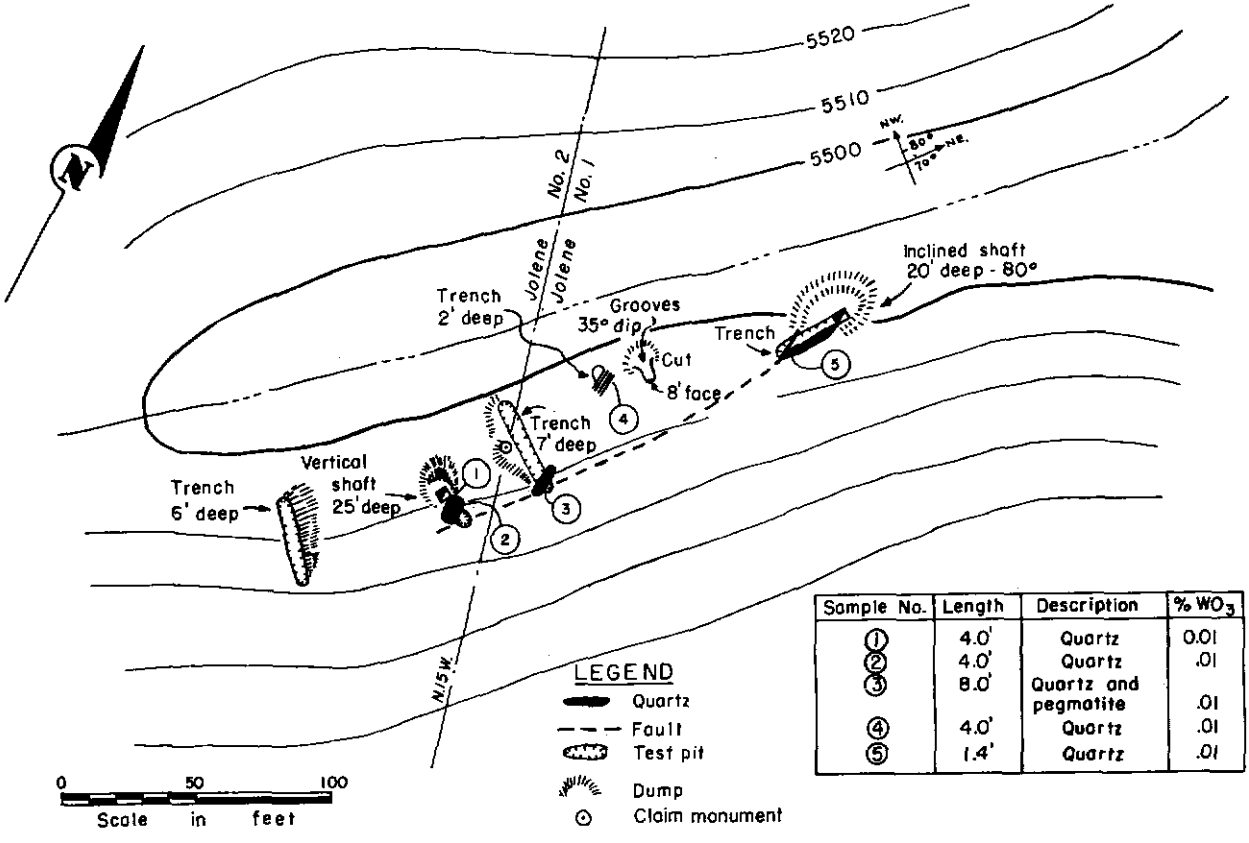
FIGURE 9. - Tunnel, El Oso Tungsten.



Sample No.	Length	Description	% WO3
1	2.7'	QUARTZ & PEGMATITE GRANITE	0.32
2	.5'	ALTERED APLITE ON FOOTWALL	.01
3	GRAB	QUARTZ ON DUMP	.28

Note

FIGURE 10. - Tunnel-Stadia Survey, El Oso No. 7 Tungsten Claim.



Sample No.	Length	Description	% WO_3
①	4.0'	Quartz	0.01
②	4.0'	Quartz	.01
③	8.0'	Quartz and pegmatite	.01
④	4.0'	Quartz	.01
⑤	1.4'	Quartz	.01

FIGURE 11. - Transit-Stadia Survey, Jolene Tungsten, Gila County, Ariz.

Wilson[9/] aptly describes the occurrence as follows:

> Here, coarse-grained, pinkish-gray granite has been invaded by aplite and pegmatite. Associated more or less closely with the pegmatite are four quartz veins a few tens of feet apart, which strike N. 20° to 25° E. and dip almost vertically. As exposed, they range from a few inches to more than 2 feet in width. The 20-foot shaft was sunk on an 8-inch vein of coarsely crystalline grayish-white quartz which contains scattered particles of wolframite, scheelite, and pyrite. Its drift cuts through about 7 feet of sericitized pegmatite which contains abundant vein quartz and local areas of disseminated scheelite, fairly abundant pyrite, and some fluorite.

Other Deposits

Other tungsten deposits exist in the Mazatzal range. They are all small, sporadic deposits similar to those discussed. There have been at least two locations on Four Peaks, about 5 miles south of the El Oso group. No recorded production has been made from any of these deposits.

9/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 32.

Spring Creek

Rose Tungsten Group

The Rose Tungsten group of five unpatented lode claims is in sec. 13, T. 8 N., R. 12 E., unsurveyed, in the upper drainage area of Spring Creek in the northern part of the Sierra Ancha at an altitude of about 4,800 feet. The property is accessible from the Globe-Young highway as follows: Drive 8.4 miles southward from the Valley Store at Young on the Globe road, and then 7.4 miles westward on a truck trail to the Jim Sam Haught ranch. A winding truck trail from the Haught ranch ends at the lower adit on the property (a distance of 4.4 miles, fig. 12). The property was idle in July 1958. Its present owner is Samuel A. Haught, owner of the Jim Sam Haught ranch.

These claims were located in 1937 by Robert O'Quinn and were subsequently sold to Jerry Binkley. Haught, the present owner, purchased the claims through Binkley's attorney several years ago.

The production record is incomplete. O'Quinn, Binkley, and others produced a few lots of tungsten concentrates with a small gravity plant. The last production was by Sam Haught, who trucked 3 tons of hand-sorted ore to the Stetler mill at Quartzsite, Ariz. This ore yielded 260 pounds of concentrates; WO_3 content is unknown, but it was reportedly high.

Workings on the property consist of a lower adit 165 feet long driven on the west vein with a 20-foot crosscut to the east vein, and approximately 20 feet of drifting on this vein; an upper adit, about 40 vertical feet above the lower adit, driven 70 feet on the east vein with a 20-foot crosscut to the west vein and 80 feet of drifting on the west vein; a 25-foot adit about 50 feet east of the upper adit; and a 30-foot adit across the canyon easterly from the other workings.

Wilson[10/] examined the property in 1941. He states:

> At the mine, a northeastward-flowing tributary of Spring Creek has carved a canyon about 300 feet deep through flat-lying quartzite, shale, and conglomerate of the pre-Cambrian Apache series, down into older tilted rocks. These older rocks here consist of laminated, somewhat schistose, ripple-marked beds, in places chloritized and impregnated with specularite. They strike northwestward, dip about 45° NW., and have been intruded by northeastward-trending sill-like bodies of fine-grained dark-gray to black rock as much as 300 feet wide. Microscopically, this dark-colored rock is seen to be a diorite porphyry that has undergone considerable silicification.
>
> Cutting the dark-gray intrusive on the west side of the canyon are two parallel quartz veins, 17 feet apart, that strike northwestward and dip 80° to 85° SW. When seen in May 1941,

10/ Work cited in footnote 9, pp. 27-28.

they had been opened by surface cuts, by a lower adit, and by two adits some 50 feet higher up the slope; these adits are each more than 40 feet long. As thus exposed, the veins average about 8 inches in width within the dark-gray rock but are not traceable beyond its borders. Their filling consists of coarse-grained, shiny, grayish-white quartz with minor calcite and scattered masses of tourmaline, hematite, wolframite, and sparse scheelite. A few small specks of copper stain are apparent in places. The wolframite tends to form fairly coarse particles, commonly up to an inch in diameter, surrounded by thin crusts of scheelite. The vein walls show alteration to coarse sericite.

Some 100 feet farther north, a short adit has been driven on a similar parallel vein, which appears to contain more abundant tourmaline.

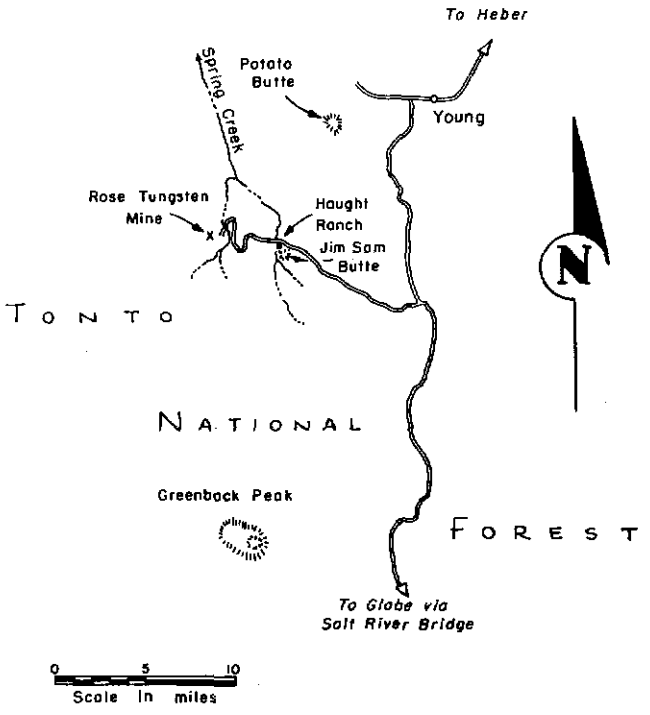


FIGURE 12. - Location Map, Rose Tungsten Deposit, Gila County, Ariz.

Since Wilson's examination, workings have been developed to the extent previously described. The ore extends to the extremities of all workings. The crosscuts between the two main veins disclose a mineralized area in the altered diorite between the veins. Scheelite is sparsely scattered in knife-blade fractures and as isolated crystals to one-quarter inch in size throughout the crosscut between the two veins in the lower adit. Small amounts of wolframite are scattered through the diorite.

Globe-Miami Vicinity

Two deposits of tungsten mineralization have been reported in the vicinity of Globe-Miami. Following is an excerpt from a previous publication.11/

Stolzite containing about 9 percent MoO_3 occurs near Miami, Gila County, Arizona. This tungsten-bearing mineral, which is considered to be an intermediate member of the isomorphous wulfenite-stolzite series, was noted by Faick and J. A. MacKallor (geologist, U.S. Geological Survey) in a prospect that was examined on behalf

11/ Faick, J. N., and Hildebrand, F. A., An Occurrence of Molybdenian Stolzite in Arizona: Am. Mineral., vol. 43, 1958, pp. 156-159.

of the Defense Minerals Exploration Administration in November 1951. This prospect is situated low on the east slope of Day Peaks in the Lost Gulch area of the Inspiration quadrangle, and is about 1-3/4 miles southwest of the Copper Cities open-pit mine. The locality is in the Globe-Miami district, the geology of which has been described by Ransome (1903, 1904, 1919) and Peterson (1954).

The prospect in which the molybdenian stolzite was found consists of an adit about 100 feet long in a mineralized zone along a nearly vertical, easterly trending fault that cuts diabasic rocks. The principal constituents in the zone are altered host rock, limonite, and minor amounts of quartz. Scheelite, which was identified by its pale-bluish fluorescence under an ultraviolet light, was observed in the altered zone as a few isolated grains and as a single small pod about one inch wide and 4 inches long. The molybdenian stolzite occurs in cavities in quartz and disseminated in limonite. The thin, tabular imperfectly formed white, lemon-yellow and orange crystals of the stolzite are megascopically indistinguishable from wulfenite.

Small amounts of scheelite occur elsewhere in the immediate vicinity of this prospect, but no work has been done solely for scheelite, nor has there been any tungsten production from this area.

Production of tungsten concentrates from Powers Gulch near Globe was noted in 1915.[12/]

Yavapai County

The first mention of production of tungsten ores from Yavapai County is made in the 1917 edition of Mineral Resources of the United States.[12/] Wolframite ores were hand-picked and shipped from the Eureka district (Black Pearl mine) by Connors, Wood, and Lawler. J. D. Gardner mined a small quantity of wolframite ore from the Humbug District (Great Cross Cut claims), and a little wolframite was recovered from the old Tip Top dump. A story persists today of nearly pure wolframite float being found in the Humming Bird basin, a few miles north of the Tip Top mine. According to the story, Jeff Martin and an Indian sheepherder found and sold $15,000 worth of wolframite float. Probably the first milling of tungsten ores was conducted at the Tip Top mine dump.

Tungsten deposits are distributed throughout southern Yavapai County. Scheelite is the prevailing mineral in all localities except the Eureka district. The scheelite occurs principally in schist and gneiss and is associated with quartz, epidote, garnet, and tourmaline. The wolframite ores are principally in granitic rocks. Distribution of the tungsten minerals within a deposit is very sporadic, and the ore generally occurs in small pockets and lenses which usually are related to structure. An interesting feature of the tungsten deposits in the southern part of the

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12/ Hess, Frank L., Tungsten: Mineral Resources of the United States, pt. 1, Metals, Geol. Survey, 1917, p. 825 and 937.

Bradshaw Mountains is the presence of dark-colored, slightly to highly magnetic, hornblende schist formations. This feature was not recognized until investigation of deposits in Yavapai County was nearly complete. Where observed, the magnetic schist was from a few tens of feet to a few hundred feet distant from the scheelite occurrence.

Altitudes of the various deposits range from 3,000 to 5,700 feet. Some of the deposits are on the cactus-studded desert, and others are in pine timber. Road conditions to the various properties vary widely.

Accurate production records for the county are not available. Following is tungsten production from the Yavapai County from 1952 through 1956:

Year:	WO_3 produced, units
1952	1,299
1953	2,468
1954	2,481
1955	4,891
1956	3,991

It is suggested by the author that total production is probably 18,500 units of WO_3, produced from 1916 through 1956.

In Yavapai County approximate reserves of tungsten ore are as follows:

Kind	Tons	WO_3 percent
Measured	175,000	0.22
Indicated	215,000	.22
Inferred	240,000	.18

Bradshaw Mountains

White Pearl Prospect

The White Pearl unpatented lode claim is in the NW¼ sec. 32, T. 13 N., R. 2 W., on the west side of Indian Creek near its junction with Hassayampa Creek in the Prescott National Forest. The altitude is about 5,500 feet. To reach the property by road travel 6 miles south of Prescott on U.S. Highway No. 89 to the Groom Creek cutoff, then 2.2 miles southeasterly down Indian Creek to the Ora Flame road. Follow the Ora Flame road westerly 0.2 mile to a trail that extends northwesterly up a tributary to Indian Creek; then travel 0.3 mile to a dim trail that branches westerly and 0.2 mile to the lower workings on the White Pearl No. 2 claim (fig. 13). The property was visited on August 8, 1958, at which time no work was in progress and no mining equipment was on the claim.

The claim is probably a part of the old Silver Dollar group of tungsten claims owned in 1943 by A. R. Roche and W. R. Fitzgerald. So far as is known no production resulted from that ownership. On July 1, 1953, Louie Berberich located one claim; he leased the property to Joe Ward in September

1955; Ward produced 1 unit of tungsten trioxide in 1956, which is the only recorded production. Charlie Thompson purchased the claim in September 1956.

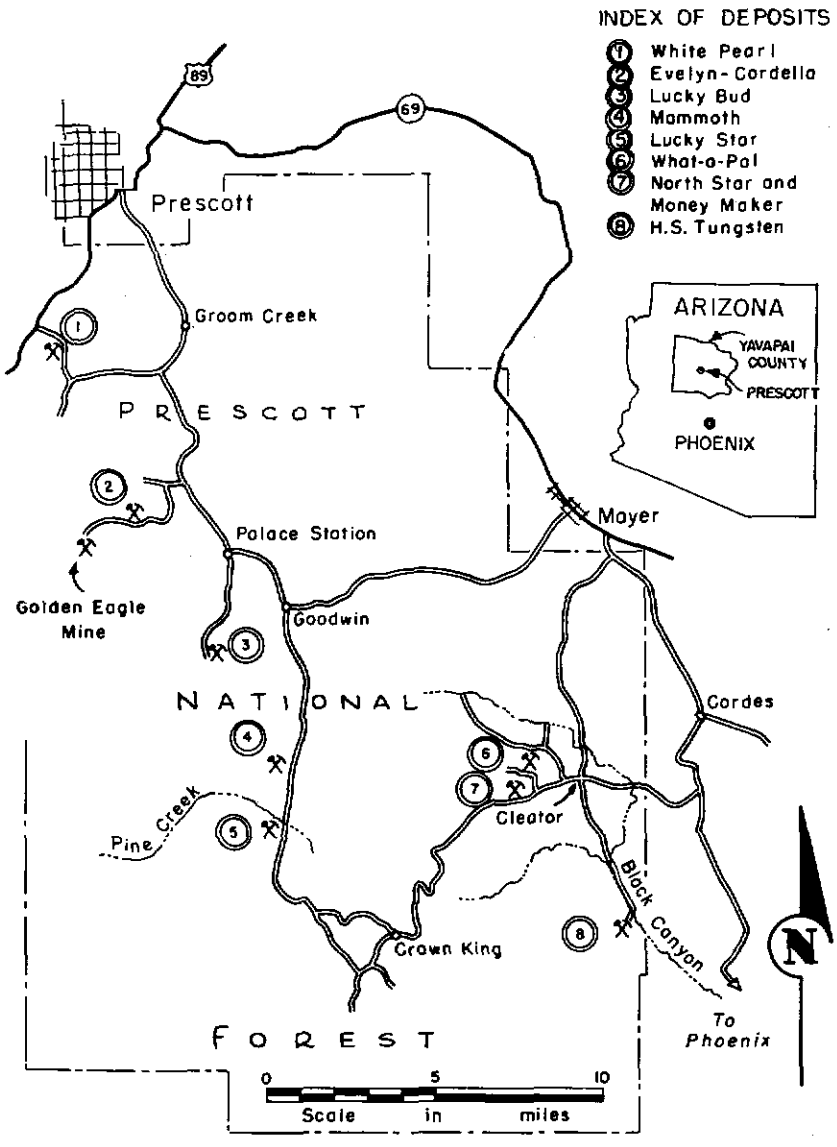

FIGURE 13. - Location Map, Tungsten Deposits, Bradshaw Mountains, Yavapai County, Ariz.

Workings on the property consist of three opencuts, all showing at least 10-foot faces.

A quartz vein strikes N. 10°E., dips 67° SE., and is in Bradshaw granite near its contact with Yavapai schist, a few hundred feet to the south. The quartz contains sparse pyrite, sphalerite, and scheelite, with a few needlelike crystals of bismuthinite or vanadinite. Fractures in the quartz are coated with limonite stain. The scheelite is white and fluoresces blue under ultraviolet light. It occurs as grains up to one-half inch in size and in seams about one-sixteenth inch wide. It is sparsely and sporadically disseminated in the quartz and in places appears to be concentrated along the hanging wall of the vein. Scheelite-bearing quartz float can be traced to the top of a ridge about 500 feet south of the lower workings. Difference in elevation from the top of the ridge to the lower workings is about 200 feet.

Evelyn-Cordella Group

The Evelyn-Cordella group of six unpatented lode claims is in approximate sec. 10, T. 12 N., R. 2 W., unsurveyed. To reach the property by road travel 19.6 miles westerly from Mayer to the Dunkirk-Golden Eagle branch road from the Senator highway and then 0.3 mile southwesterly to the junction of the

Dunkirk and Golden Eagle roads; keep left and continue 2.6 miles to the workings on Evelyn-Cordella claim No. 2 (fig. 13). David M. Allen of Prescott and J. A. Phillips located the claims in August 1954. Original locations were on gold showings. Workings consist of a shaft 15 feet deep and several small opencuts and shallow pits. There has been no tungsten production.

Very small grains of very sparse scheelite occur along knife-blade fracture through narrow quartz veins in gneissic Bradshaw granite. The 10-inch vein on Evelyn-Cordella No. 2 strikes N. 65° E. and is essentially vertical. The quartz is iron stained and contains cubic cavities. The scheelite is associated with muscovite and chlorite along the fractures.

Lucky Bud Prospect

The Lucky Bud prospect is in approximate sec. 36, T. 12 N., R. 2 W., unsurveyed, on the east side of Crooks Canyon at an altitude of about 5,700 feet. From Palace Station on the Senator highway continue 2.4 miles southerly down Crooks Canyon, turn sharply left across the canyon, and drive 0.2 mile further to a millsite. The Lucky Bud workings are 0.6 mile southerly from the millsite and about 350 feet above the bottom of Crooks Canyon (fig. 13). David S. Jones and Paul Stone located the claim in November 1954. Apparently no location work was done, because on May 4, 1955, the claim was relocated by David S. Jones. When the property was examined in August 1958, no work was in progress, and all machinery and equipment had been removed. No production has been recorded to date.

The workings consist of an inaccessible shaft probably 30 feet deep, an opencut 20 feet long by 4 feet wide by 6 feet deep, and several other smaller cuts and trenches. Apparently a small test plant had been set up in Crooks Canyon, but its components are not known.

White scheelite is found along a fracture between an inclusion of dark micaceous schist and decomposed Bradshaw granite. The fracture strikes N. 50° E. and is essentially vertical. The scheelite ranges in size from minute particles to 1-inch grains. Deposits are also in stringers as much as three-sixteenths of an inch wide. The scheelite is extremely sporadic and locally concentrated, and seems to be confined to a width of about 6 inches. It is associated with quartz, tourmaline, epidote, and iron oxides. The area is covered with detritus and heavy oak brush. Float was found a few hundred feet north of the opencut where the scheelite ore appears.

Mammoth Prospect

The Mammoth prospect is in approximate sec. 20, T. 11 N., R. 1 W., unsurveyed. The claim lies in a southwestward-draining tributary about midway between Walnut Spring and Barrel Spring, both of which are shown on the Geological Survey topographical map of the Mt. Union, Ariz., quadrangle. From the junction of the Prescott-Mayer road at Goodwin, drive south on the Crown King road for 6.7 miles (fig. 13). A southwestward-trending trail leaves the road from a sharp ridge where the road makes a hairpin curve from west to southeast. The trail ends at the Mammoth workings on the northwest side of a canyon about 0.3 mile from the road.

The property first was located as the Mammoth claim about 1953 by Woodrow Carpenter. It subsequently was leased to R. Fairchild and finally purchased by him. A few tons of ore was packed from the claim in 1956, but the production is not known. No equipment was on the property, and no work was in operation when it was examined in August 1958.

The workings consist of two opencuts, 25 feet long by 6 feet wide by 6 feet deep, and 20 feet long by 4 feet wide by 6 feet deep, respectively.

The scheelite occurrence here is similar to that on the Lucky Star claim on Pine Creek about 1.5 miles to the south. A narrow quartz-tourmaline vein carries sparse, sporadic scheelite grains with small, localized concentrations. The vein strikes N. 5° E., dips 70° W., and is in Yavapai schist. A small parallel fault, probably postore, shows on the west side of the larger cut. More epidote is present here than at the Luck Star occurrence.

Lucky Star Claim

The Lucky Star unpatented lode claim is in approximate sec. 32, T. 11 N., R. 1 W., unsurveyed, in the Bradshaw Mountains between Goodwin and Crown King. The claim lies on the south side of Pine Creek about one-fourth mile downstream from the Crown King road crossing. From the junction of the Prescott-Mayer road at Goodwin, travel south on the Crown King road for 9.4 miles to Pine Creek, then 0.2 mile downstream to the end of a truck trail (fig. 13). The workings are about 100 yards downstream from the end of the road, on the south side of the creek about 100 feet above its bottom at an altitude of 5,500 feet.

This claim was located on October 7, 1952, by Clifford L. Ellsworth and Woodrow Carpenter. When the claim was visited in August 1958, no work was in progress, nor was there any mining equipment on the property. The only production is 7 tons of ore containing 3.7 percent WO_3 from which 15 units were sold in 1953. Workings consist of three opencuts, two of which are caved portals to unknown underground workings.

At this prospect scheelite occurs in a quartz-tourmaline vein with some epidote in a soft, brown Yavapai schist. The vein strikes N. 20° E. and dips 82° NW. The scheelite is in sparse, sporadic grains ranging from minute particles to 1 inch in size, and in short, discontinuous stringers up to one-eighth inch wide. Vein widths range from 3 inches to 3 feet. The deposit can be traced discontinuously for a distance of about 400 feet.

The Yavapai schist contacts Bradshaw granite approximately 100 yards west of the workings.

What-A-Pal Prospect

The What-A-Pal unpatented lode claim is in sec. 34, T. 11 N., R. 1 E., in the Bradshaw Mountains near the old DeSoto copper mine at an altitude of about 4,000 feet. The claim is 1.5 miles west of Cleator on the Crown King

road, then northwesterly on a bulldozer trail for 1.1 miles in figure 13. The workings are north of the road about 500 feet, across a canyon and 100 feet above its bottom. They consist of three opencuts, one 30 feet long with a 15-foot face, one 15 feet long with a 10-foot face, and one 8 feet long by 6 feet deep, with widths ranging from 4 to 8 feet.

Benjamin P. Scott, Bumblebee, Ariz., located the claim on January 15, 1953, and retains possession today. According to him an estimated ton of ore has been taken from the prospect with an estimated grade of 20 percent WO_3. When the prospect was visited in August 1958 no work was being done, nor was there any mining equipment on the claim.

Scheelite deposits are scattered along the southeast side of a mineralized zone about 3 miles long and 1 mile wide. A series of roughly parallel, narrow quartz stringers in Yavapai schist contains small, sparse, very sporadic and irregular masses of scheelite ore, generally very low grade.

On the What-A-Pal claim, scheelite is present in a quartz vein from 6 inches to 1 foot wide which strikes N. 15° E. and dips 52° NW. The scheelite is milky white and fluoresces blue under ultraviolet light. It appears as irregular grains from minute particles to 2 inches in size and in discontinuous, irregular stringers from paper-thin to 2 inches wide. The quartz also carries abundant tourmaline and some iron oxides, and some fractures are filled with caliche. The enriched zone seems to be about 20 or 25 feet long. The surface is covered with detrital material, and the workings are caved, but scheelite float can be traced along the strike of the vein for about 200 feet.

The Yavapai schist around the workings is dark green and contains abundant hornblende. Stringers of crystalline calcite also were observed in the area.

North Star and Money Maker Group

The North Star and Money Maker group of seven unpatented claims is in secs. 5 and 6, T. 10 N., R. 1 E., along tributaries to Crazy Basin Creek at an altitude of 4,700 feet. The property is 4.6 miles by road west of Cleator to Huff Canyon, then about 0.75 mile up the canyon by trail to the discovery hole on Moneymaker No. 1 claim. (See fig. 13.) The other six claims extend about N. 40° E. from the Money Maker.

The claims were located from January to March 1953 by Ben Scott of Bumblebee and Mrs. R. P. McLeod of Mayer. Workings consist of a few shallow pits and opencuts. Thirteen units of tungsten trioxide have been produced from these claims and from the What-A-Pal claim about 2.5 miles to the northeast. All the ore from the North Star and Money Maker groups came from the surface and was packed to the road by men.

The Money Maker claim is near the southwest end of a wide mineralized zone which strikes about N. 40° E. for a distance of 3 or 4 miles. Sporadic scheelite minerals are found over an area about 1 mile wide. The regional formation is Yavapai schist, as may be seen on a geologic sheet by Lindgren.[13/]

13/ Lindgren, W., Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles, Arizona, Plate 2: Geol. Survey Bull. 782, 1926, 192 pp.

Scheelite is present in three distinct types of rock in this area. At the location hole on the Money Maker No. 1 claim in the bottom of Huff Canyon it occurs in silicified schist which contains much epidote with some chlorite, hornblende, needlelike crystals of black tourmaline, and quartz stringers with a maximum width of 1 inch. This formation is about 125 feet wide. The area is covered with detrital material, and the silicified, epidotized schist can be seen only in the canyon. Very sparse and sporadic small grains of scheelite are near the center of the formation. At the location hole there is a fracture about 4 feet wide which contains much quartz, some muscovite, and considerable iron oxides. No evidence of faulting could be seen. There is a 3-foot pegmatite dike about 225 feet down the canyon from the location hole.

From the location hole on Money Maker No. 1 northward for several miles to about 1 mile northeast of the 600 level DeSoto mine adit, numerous discontinuous quartz veins trend N. 40° to 45° E. for most of the entire distance. They range in width from a fraction of an inch to 5 feet. Very small, very sparse and sporadic pockets of scheelite ore occur throughout these quartz veins. In addition to scheelite the quartz contains black tourmaline and small amounts of feldspar.

About 1 mile east of the DeSoto adit a few scattered grains of scheelite were observed in a pegmatite dike consisting of quartz, feldspar, and muscovite. Some step faulting was observed in the area.

H. S. Tungsten Claims

The H. S. Tungsten group of six patented claims is in sec. 25, T. 10 N., R. 1 E., in Black Canyon a short distance below the junction of Poland and Turkey Creeks. The altitude is about 3,000 feet. Road directions are simple: travel 4.6 miles southeast of Cleator. (See fig. 13.) The property is on Dead Cow Gulch (Boulder Creek) about one-third mile from its junction with Black Canyon. It lies half way between the Howard silver mine and the Howard copper mine, both of which are shown on the Geological Survey topographical map of the Bumblebee, Ariz., quadrangle.

The property was visited in August 1958. No work was being done, and the portal of the adit into the scheelite-bearing formation was caved and inaccessible. An old-type stationary compressor and engine were near the adit.

The property was operated by Howard Silver Co. from 1901 to 1926 for argentiferous lead-zinc ores. A small amount of wolframite ore is reported to have been shipped from the silver workings during World War I. No production records are available. W. C. Kinnon of Phoenix, Ariz., the present owner, discovered a scheelite deposit several hundred feet from the silver workings in 1942.

The extent of the old silver workings is unknown. An adit has been driven about 139 feet into the scheelite deposit. The following description of the deposit was abstracted from the files of the Defense Minerals Administration.

The H. S. Tungsten deposit occurs in a tongue of brecciated and silicated granite, pegmatite, and aplite, cut by numerous quartz veins extending into schist as shown on figure 14. The granite expands southward where it reaches 200 feet in width. Schist, which does not appear to be brecciated or silicified, surrounds the zone, except to the south where it probably merges into a large granite mass. The mineralized zone trends N. 10° E. and is essentially parallel to the foliation of the schist.

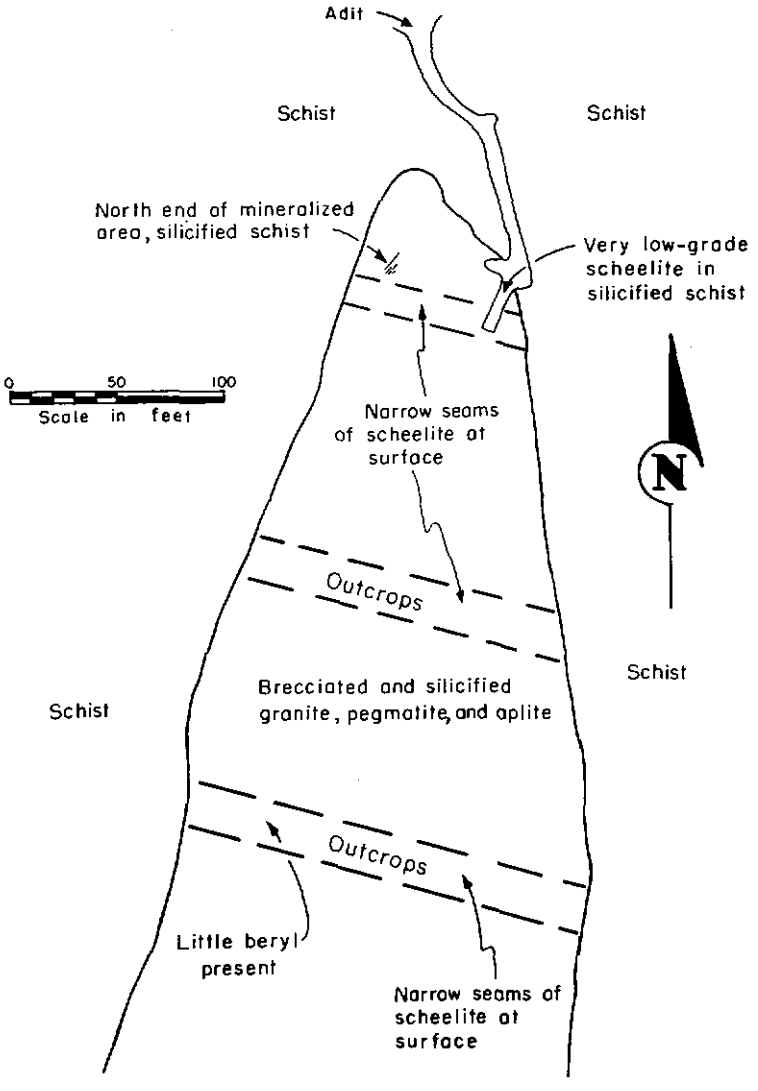

FIGURE 14. - H. S. Tungsten Mine, Yavapai County, Ariz.

Quartz veins in the brecciated granite range from tiny veinlets to veins several feet in width. There is some random orientation of veins, but two preferred orientations were noted. One set is parallel to the trend of the brecciated zone, and the other is transverse, N. 70° to 80° W. Concentrations of these veins have formed two bold outcrops, locations of which are shown in figure 14. The granite and the quartz are stained with limonite, particularly along fractures. Cubic cavities partially filled with limonite indicate the former presence of pyrite. Talus covers the area explored by the adit.

Pyrite is common to the silicified schist particularly in schist fragments between quartz veins. Scheelite is sporadically present in scattered grains, one-sixteenth to plus one-fourth inch in size. In a few places it is present as chainlike veinlets of disconnected grains. The higher grade scheelite veinlets are only several inches in length and occur in small quartz veins.

The surface was examined at night with an ultraviolet light. Scheelite was observed at scattered places in the vicinity of the bold outcrops. At the

northernmost outcrops much of the scheelite is concentrated along N. 70° to 80° W. fractures as stringers in quartz or adjacent to granite fragments. The scheelite grains range in size from one-thirtysecond to plus one-fourth inch. The south outcrop contains veinlets of scheelite, trending N. 70° to 80° W., and grains of scheelite with a maximum size of one-half inch. The veinlets appear to be confined to a zone, 3 to 4 feet wide, that extends over much of the outcrop length. A little beryl is present in the western part of the zone.

Tip Top District

The following description is quoted from a previous publication:[14]

> Tip Top is in the southern foothills of the Bradshaw Mountains at an altitude of about 2,600 feet. The district is accessible by some 10 miles of road that branches westward from the Black Canyon highway at a point 42 miles north of Phoenix.
>
> The surface has been carved into ridges separated by canyons 1,000 to 1,500 feet deep. This portion of the range consists mainly of pre-Cambrian Bradshaw granite invaded by pegmatite and long branching dikes of rhyolite porphyry. Locally the granite is gneissic and contains inclusions of schist. The rhyolite porphyry dikes strike prevailingly east to northeastward and dip northward.
>
> Several persistent parallel veins, of which the Tip Top has been the most productive, occur in this vicinity.

Wilson also states:

> According to Lindgren,[15] practically all the veins of northeast strike in this district carry wolframite. Several veins of this type occur in the vicinity of Tule Creek.

According to Guy F. Mitchell of Bumblebee, Ariz., a man named Jeff Martin and an Indian sheepherder discovered and collected rich wolframite float in Humming Bird Basin in World War I, and about $15,000 worth of wolframite was sold from this enterprise. Mitchell thought that this ore came from the surface enrichment of eroded outcrops because the only wolframite remaining occurs as very sparse, very small masses in narrow quartz veins.

In 1943, Newton White and Henry Cordes mined and shipped 5,000 pounds of wolframite-scheelite concentrate to Salt Lake City, Utah. This ore contained 32 percent WO_3. According to Cordes the deposit was situated on

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14/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, pp. 23, 24.

15/ Lindgren, W., Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles, Arizona: Geol. Survey Bull. 782, 1926, pp. 179-182.

Boulder Creek 3 miles eastward from the Tip Top mine. The ore occurred as a lenticular deposit in a black schist, and was entirely mined out.

Partners named Carpenter and Ellsworth in 1953 or 1954 worked several very small quartz stringers in schist, which contained sparse, sporadic scheelite. According to Mitchell, a pickup truck load of ore worth $370 was hand-picked from shallow surface pits. This ore came from a northeastward-trending ridge on the north side of Cottonwood Creek 3 miles by road southeast of the old Tip Top mill foundations.

Scheelite has been reported in a narrow, northeasterly trending quartz vein on the old Foy property at the extreme northeast corner of sec. 5, T. 8 N., R. 1 E.

Tip Top Mine

The Tip Top mine is comprised of three patented and three unpatented lode claims in sec. 10, T. 8 N., R. 1 E. The main workings are accessible by road from Black Canyon, 47 miles north of Phoenix. Drive 6.7 miles south from Black Canyon on State Route 69, then westerly on a dirt road for 4.7 miles to the Agua Fria River, and 0.3 mile downstream to a roadfork; turn sharply right and continue 7.9 miles northwesterly to the Tip Top mine on the north side of Cottonwood Creek (fig. 15).

Following is a quoted description of the mine:[16]

> From 1875 to 1890, the Tip Top mine produced[17] approximately $2,000,000 worth of silver and $200,000 worth of gold. During the World War, some tungsten was recovered by hand sorting and by milling of the dumps and stope fills above the 200-foot level in a small gravity plant. A small production also was made in 1928. In 1936 La Bajada Exploration, Engineering and Equipment Company built a flotation mill of 50 tons daily capacity and produced silver-gold concentrates. Since that time, a small tonnage of sorted tungsten ore has been shipped from the district.
>
> In the vicinity of the mine the country rock consists of granite and pegmatite with local inclusions of schist. The vein strikes N. 50° to 60° E., dips 65° to 70° NW., and ranges from a tight seam to 6 feet in width. Its principal gangue is quartz, in part fine-grained and in part comb-textured. The ore minerals consist of wolframite, arsenopyrite, pyrite, sphalerite, bornite, and galena. The wolframite occurs in well-crystallized crusts along the walls. In the oxidized zone, within 200 feet of the surface, cerargyrite, ruby silver, and native silver are said to have been common. The ore shoots pitch northeastward.

16/ Work cited in footnote 14.(p. 28), pp. 23-24.

17/ Elsing, M. J., and Heineman, R. E., Arizona Metal Production: Univ. of Ariz., Arizona Bureau of Mines Bull. 140, 1936, p. 103.

Mine workings include a shaft 800 feet deep on the incline, connected with an adit tunnel on the 200-foot level. Below this level the workings are filled with water. According to Coupal,[18] the major part of the ore shoot near the shaft has been stoped down to the 500-foot level.

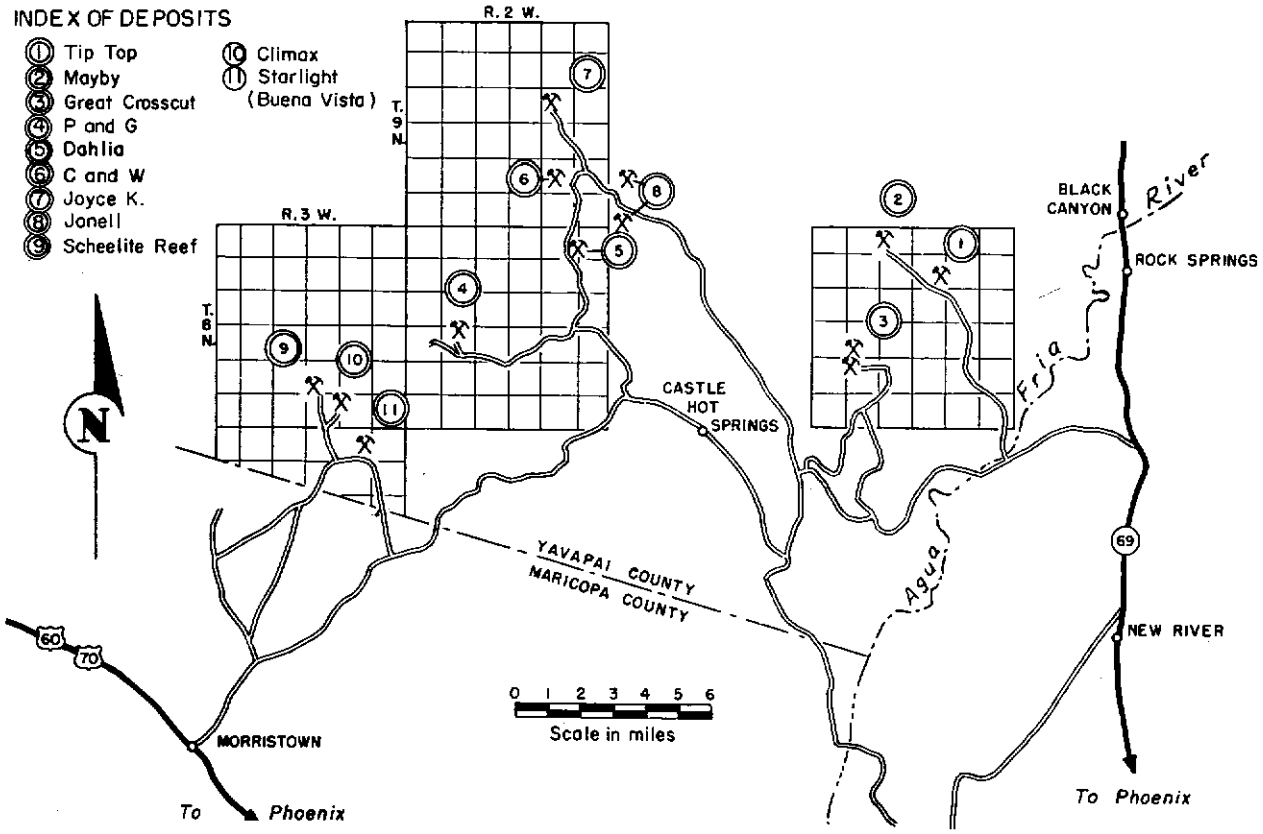


FIGURE 15. - Location Map, Tungsten Deposits in Tip Top, Castle Creek, and White Picacho Districts, Yavapai County, Ariz.

Mayby Prospect

The Mayby group of four unpatented lode claims is in secs. 4 and 5, T. 8 N., R. 1 E., on the upper drainage of Cottonwood Creek about 1.5 miles northwest of the Tip Top mine. The prospect is accessible by road by traveling 6.7 miles southerly on State Route 69 from Black Canyon, then westerly on a dirt road for 4.7 miles to the Agua Fria River, and 0.3 mile downstream to a road fork. Turn sharply right at the fork and continue 10.9 miles northeasterly up Cottonwood Creek (fig. 15). The location hole on Mayby No. 2 claim is 600 feet downstream from this point. The altitude is about 3,200 feet.

This prospect was examined on October 28, 1958. No work had been done for many months before the author's visit.

18/ Coupal, J. S., Tip Top Mine: Min. Jour. (Arizona), vol. 20, No. 5, 1936, pp. 3-5.

The property was located in November 1952 by William and Barbara Bledsoe and Guy F. Mitchell. It was deeded to W. S. and Esther G. Hudson in January 1953. Production has amounted to almost 40 units of WO_3, according to Mitchell. Workings consist of a few shallow surface cuts and shafts, none more than 12 feet deep.

Sparse, sporadic scheelite occurs in altered schist in several places on the property. At the location hole on Mayby No. 2 claim sparse scheelite occurs in a 3-in. stringer through biotite schist. The stringer strikes N. 32° E. and dips 80° NW. The gangue minerals are quartz, feldspar, and tourmaline with weak limonite staining. The stringer has been opened for 30 feet to a depth of 6 feet. On a ridge about 150 feet west of the No. 2 location hole Precambrian Bradshaw granite grades into gneiss and schist. Very sparse, fine-grained scheelite occurs along the schistosity over quite wide zones, and locally in small, enriched shoots from which all production has come.

According to Mitchell a trench sample was cut 30 feet across the schistosity that assayed 0.64 percent WO_3, and ore was mined that assayed as much as 5.73 percent WO_3. No samples were cut by the author because of the unreliability of small samples from this type of deposit. Very little surface float was present, and most of the area was covered with detrital material; hence little can be said about the extent of the mineralization.

Schistosity in the area strikes N. 50° to 70° E. and dips about 75° NW. Conformable to the schistosity are narrow dikes of pegmatitic nature. The dikes are composed of quartz, feldspar, muscovite, and minor amounts of tourmaline. Insignificant amounts of beryl are scattered through the dikes.

Great Cross Cut Claims

The author did not examine this property. The following description is abstracted from the files of the Defense Minerals Exploration Administration.

The Great Cross Cut group of three unpatented lode claims is in the $N\frac{1}{2}$ sec. 29, and the $S\frac{1}{2}$ sec. 20, T. 8 N., R. 1 E., at an altitude of about 2,500 feet. To reach the property by road, turn left from State Route 69 at a point 5.4 miles north of New River. From this turnoff the property is 18 miles in a westerly direction via dirt roads that lead down the canyon of the Agua Fria River, then up the divide between Tule and Humbug Creeks (fig. 15). The property is owned by Jim Johnston of Hayward, Calif.

According to George Walters, who worked at the Great Cross Cut during World War I, and Johnston, the owner, the property was worked primarily for silver in the 1870's and 1880's. Tungsten production began about 1915 or 1916. A small dry mill was erected at the Pearl adit for treating the ore. Ore from the Glory hole consisted of hand-cobbed wolframite packed out on burros. A shipment of this ore brought $87,000 at the dock in New York in the peak market at $90 per unit.

In 1937 and 1938 Sam Coupal operated a small mill on Tule Creek below the Mystery mine, 1 mile east of the Great Cross Cut. This mill treated tungsten ore from the surrounding area, including 80 tons from the Pearl adit, and recovered wolframite, but not scheelite. Remnant tailing from this mill contains fairly abundant disseminations of scheelite grains.

Since 1938, tungsten production has been almost nil. In 1955, Walter G. Johnston mined 2.5 tons of ore which yielded 62 pounds of concentrate. This is 25 pounds of concentrate per ton of ore, or about 15 pounds of tungsten trioxide per ton.

The workings are distributed along the northerly trending Great Cross Cut fault. From south to north these workings consist of (1) The Pearl adit, 250 feet long with a small amount of stoping to the surface, (2) several shallow cuts and a 50-foot adit, all within a distance about 700 feet north of the Pearl adit dump, (3) the Glory hole, about 2,600 feet north along the fault from the Pearl adit dump, and (4) a stripped zone marked by shallow cuts and several small, caved openings over a distance about 400 feet north from the Glory hole.

The Great Cross Cut claims are in an area of coarse-grained pegmatitic Precambrian granite. The granite is foliated; it contains a few thin schist inclusions. The foliation, as well as the inclusions and schistosity, strikes about N. 65° E. and dips 50° to 60° NW. A prominent structural feature is the so-called Great Cross Cut vein. This is a fault with some dike and vein material, which strikes N. 10° to 25° E. and dips 55° to 80° W. From its south end it is traceable for at least 3,000 feet to the north.

The Great Cross Cut fault in most places contains nearly 2 feet of clayey brown gouge. Frequently, it contains highly silicified, altered dike material reaching 12 feet in width, and, less frequently, quartz vein material as much as 2 feet thick. The quartz veins are banded and in places exhibit comb structure. In many places along the fault, the quartz occurs as discontinuous lenses separated by slivers and horses of country rock. The only place containing a fairly continuous quartz vein of even width was a distance of approximately 75 feet along the Pearl adit.

Lindgren states[19/] that in the Tip Top district practically all the veins trending east-northeast contain tungsten. At the Great Cross Cut mine the ore minerals are wolframite and scheelite with wolframite predominating. The main gangue mineral is quartz with minor coatings of hyalite opal. Wolframite seen in the Pearl adit occurs in very thin veinlets parallel to the vein structure, and near the base of quartz crystals that form comb structures within the vein. Scheelite generally occurs in close association with the wolframite, and in some cases as rims around wolframite grains.

Only traces of wolframite were seen during the examination.

19/ Lindgren, W., Ore Deposits of the Jerome and Bradshaw Mountains Quadrangle: Geol. Survey Bull 782, 1926, p. 182.

Castle Creek Area

P and G Claims

The P and G group of four unpatented lode claims is in sec. 20, T. 8 N., R. 2 W., on Dugan Wash, a tributary to Buckhorn Creek shown on the Geological Survey topographical map of the Bradshaw Mountains, Ariz., quadrangle. The altitude is about 3,100 feet. The property may be reached from Morristown by traveling 21.2 miles on the Castle Hot Springs road, then left on a road that leads to Castle Creek, a distance of 3.3 miles; continue left, or southerly, for 1.5 miles to Buckhorn Creek, and 1.6 miles up Buckhorn Creek to Dugan Wash. Turn up Dugan Wash northwesterly for 1 mile to a 10-foot shaft in the wash on the P & G claim (fig. 15). The property was located in 1953 by G. D. Gloyd and W. L. Palmer. No work was in operation when the claims were examined on October 31, 1958. No production is recorded.

Workings consist of a shaft 10 feet deep, a sidehill dozer cut 120 feet long with a 12-foot face, and a few shallow prospect pits.

The prevailing formation is schist cut by dikes and masses of pegmatite. The schistosity strikes from N. 40° to 80° E. and dips 35° to 45° NW. The formation varies from a hard, magnetic, hornblende schist to a soft, brown, micaceous schist. Pegmatite dikes on the claims generally strike N. 35° E. and dip 76° NW. There is evidence of north-trending faults which dip steeply east. The pegmatites are highly feldspathic and carry tourmaline.

A cross fracture striking N. 20° E. and dipping 82° SE. was noted in the 10-foot shaft in Dugan Wash. An enriched scheelite mineralized zone 10 in. wide extends along this fracture. The mineralized zone has been opened about 10 feet along the strike. Gangue minerals are epidote, garnet, quartz, and calcite.

At a point approximately 500 feet northeast of the shaft is another exposure of scheelite ore in an altered band of brown micaceous schist. Scheelite occurs in epidote and calcite with a minor amount of quartz. The ore averages perhaps 10 inches wide and has been exposed for about 15 feet. It is estimated that this zone will carry from 0.3 to 0.4 percent WO_3.

Down the canyon 100 yards below the shaft is a pegmatite dike exposed on the southwest side which strikes N. 36° E. and dips 74° NW. It is 2 feet wide where it crosses the canyon. On the hanging-wall side of the dike is a stringer of pure scheelite possibly one-eighth of an inch wide. This occurrence has not been prospected.

Other smaller, less significant occurrences are on the property, none of which have been prospected.

Dahlia Group

The Dahlia group of two unpatented lode claims is in sec. 2, T. 8 N., R. 2 W., on the west side of Walker Gulch at an altitude of about 3,000 feet.

The property may be reached from Morristown by traveling 21.2 miles on the Castle Hot Springs road; then turn left on a road that leads into and up Castle Creek, a distance of 3.2 miles; next turn right or northerly up Walker Gulch for 2.8 miles. A dim bulldozer trail turns right about 200 feet to the main workings on the claims. See fig. 15. No work was in operation when the claims were examined on October 30, 1958.

These claims were located on November 1, 1953, by W. L. Palmer. There has been no production. Workings consist of a sidehill cut about 40 feet long by 10 feet wide with a 6-foot face, and a few shallow prospect pits.

The prevailing formation here is a brown, thinly fissile, micaceous schist. A vein, which thickens, thins, and cuts out entirely in places and which is composed of quartz, tourmaline, and sparse sporadic scheelite, cuts the schist. It strikes N. 35° to 45° E. and dips 70° NW. The vein appears to be discontinuous. Masses of quartz and tourmaline crop out at two other places not on the strike of the vein.

The scheelite is in relatively coarse masses, as much as 2.5 inches in width, and shows no preference in association with quartz or tourmaline. The vein crops out intermittently, about 200 feet, but only a small percent of the exposed quartz and tourmaline carries scheelite. The widest exposure is about 4 feet but only 10 to 12 inches seems to carry the tungsten mineral.

This is a raw prospect, and no exploration has been done to determine the size of the mineralized zones.

C and W Claims

The C and W group of three unpatented lode claims is in sec. 25, T. 9 N., R. 2 W., on a saddle between Walker and Banty Creeks at an altitude of about 3,500 feet. The property may be reached by road and trail by traveling up Walker Gulch for 5.8 miles from its junction with Castle Creek, then left or northwesterly for 0.9 mile to a trail on the south side of the road (fig. 15). Follow this trail southerly through a barbed wire gate for a distance of 0.75 mile from the road.

These claims originally were located by G. A. Westerdahl and W. L. Palmer in 1940. Westerdahl now is sole owner. Only the required assessment work has been done for a number of years. A few hundred pounds of wolframite and scheelite concentrate has been produced from a portable hand jig.

Workings consist of a caved opencut about 25 feet long with a 15-foot face, a caved shaft 30 feet deep, and several shallow prospect pits and trenches.

Following is a geological description by Wilson.[20] Very little work has been done since his examination.

20/ Work cited in footnote 5 (p. 7), pp. 25, 26.

- - -Here the prevailing formation is pre-Cambrian sedimentary schist, intruded on the south by granite and invaded by large sill-like bodies of tourmaline-bearing pegmatite.

In the vicinity of the claims a prominent belt of granular dark-colored schist a few hundred feet wide strikes generally northeastward and dips about 60° NW.; it strongly affects a compass needle, indicating high content of magnetite. This belt is cut at right angles by a fault zone about 2 feet wide and marked by strong gouge in the hanging wall, which dips 80° SE. Its walls show some sericitization. When visited in June, 1941, this fault zone had been opened by a pit 20 feet long by 20 feet deep from which lenticular bodies, 1 to 2 inches wide, of quartz with massive wolframite and scheelite are reported to have been mined. No visible tungsten minerals remained in the face.

Joyce K Group

The Joyce K group of three unpatented lode claims is in sec. 14, T. 9 N., R. 2 W., on the upper drainage of Ryland Gulch, a tributary to Castle Creek shown on the Geological Survey topographical map of the Bradshaw Mountains, Ariz., quadrangle. The altitude is about 3,700 feet. The property may be reached from Morristown by traveling 21.2 miles on the Castle Hot Springs road, they turn left on a road that leads up Castle Creek a distance of 3.2 miles, and right, or northerly up Walker Gulch for 5.8 miles to the old Phoenix-Prescott stage road. At that point turn left or northwesterly, and continue 2.9 miles to Ryland Gulch. The workings are on the west side of the gulch about 200 feet upstream from the point where the road enters the gulch. (See fig. 15, p. 30.)

These claims were located in 1956 by W. L. Palmer. There has been no production. No work was in operation when they were examined on November 8, 1958. Workings consist of three shallow prospect shafts, each no more than 12 feet deep.

Here the prevailing formation is a banded, magnetic, dark-colored schist. It strikes easterly and dips steeply north. The schist has been invaded on the west by pegmatite dikes with considerable tourmaline, and on the east by a fine-grained extrusive, probably basalt.

Altered bands of schist are present. These are composed of epidote, quartz, and calcite which carry sparse, sporadic scheelite. Three small occurrences have been exposed, which range in widths from 2 to 6 inches. The strike of the mineralized zones is about N. 85° E. with a 70° N. dip. The magnetic schist carries thin coatings of scheelite on the schistosity planes. This is well exposed on the east side of Ryland Gulch.

Investigators estimated that ore from the shallow shaft in Ryland Gulch could be hand-sorted to a grade of about 1.5 percent WO_3.

Jonell Group

The Jonell group of five unpatented lode claims is in secs. 30 and 31, T. 9 N., R. 1 W., at an altitude of about 3,500 feet. The property is accessible by road by traveling 5.8 miles up Walker Gulch from its junction with Castle Creek, then southeasterly for 1.5 miles to a dim trail on the right. Follow this trail southerly for 0.3 mile to a shallow pit on Jonell No. 5 claim.

No work was in operation when the property was examined on December 12, 1958. There has been no production. The claims were discovered and located by W. L. Palmer and L. T. Wilbanks in 1953. Palmer now is sole owner. Workings consist of seven shallow opencuts made with a bulldozer, and several hundred feet of bulldozer trenches.

The geologic setting is Precambrian schist. This schist, about 2 miles wide, is shown on the new geologic map of Yavapai County prepared by the Arizona Bureau of Mines. It strikes N. 10° to 30° E. and dips 75° to 80° NW. At the south end of the property the schist is cut by a fine-grained gabbro dike about 20 feet wide which strikes N. 24° E. This dike shows gneissic structure in local areas and contains much epidote in fractures. At the north end of the property there are irregular masses and veins of barren quartz.

Sparse, sporadic scheelite occurs in short, narrow, discontinuous quartz stringers in the schist. These stringers in general are conformable to the strike of the schist, and only a few have been uncovered. Sparsely disseminated grains scheelite occur in the gabbro dike, and there seems to be little or no association with the epidote.

A 1-inch stringer begins about 100 feet east of the gabbro dike and strikes N. 48° E. and dips 74° NW. This stringer contains quartz with some hematite and a little sericite on the walls, and sporadic wolframite and scheelite. This stringer has been exposed for only a few feet.

Scheelite is thinly scattered over an area in excess of 1 mile long and a few hundred feet wide.

White Picacho District

Scheelite Reef Prospect

The Scheelite Reef group of two unpatented lode claims is in secs. 26 and 35, T. 8 N., R. 3 W., at an altitude of approximately 3,600 feet. The property may be reached by road from Morristown, traveling 3.2 miles on the Castle Hot Springs road, then westerly for 3.3 miles on a graded road to San Domingo Wash, and 5.8 miles up the bottom of this drainage to a road and canyon fork. Keep right for 0.5 mile to another road and canyon fork. Keep left for 1.4 miles to where the road becomes impassable. Keep right on a bulldozer trail and walk about 0.5 mile to a small opencut on the Scheelite Reef No. 1 claim. (See fig. 15.)

The claims were located by Earl F. Anderson on September 12, 1943. He retains possession of them today. No work was in operation when the property was visited on November 5, 1958; and very little work has been done since 1950.

Workings on the property consist of an opencut 40 feet long by 12 feet wide with a 15-foot face, a trench 10 by 2 by 2 feet deep, and about 300 lineal feet of trenching in the form of a sidehill road cut.

Production amounts to 6 or 7 tons of ore from which came 37 pounds of concentrates which assayed 62 percent WO_3.

The following description is abstracted from a Bureau of Mines report made in 1950:

Exposed on the property are pegmatite, lamprophyre, unaltered brown schist, and a dark-colored schist, probably hornblende. Contact metamorphism has altered the latter to a rock with a banded structure; bands of unaltered black schist up to 1 inch thick are separated by bands 0.25 to 1 inch thick composed of epidote with a little garnet, quartz, and calcite. The banding is conformable to the schistosity which strikes N. 50° E. and dips 45° to 50° NW. Scheelite is confined to highly altered portions of this schist where it is cut by fractures. It occurs principally as crystals up to one-eighth inch in size, which are on the faces of druses and fractures. Minute particles of scheelite also are sparsely disseminated in the epidote.

The best showing of scheelite is found in the opencut. The schist is fractured and iron stained over an area about 20 feet square. Lamping of this area showed the zone of highest scheelite concentration to be localized along a fracture that strikes S. 60° W. and dips 65° SE. The hanging wall of the fracture contains a zone averaging 0.5-inch thick that contains an estimated 1.0 percent WO_3. Scheelite in possible economic amounts extends 2.5 feet into each wall of the fracture.

Insignificant amounts of scheelite were observed at other widely scattered places on the property. A 10-foot trench, originally about 2 feet deep and sampled by the Bureau of Mines in 1943, assayed 0.01 percent WO_3 for unsorted material and 0.34 percent tungsten trioxide. This trench is now filled with debris, but the Bureau of Mines determined that the scheelite here occurred irregularly along a weak shear zone. The scheelite did not extend into the walls of the shear, but its occurrence was restricted to a few lenses up to 1 inch thick.

A metallurgical test by the Bureau of Mines was made on a 31-pound sample. Gravity concentration of the sample by tabling failed to produce a clean concentrate. The table concentrate, mainly scheelite and epidote, then was cleaned magnetically. The concentrate from this operation assayed 75.0 percent WO_3 and less than 0.01 percent copper. The tests indicate that concentration of the ore by tabling and magnetic separation would probably result in a concentrate containing in excess of 60 percent tungsten trioxide.

Climax Prospect

The Climax group of two unpatented lode claims is in sec. 35, T. 8 N., R. 3 W., on San Domingo Wash at an altitude of about 3,300 feet. The property may be reached by road from Morristown, traveling 3.2 miles on the Castle Hot Springs road, then westerly 3.3 miles on a graded road to San Domingo Wash, and 5.8 miles up the bottom of this drainage to a road and canyon fork. Keep right and continue for 0.5 mile to another road and canyon fork. Keep left for 0.7 mile to a dim trail that branches to the right up the northeast side of the canyon. Follow this trail 0.5 mile to the foot of the hill about 250 feet west of the Climax workings (fig. 15). No work was being done on the property when it was visited on November 5, 1958.

The claims probably were located originally by M. Pachan and D. J. McMillan. They were relocated in July 1939 by James and Carrol Kaler of Morristown, Ariz. Papers on the property show that the property was relocated again in July 1953 by James F. and Emma Kaler of Hollywood, Calif.

Workings on the property consist of two opencuts, each about 50 feet long by 5 feet wide with 10-foot faces, an adit 110 feet long, and a few shallow prospect pits.

Production has amounted to 11 tons of ore assaying 1.1 percent tungsten trioxide, which was shipped to the Metals Reserve stockpile in 1942, and about 29 tons of ore, milled on the property, which yielded 771 pounds of concentrate averaging 50 percent WO_3. In 1954 or 1955 a few tons of ore was shipped from the property by a man named Soloman to the Stetler tungsten mill at Quartzsite, Ariz. The exact amount and content are not known.

Fine-grained sericitic schist striking eastward and dipping northward contains several scheelite-bearing zones. One of these zones, striking N. 85° E. and dipping 55° NW., has been worked from surface cuts for 100 feet along the strike. The schist has been altered along a fracture to epidote with varying amounts of quartz, calcite, and garnet. Scheelite occurs in the gangue ranging in widths from 1 to 2 feet, as grains and crystals ranging in size from dust to as much as 1 inch. Grade of the tungsten-bearing material was estimated by the author to be from a few hundredths to 2 percent WO_3. A pile of ore on the dump indicates that hand-sorting may yield ore assaying 3 to 4 percent WO_3. Small northerly trending cross fractures are mineralized, and scheelite extends along these cross fractures for several feet on both sides of the main fracture.

Although the surface is covered with detrital material, an extrusive volcanic rock, probably andesite, appears to have cut off mineralization 75 feet east of the upper cut.

An adit 110 feet long has been driven from the north about 75 feet below the upper cut. This adit has not cut the mineralized zone worked on the surface.

Starlight (Formerly Buena Vista) Group

The Starlight group of two unpatented lode claims (formerly the Buena Vista) is in secs. 1 and 2, T. 7 N., R. 3 W., on the east fork of San Domingo Wash. The altitude is about 3,500 feet. The property may be reached by road from Morristown, traveling 3.2 miles on the Castle Hot Springs road, then westerly 3.3 miles on a graded road to San Domingo Wash and 5.8 miles up the bottom of this drainage to a road and canyon fork. Keep right and follow the more heavily traveled road for 1.2 miles to the Buena Vista fork. Turn left or northerly and go 0.5 mile to the main workings (fig. 15). No work was being done on the claims when they were examined on November 6, 1958.

The Buena Vista claims were owned for a number of years by James Kaler and D. J. McMillan. The property was leased in 1942 to M. L. Tobin and H. D. Dean. C. F. Cole relocated two claims, called the Starlight, over the tungsten showings on June 19, 1954. His widow, Dora Will of Morristown, retains possession of the property today.

Workings consist of an opencut 25 feet wide by 50 feet long with a 25-foot face, an adit 20 feet long, several shallow prospect cuts and shafts, and several thousand lineal feet of bulldozer cuts on the hillsides. Eighteen tons of ore, grade unknown, was shipped from the property in 1941 or 1942. The claims were leased in 1954 to a man named Pachen who did some prospecting and mined a few tons of ore, quantity and grade unknown.

Schist covers the Starlight group. The schist is cut by a number of pegmatite dikes which at some places appear to cut through the foliation and at other places to conform to the schistosity. The schist strikes N. 60° to 75° E. and dips 35° to 45° NW. One dike strikes east and dips 47° N.; another strikes N. 75° E. and dips vertically; and another strikes N. 15° E. and dips 58° SE. There is much faulting in evidence in the deep canyon west of the main workings.

The pegmatite dikes are highly feldspathic and contain some tourmaline. Scheelite, as grains to 0.25 inch in size, is present in altered bands of hornblende schist. The bands are as much as 15 feet wide and are composed principally of epidote with varying amounts of quartz, calcite, and garnet. The scheelite occurs sporadically within the bands to widths of 3 feet. Cross fractures striking N. 12° W. and dipping 80° SE. appear to have caused local enrichment within the mineralized zones.

In the deep canyon to the west are two parallel stringers about 1 inch wide of nearly pure blue and yellow fluorescing scheelite. The stringers strike easterly and are nearly vertical. Copper oxides occur in a parallel quartz vein a few feet west of the stringers. This occurrence of scheelite has not been propected.

There are at least six mineralized bands, each about 3 feet wide, in a zone 300 feet wide. One of these bands has been traced for about 600 feet, and smaller mineralized areas are traceable for one-half mile eastward from the main workings.

Estimated grade of the tungsten-bearing material at the workings is low. The mineralized zones probably will not carry more than 0.3 percent WO_3, but hand-sorting would probably yield material as high as 0.7 or 0.8 percent WO_3.

Congress Area

Gray Fox Prospect

The Gray Fox unpatented lode claim is in sec. 25, T. 10 N., R. 5 W., at an altitude of about 4,200 feet. The property may be reached by road from U.S. Highway No. 89 as follows: Turn east on the Stanton-Octave road 1.9 miles north of Congress Junction and continue 6.5 miles to the Antelope Creek road, then northerly up Antelope Creek 1.4 miles to a dim eastward-branching truck trail, and 0.5 mile to the Gray Fox workings on the west side of Rich Hill (fig. 16).

This claim was located by James A. Williams and Elmer Mitchell on August 6, 1951. They produced nine units of WO_3 from 1952 to 1954. The property was sold to Orwin Smith, Littleton, Colo., on November 2, 1953. No work was in process when it was examined on December 18, 1958.

Workings consist of two shafts, one about 10 feet deep and the other about 20 feet deep, and three shallow sidehill cuts, none exceeding 4 feet deep.

Sparse, sporadic scheelite and ferberite (?) occur in altered hornblende schist adjacent to a granite contact on the west side of Rich Hill. Both of these formations are Precambrian according to the geologic map of Yavapai County prepared by the Arizona Bureau of Mines.

The schistosity strikes N. 40° to 60° E. and dips 60° to 70° SE. Small, irregular, discontinuous stringers as much as 3 inches wide of iron-stained quartz and altered feldspar occur conformable to the schistosity. Sparse, sporadic ferberite (?) and scheelite occur in both quartz and feldspar. The ferberite(?) is associated with dark blue fluorite. Sparse, isolated pods of quartz and feldspar with tungsten minerals and fluorite occur in the schist as much as 10 feet from the contact. One such pod weighing approximately 10 pounds was dug from the schist and was estimated to carry about 15 percent ferberite (?). A few feet north of the workings sparse small grains of scheelite occur in a small, irregular mass of epidote with a little garnet.

The mineralized schist is covered with detritus, and outcrops are rare. No work has been done to determine the extent of the formation.

The author found the same formation for 100 feet southwest of the workings and 50 feet to the northeast. Only in the vicinity of the workings was any scheelite float observed.

Mesa Grande Addition Prospect

The Mesa Grande Addition group of two unpatented lode claims is in the NE¼ sec. 8, T. 9 N., R. 4 W., at an altitude of about 3,600 feet. To reach the property by road turn easterly on the Stanton-Octave road 1.9 miles north of Congress Junction; continue easterly 10.4 miles and walk by trail about 0.3 mile north to the workings (fig. 16).

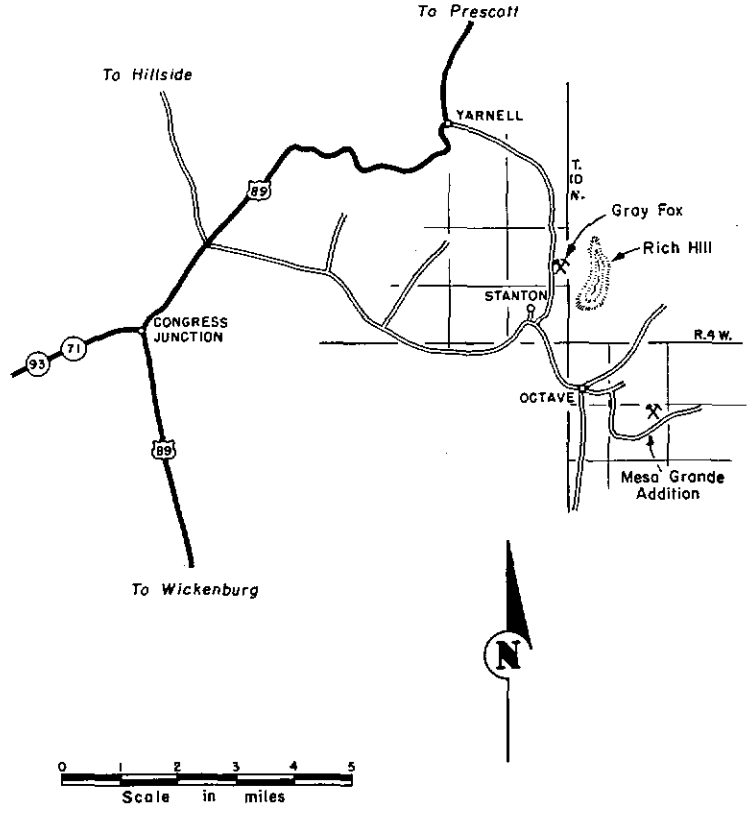


FIGURE 16. - Location Map, Gray Fox and Mesa Grande Addition Prospects, Yavapai County, Ariz.

The claims were located in September 1953 by George W. J. Miller. The property has yielded 150 pounds of concentrate which assayed 74 percent WO3. No work was in progress when the property was examined on December 19, 1958.

Workings consist of three hillside opencuts, each about 15 feet long and none with more than 8-foot faces, and a few shallow prospect pits.

The geologic setting here is Precambrian granite and gneiss with small schist remnants. Sparse, sporadic scheelite has been found in a 2-foot vertical quartz vein which strikes N. 13° E. The quartz cuts altered granite and gneiss and carries small amounts of epidote. Scheelite enrichment occurs at the intersections of the vein with narrow, quartz-filled cross fractures that strike N. 70° E. with a 70° NW. dip and N. 10° W. with a 65° SW. dip. Scheelite is in sporadic masses up to 4 inches in cross section. This vein has been traced on the surface for 50 feet. The surface is covered with detrital material.

Sparse, sporadic scheelite also occurs in a small cut approximately 300 feet southwest of the main workings, and in a small quartz stringer.

North of the main workings about 75 feet is a cross vein of quartz ranging from 3 to 4 feet wide. This vein strikes N. 75° W. and can be traced on the surface for almost 70 feet. This quartz is impregnated with flour scheelite, and under the ultraviolet light appears to be quite high grade. However, the specific gravity of the rock is essentially that of quartz. Scheelite float is thinly scattered above and below the main workings.

About 150 feet east of the workings is a formation of dark-colored schist which strongly affects a compass needle. This schist formation contains magnetite and small amounts of ilmenite and chromite. It is composed predominantly of hornblende and chlorite.

Bagdad Area

Black Magic Group

The Black Magic group of five unpatented lode claims is in secs. 23 and 26, T. 16 N., R. 7 W., in the Connell Mountains at the western edge of the Prescott National Forest. The altitude is about 5,600 feet. No work was in progress when the property was visited in September 1958; Thelma Martin of Wikieup was the owner. The claims may be reached from Camp Wood, which is 40 miles northwest of Prescott, by traveling 5.6 miles westward from Camp Wood on the Yolo Ranch Road, then 2.3 miles southward on the Beacon Light Road to a road fork. Keep left and continue southward down a canyon for 1.2 miles to an adit on the west side of the canyon (fig. 17).

Ben E. Joy of Prescott located a group of 10 claims in 1937 on a wolframite occurrence which he discovered by tracing float to its source. Joy dug many shallow pits on the better showings of small enriched zones, and then obtained a $20,000 Reconstruction Finance Corporation loan to drive a 600-foot adit. He cut at least one of the enriched zones that showed on the surface, but the tungsten minerals did not extend to the adit level. Joy's production figures are not known, but he produced at least 700 pounds of tungsten concentrates assaying 52 to 63 percent WO_3. History of the property is not known from the time Joy stopped working it until it was relocated in October 1955 by Thelma Martin. The only recent work on the property is a little stripping with a bulldozer and a shallow, caved shaft.

The mineral deposits comprise parallel quartz veins carrying sparse, sporadic wolframite. The veins occur in a coarse-grained, altered granite which has been intruded by large pegmatite dikes containing pink orthoclase. The western part of the area is overlain by a lava flow about 100 feet thick. There are some schist inclusions in the granite. About 40, generally narrow, veins have been found, only a few of which have contained several scattered masses of wolframite. The quartz veins are seldom more than 2 feet wide, strike eastward, and dip 45° to 50° S.

Wilson[21] examined the property in 1940. An excerpt of his report follows:

21/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, pp. 22, 23.

They (the veins) are traceable for lengths of 2,000 to 4,000 feet across the canyon. Their filling consists of coarsely crystalline grayish-white quartz from 3 inches to 10 feet wide. In places it contains bodies of wolframite as scattered particles ranging from a fraction of an inch to more than 3 inches in diameter, associated more or less closely with pyrite. The vein walls have been strongly altered to coarse-grained sericite.

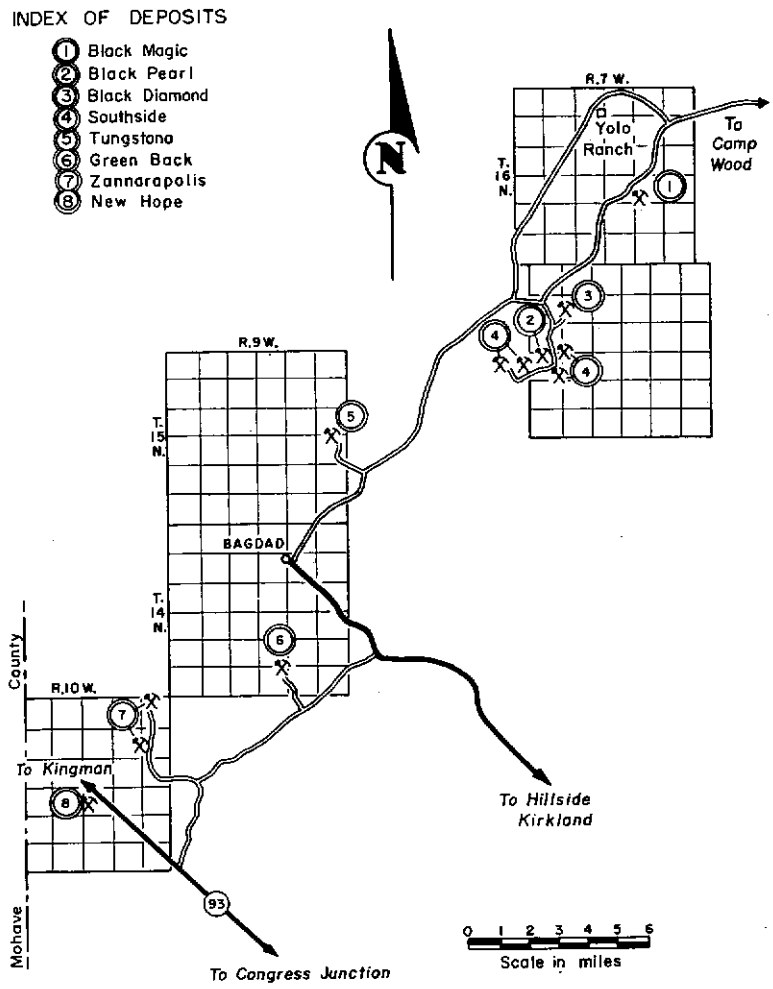


FIGURE 17. - Location Map, Tungsten Deposits in Bagdad Area, Yavapai County, Ariz.

Unfortunately, the adit driven by Joy was caved and filled with water at the time of the author's examination. Reports show that Joy cut at least one of the veins at depth. The quartz was reported to carry only iron minerals, and no tungsten.

Black Pearl Mine

The Black Pearl group of 11 patented claims and 5 unpatented claims is in secs. 7, 8, and 18, R. 7 W., and secs. 12 and 13, R. 8 W., T. 15 N. (fig. 18). The Black Pearl mine is in the NW¼ sec. 18 at an altitude of about 5,700 feet. It is accessible from Bagdad by 19 miles of county-maintained dirt road (fig. 17). The mine is shown on the Geological Survey topographical map of the Bagdad, Ariz., quadrangle (1948 edition), but the road from Bagdad to the mine is shown only as far as Wildhorse Basin, although it now extends to the mine. The mine was idle in September 1958.

The Black Pearl claims were located first by William Conners. Several veins are known to exist on the claims, but only one has been explored to any extent. This lode was explored intermittently by small test pits and adits over a length of 1,900 feet by William Lawler and Homer Wood from 1915 to 1935. A small amount of stoping was done during this period and a production was made of 62,100

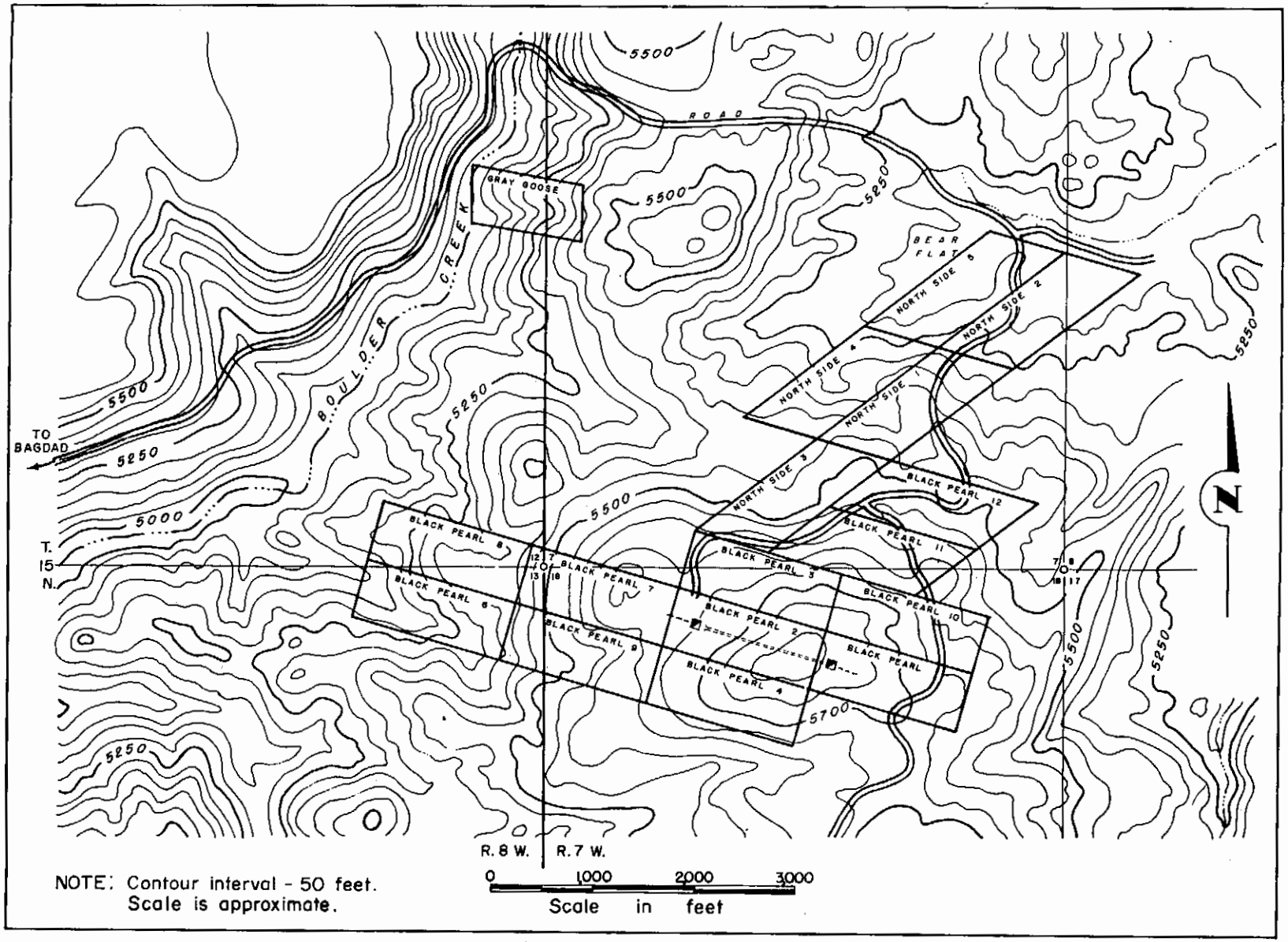
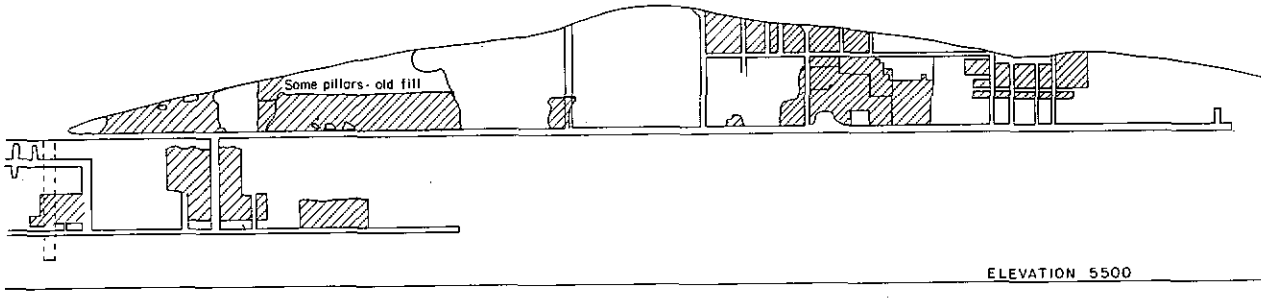


FIGURE 18. - Topographic and Claim Map, Black Pearl Mine, Yavapai County, Ariz.

pounds of concentrates containing 70 percent WO_3.[22/] In 1936 Vega Mines Co., an Arizona corporation, drove and sampled 180 feet of adit.

R. D. Tripple, operating as Dixon Mineral Co., leased the claims in 1950, and on April 30, 1951, E. A. Scholz and J. H. Cazier secured a lease and option to buy the claims from the owners, John Lawler, J. E. and K. I. Harrington, Joseph and Florence Walton, and Mary Lyons. The option has been extended to October 1, 1964. On February 2, 1955, a Defense Minerals Exploration Administration contract was granted to Black Pearl Mining Co. (Scholz, Cazier, and L. K. Lindahl). The company continued working until November 1, 1955, when Hillside Mining and Milling Co. obtained a sublease and option. The contract then was assigned to the Hillside Mining & Milling Co. by the Defense Minerals Exploration Administration. The latter company continued mining operations through July 1956. Hillside Mining & Milling Co. released its lease and option in February 1957, and the property reverted to Black Pearl Mining Co. Production from 1951 through 1956 was 6,312 units of WO_3. Figure 19 is a map of the principal workings.



LONGITUDINAL PROJECTION OF WORKINGS

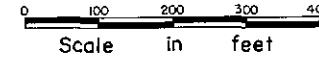


FIGURE 19. - Black Pearl Mine, Yavapai County, Ariz.

When the author visited this claim the entrance gate to the property was padlocked and workings were inaccessible. The following geological and mineralogical descriptions are taken from the files of the Defense Minerals Exploration Administration.

> The Black Pearl mine is developed on a northwesterly trending fissure vein which dips steeply to the south in a granite host rock. This rock is probably of early Precambrian age, and apparently forms the basement rock of an extensive region. Relatively

22/ Work cited in footnote 21 (p. 42), p. 21.

large parts of the region are covered by a series of Quarternary or Tertiary lava flows with which gravel deposits are interbedded. Lavas form the tops of broad mesas in this area, but near the mine the lavas and gravels are absent and the underlying rock is granite.

The normal granite near the mine, forming the host rock for the Black Pearl vein, is a medium to dark gray, relatively coarse-grained aggregate of quartz, orthoclase, hornblende, and biotite. The granite is cut by a series of joints spaced from 0.5 to 1.5 feet apart and approximately parallel to the vein. The joints occupy a zone on the south side of the vein, but similar joints were not found north of the vein. (Author's note: Mr. Cazier states that these joints show in the shaft north of the vein.) Crystals or clots of feldspar lying across the joints in the granite are not offset or otherwise affected.

A type of granitic rock, distinctly different from that described above, crops out a few hundred feet west of the exposed part of the Black Pearl vein. This granitic rock is a uniformly fine-grained, whitish, aplitic rock in which quartz is the dominant mineral. In appearance the rock is similar to alaskite. (Author's note: Scholz states that the rock varies from the Alaskite to Aplite.) In this rock, and about on the projection of the Black Pearl vein, there are many dark brown or reddish spherical clots. Some of these clots, not so deeply weathered as others, reveal a core of granular pyrite. A dike of similar, aplitic, light-colored granite crosses the Black Pearl vein near its eastern end, but neither the dike nor the vein appears to be noticeably affected by the other at the junction.

The Black Pearl vein (figs. 20 and 21), which occupies a narrow fissure in granite, strikes N. 70° to 75° W. and dips 75° to 85° south. The strike length of the vein at the outcrop is about 1,800 feet, and the potentially productive part of the vein is about 1,600 feet. The continuity of the vein is interrupted only by a slight echelon arrangement of the vein segments and by short intervals that are barren or only slightly mineralized. The vein is of fairly uniform thickness, averaging about 3 feet; however, it thins appreciably and apparently pinches out at both ends.

The vein makes a sharp contact with the granite and in most places where the contact can be observed there is a thin selvage of gouge between the vein and the granite. This gouge is commonly slickensided and the plunge of the striations on it varies from nearly horizontal to nearly vertical. There is no indication that appreciable displacement has taken place along the fissure, either prior to or following emplacement of the ore.

The granitic host rock near the vein has been altered to greisen, which is recognizable mainly by a preponderance of

coarse, white mica. The mica is a common mineral in the wall rock next to the vein, along the faults and fractures that intersect the vein, and also in relatively barren parts of the vein.

The predominant gangue mineral in the Black Pearl vein is massive, grayish-white, coarse-grained crystalline quartz. Associated locally with the quartz are abundant masses or veins of coarse muscovite, and some relatively small amounts of a pinkish feldspar occurring as veinlets. The quartz commonly has a network of tight fractures. At the surface these stand out as thin, reddish brown lines. Coarse, euhedral crystals and crystal aggregates of blue-green beryl are relatively abundant in the vein, and in a few places purpose fluorite is abundant.

The principal hypogene metallic minerals in the vein in decreasing order of abundance are: pyrite, wolframite, specularite, bismuthinite, and molybdenite. Gold and silver are reported to be sparingly present in the ore and chalcopyrite is present in trace amounts. Scheelite is reported to be present in minor amounts.

Pyrite is the most abundant of the metallic minerals and according to Scholz it constitutes about 25 percent (by weight) of the vein material. The pyrite varies from coarse- to fine-grained, crystalline or massive, but generally occurs in large masses in the vein. These masses tend to be crudely elongated normal to the vein walls.

The ore mineral is wolframite. This occurs in the vein as isolated euhedral to subhedral crystals which range from a fraction of an inch to many inches in maximum dimension, and crystals 2 or 3 inches across are moderately abundant. Scholz reports that the largest single piece of wolframite recovered from the mine weighed about 250 pounds and that pieces which weigh from 10 to 15 pounds are frequently recovered. He also reported that the iron content of the wolframite is slightly higher in the west part of the vein and the manganese content is highest in the east part of the vein. The ratio of iron to manganese is about 1:1 on the west end of the vein and 1:1.3 on the east end. The wolframite tends to be lighter colored on the east end and darker colored on the west.

Specularite is abundant in parts of the vein zone and appears to be concentrated in or very close to barren parts of the vein. The parts of the vein that contain specularite contain little or no wolframite; apparently these two minerals are incompatible. This relationship of specularite to wolframite may be a useful guide in exploration.

Bismuthinite occurs in coarse- to fine-grained platy or acicular crystals in small masses or nuggets but is not abundant. Scholz and

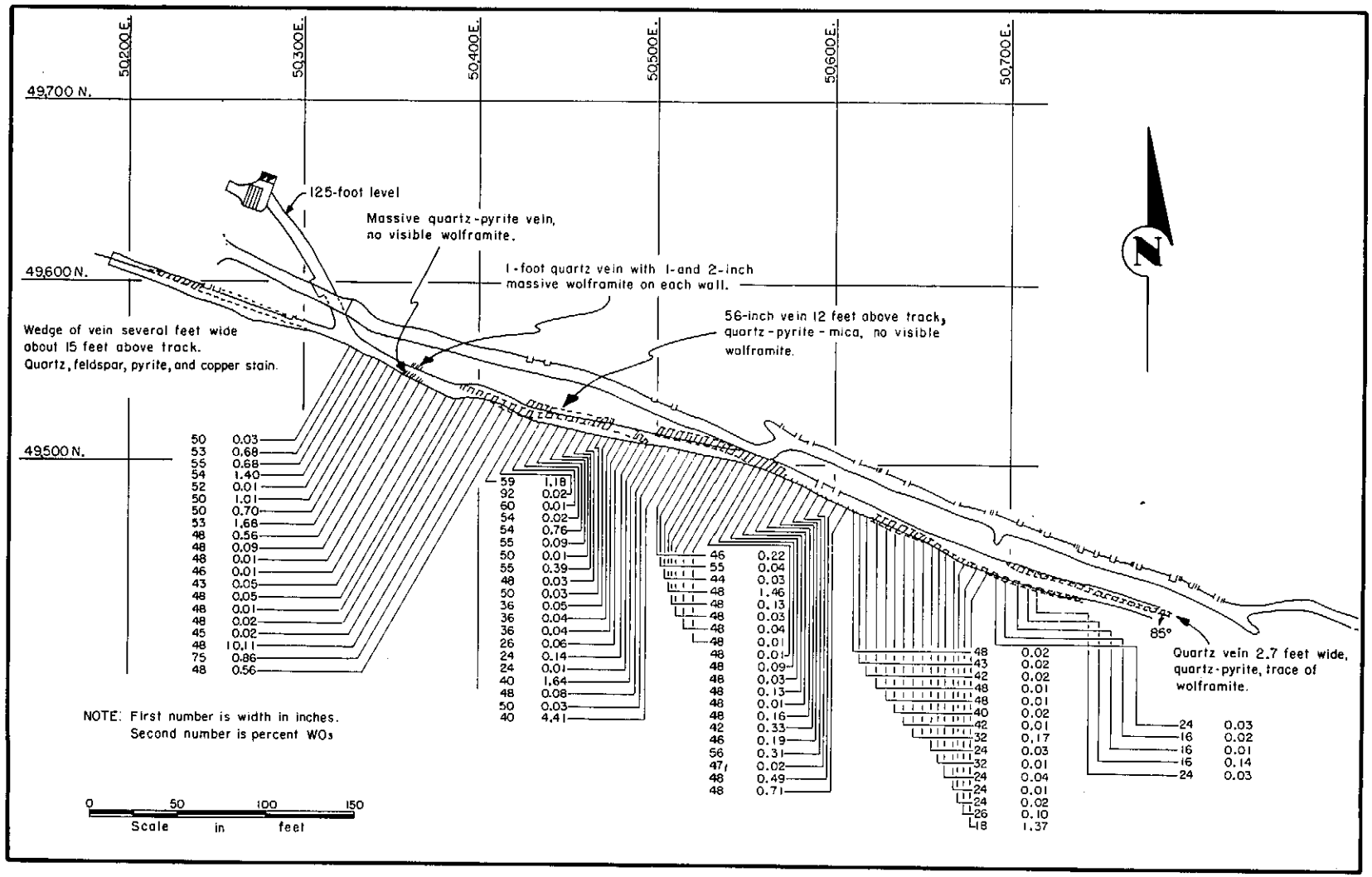


FIGURE 20. - Plan and Assay Map, West End of Black Pearl Mine, Yavapai County, Ariz.

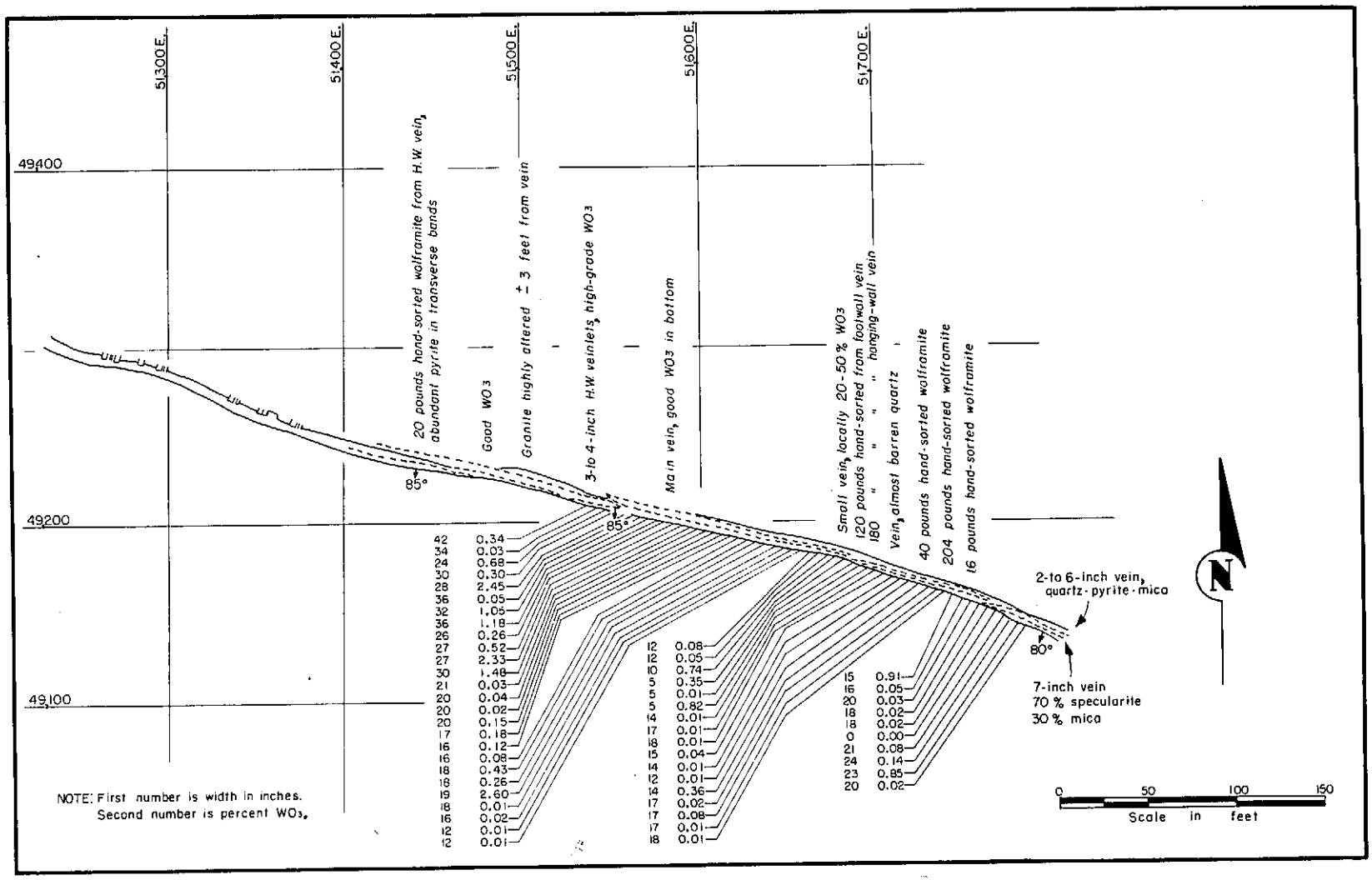


FIGURE 21. - Plan and Assay Map, East End of Black Pearl Mine, Yavapai County, Ariz.

Cazier estimated that the ore contains 0.12 percent bismuth, probably all in the bismuthinite, which, if recoverable, would constitute a valuable by-product of the ore. (Author's note: According to Cazier silver values appear to be associated with the bismuthinite.)

Molybdenite occurs in a coarse to fine platy granules and apparently is widely distributed in the vein in very small amounts. It is doubtful if it could be recovered economically.

Beryl is sufficiently abundant in the ore to be of possible commercial value; Scholz and Cazier estimated that the BeO content of the ore ranges from 0.15 to 0.5 percent. The beryl occurs as pale-blue euhedral crystals and columnar aggregate. The individual crystals are often from 1 to 2 inches long, and crystal aggregates several inches across and weighing several pounds are not uncommon. Some of the beryl is recovered by hand sorting but none of it has been marketed.

Muscovite is relatively abundant. Scholz and Cazier estimated that this mineral constitutes 2 to 4 percent of the vein filling. The muscovite is generally concentrated along the vein walls and forms seams from about 1/4 to 2 inches wide, but in some places occurs as more or less isolated masses. Most of the muscovite is coarse-grained; however, a very fine-grained mica was found in a few thin veinlets cutting vein quartz.

Oxides of iron, largely derived from weathering of pyrite, occur abundantly in the outcrop and in the near-surface mine workings. Pyrite is not present in the outcrop but cavities from which pyrite has been leached are abundant. Oxidation has extended to a depth of at least 40 feet below the outcrop and has caused a slight disintegration of the vein to this depth, thus making the ore somewhat more amenable to mining and milling than the unoxidized ore.

The paragenesis of the hypogene vein minerals is very complex. The deposit appears to be a pegmatite that verges on the hypothermal type of vein. The mineral sequence suggests overlapping or "telescoping" of the two types of deposits, and it is possible that the exposed part of the Black Pearl vein represents the transition zone between a hypothermal quartz vein and a pegmatite.

Margie C. (CTM) and Black Diamond Group

The Black Diamond and CTM group of 25 unpatented lode claims is in sec. 12, R. 8 W., and sec. 7, R. 7 W., T. 15 N., at an altitude of about 5,200 feet. The property adjoins the Black Pearl group on the northwest. The claims are accessible from Bagdad by traveling 16.6 miles northeasterly on the Black Pearl Road, and left, or northerly 0.5 mile to the principal workings on the claims (fig. 17). The property was idle in September 1958.

These claims are relocations of 16 claims originally located by Joe Strotjost about 1940, and reports indicate that he recovered a few pounds of high-grade wolframite float. Many relocations have been made on these claims. Clint Camp lived on the property for 10 years and sold some high-grade float found on the property. Tungsten Consolidated Mines, Inc., acquired the property in the mid-1950's. The last relocations of 25 claims are dated July 5, 1956. Yucca Tungsten Corp. leased the property in 1956 and milled a few tons of ore, but the concentrate did not meet market specifications.

Workings consist of an inaccessible inclined shaft probably 50 feet deep, an inclined adit about 100 feet long, a small amount of bulldozer stripping, and several shallow pits and prospect holes.

Several quartz veins are present, ranging in width from 3 to 18 inches. The veins are in a gray, altered, medium-grained granite which contains both muscovite and biotite. The granite is highly altered in places and is stained with iron in the vicinity of the quartz veins.

Very sparse, sporadic, small crystals of wolframite occur in the quartz veins. Also present are variable amounts of muscovite and limonite with some manganese stains. The quartz veinlets which have been worked most extensively are discontinuous. The veinlet in the inclined adit strikes N. 80° E. and dips 78° S. It can be traced for perhaps 150 feet. Some scheelite float has been found in this vicinity.

South Side Group

The South Side group of 29 claims is in secs. 17 and 18, R. 7 W., and sec. 13, R. 8 W., T. 15 N., at an average altitude of approximately 5,400 feet. The property is accessible from Bagdad by traveling 17.2 miles northeasterly on the winding Black Pearl Road, and southwesterly 1.8 miles to the South Side campsite by way of a trail that branches left or easterly from the Black Pearl Road (fig. 17). Arvid Alm was living on the property and doing assessment work when the property was examined in September 1958.

Claim locations on this property were made as early as 1916 or 1917 when Laso Bozarth sank a shallow shaft on Double Jack Hill. Ore from this shaft is reported to have contained 3 to 4 percent WO_3. Claude Eckel and Robert Stark worked the claims intermittently from 1935 to 1940, when Eckel, Stark, and Arvid Alm relocated some of the better showings. A small mill was built on Boulder Creek, and about 1 ton of concentrates containing about 70 percent WO_3 was produced in 1942. Both Eckel and Stark died a few years ago. In 1954, Alm, Joseph Lyle, Oscar Hylton, and Alvin Cook relocated several of the claims. Subsequent relocations of adjoining ground have been made.

A small production has been made from several surface pockets on the property. No record is available, but Alm estimates that 3 tons of concentrates and cobbed ore containing at least 60 percent WO_3 has been produced. Much of this production came from small, nearly pure pockets of wolframite.

As an example, the location hole on the Red Line No. 10 in the extreme northeast corner of sec. 18 produced 10 units of WO_3.

Workings on the property consist of several adits from 20 to 100 feet long, several shallow shafts from 10 to 40 feet deep, and many shallow pits and opencuts.

The geologic setting is granite with one small remnant of schist and gneiss. The predominant type of granite is medium to dark gray, coarse-grained, and extensively altered in places. This formation is cut by at least three joint sets. Some of these joints adjacent to the south side line of the Black Pearl group show movement. This granite is the principal host rock for numerous quartz veins.

A type of granite, distinctly different from that first described, crops out a few hundred feet south of the south sideline of the Black Pearl group. This is a uniformly fine-grained, light gray, aplitic rock in which quartz is the predominant mineral. This rock contains many dark reddish-brown nodules or clots. Some of these, not so deeply weathered as others, reveal a core of granular pyrite. These nodules or clots were reported to carry yttrium, but a sample from outcrops showed only a trace amount.

A pink, very coarse-grained dike of granite is immediately north of the aplitic rock. It is predominately pink orthoclase with some glassy quartz and small books of muscovite. It strikes N. 80° W.

At 0.3 mile east of the Alm campsite, the road has cut a mineralized zone 3 to 10 feet wide. Muscovite mica with cubes of limonite (after pyrite) is predominate in this zone. Fluorite is locally present in very small crystals. The owners reported that lithium assays to 2 percent had been obtained from this zone. A sample cut 3.5 feet across the best mineralized portion showed only a trace of lithium.

On the north side of Double Jack Hill are two short adits driven into a fault through a remnant of schist and gneiss. The owners reported that chromium assays to 6 percent had been obtained here. The author cut a sample across 1 foot of the fault material, which gave only a trace of chromium. The strike of this fault was N. 80° E. and dip was 81° S.

Sparse, sporadic wolframite occurs in numerous quartz veins which cut the gray, coarse-grained granite. The veins are discontinuous and are sometimes parallel with only a few feet of granite separating them. The veins seem to fit into one of three patterns: East strike with 80° to 85° S. dip, N. 50° to 80° W. strike with 75° to 85° S. dip, and N. 70° to 80° E. strike with 70° to 80° S. dip. They range in width from 1 to 40 inches. Several flat spur veinlets were observed on the South Side No. 7 claim (formerly Bonus). These spur veins were wedge shaped in cross section, and were several inches thick at the intersection with the main vein, but thinned to mere fractures in the granite a few feet from the hanging wall of the main quartz vein. From the workings it seems that these flat spur veinlets at the intersection with the main quartz vein were probably a source of tungsten.

According to Alm the wolframite for the most part occurred as large crystals and aggregates so that a high-grade product resulted from sorting and cobbing the ore. The wolframite does not seem to be confined to any one set of veins, but appears to be distributed very erratically throughout.

The quartz carries varying amounts of iron oxides and locally abundant muscovite. Small amounts of fluorspar were observed. According to Alm, wherever abundant muscovite is found in the quartz veins, wolframite is found adjacent to it.

Tungstona Mine

The Tungstona mine comprises 18 unpatented lode claims in secs. 13, 14, 23, and 24, T. 15 N., R. 9 W., in the Eureka mining district. The altitude is about 4,000 feet. The property is accessible from Bagdad by traveling 3.9 miles northeasterly on a county-maintained dirt road, and 2.6 miles to the Tungstona shaft and mill (fig. 17). The claims were idle when visited in September 1958. The property is owned by Bagdad Copper Corp.

Three claims of the group were located originally by Julius Comode in 1932. Comode abandoned the claims, probably in 1943, after having mined a few tons of ore from deposits near the portal of the present adit of the Tungstona mine. The ore was milled on the property with a sample crusher, rolls, and concentrating table. The few pounds of concentrate produced were marketed with an ore buyer in Tucson, Ariz.

In 1945, Russell Samson of Bagdad located a group of five claims, including the three original ones. He did little work on them to the middle of 1952, when the property was acquired under a lease and option agreement by Hillside Mining & Milling Co. Shortly thereafter the company located 13 additional claims (fig. 22) and initiated an underground exploratory program by driving an adit designed to crosscut the most favorable surface-exposed zone at a depth of about 250 feet. The zone was encountered and extensively explored by drifts and crosscuts. Five stopes were prepared and mined until approximately 15,000 tons of stope and development ore, containing an average of 0.15 percent WO_3, had been produced. The ore was trucked to the Hillside mine for pilot plant tests. The tests, completed in September 1953, resulted in the production of 17,000 pounds of concentrates containing 63 percent tungsten trioxide. A 500-ton plant was built on the property and began operating on November 3, 1954. The property continued to operate until the price of tungsten dropped. Production from 1952 through 1956 was 7,449 units of WO_3 from possibly 50,000 tons of ore.

Bagdad Copper Corp. has acquired sole ownership of the property. At the present time, water is being pumped from the mine for domestic use at Bagdad.

Figure 23, a map of the mine workings, and figure 24, a topographic map of the area, were furnished by the owner.

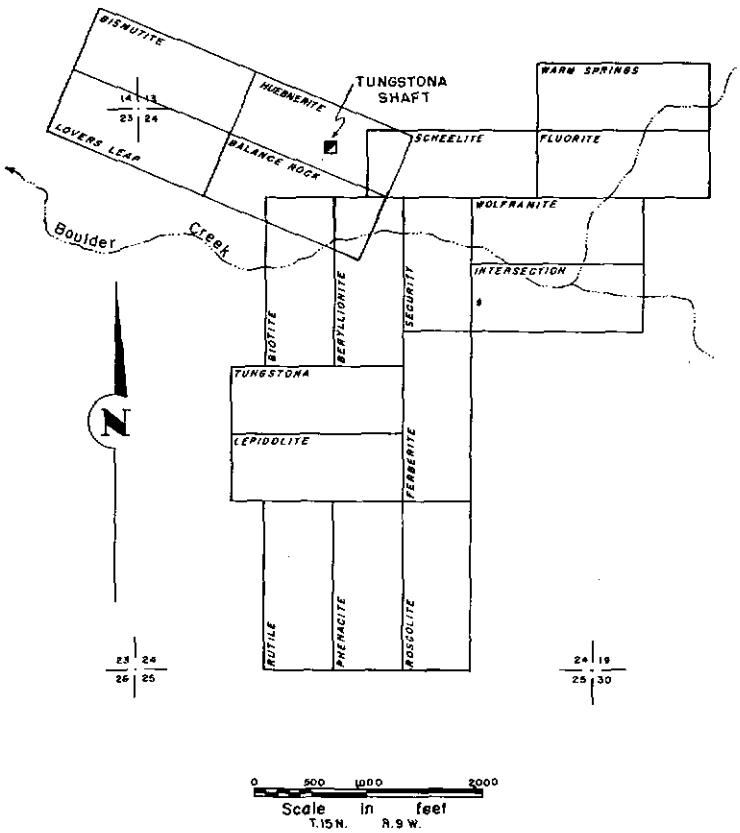


FIGURE 22. - Claim Map, Tungstona Mine, Yavapai County, Ariz.

The U.S. Geological Survey has published a paper on the geology and ore deposits of the Bagdad area.[23]

The following is an excerpt from page 79 of this report:

Along Boulder Creek in the northeast corner of Bagdad area, wolframite-bearing veins appear in the muscovite-granite facies of the Lawler Peak granite (Precambrian). The wolframite crystals, as much as one-quarter of an inch long, occur in closely spaced, nearly vertical, parallel quartz veins as much as 1 inch and, rarely, 2 inches wide. South of Boulder Creek they form a zone nearly 12 feet wide and strike northwest and have a continuity of 200 or 300 feet. On the north side of the creek, however, an easterly-trending zone of veinlets that is 10 to 50 feet wide crops out for a distance of more than 2,000 feet. Development of this easterly-trending zone of veinlets was being done at the Tungstona mine in 1952.

Beryl is an important accessory mineral in the quartz veins and locally is very abundant. Small amounts of scheelite occur in thin films and crusts on the surface exposures and it is reported that scheelite has been found in the underground workings of the Tungstona mine. Genetically the veins are the result of filling of fissures by late-stage emanations from the Lawler Peak granite magma.

The following geological and mineralogical descriptions are abstracted from a previous report by the Bureau of Mines in 1954.

The granite surrounding the mine ore is medium to coarse grained pinkish in color, and appears to be unaltered. In the mine area, the granite has been silicified and altered to a light gray color. The altered granite is confined to a roughly elliptical area, possibly 2,000 feet long by 1,000 feet wide.

23/ Anderson, C. A., Scholz, E. A., and Strobell, J. D., Jr., Geology and Ore Deposits of the Bagdad Area, Yavapai County, Arizona: Geol. Survey Prof. Paper 278, 1955, 103 pp.

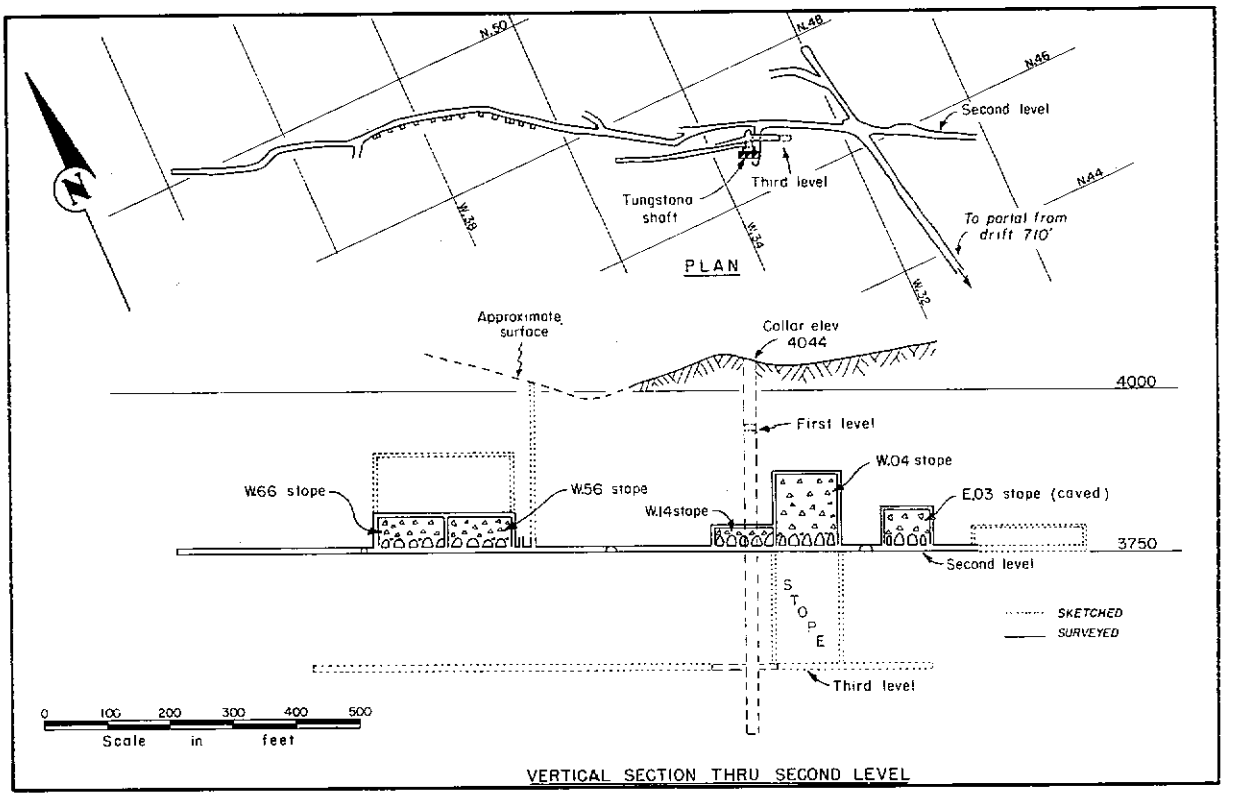


FIGURE 23. - Mine Workings, Tungstona Mine, Yavapai County, Ariz.

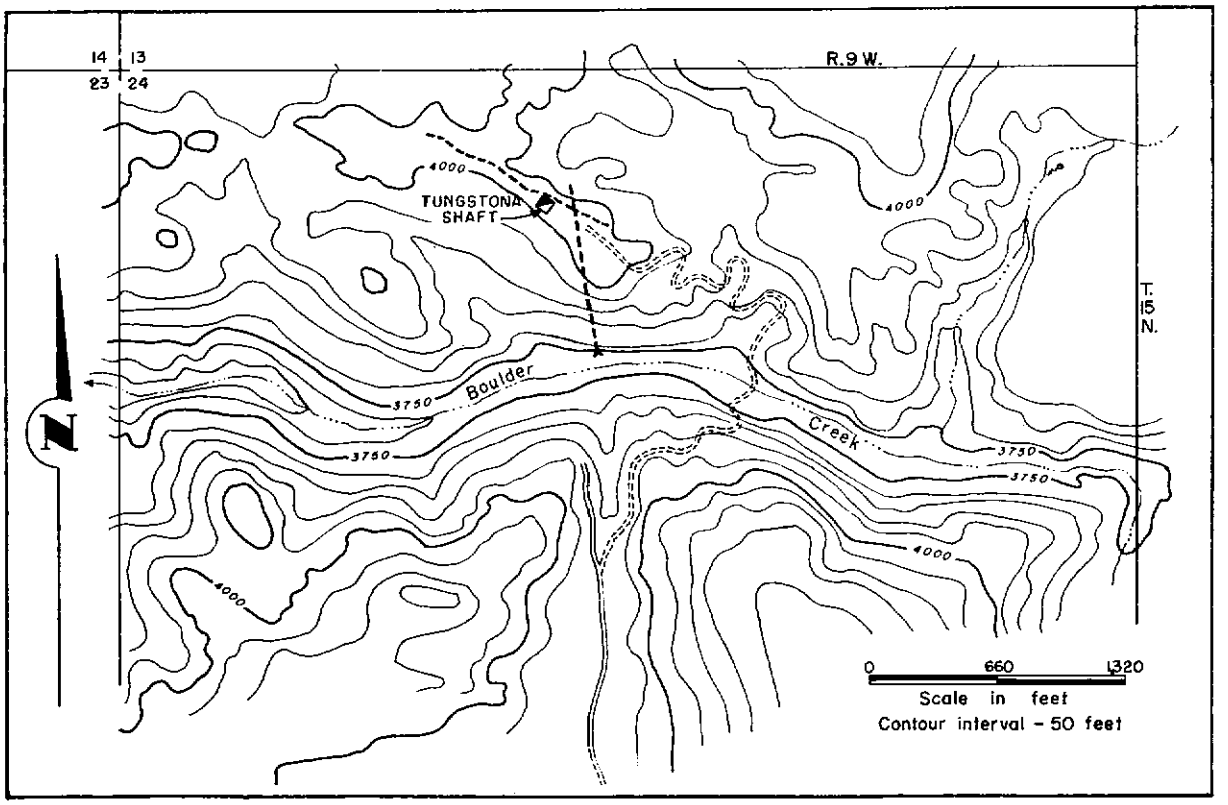


FIGURE 24. - Topographic Map, Tungstona Mine, Yavapai County, Ariz.

The altered granite is cut by three parallel shear zones that strike approximately N. 70° W., and dip about 75° to the south. The shear zones are traceable for several hundred feet.

Ore minerals seem to be confined to fairly persistent quartz veinlets that occupy fractures in the shear zones and that are roughly conformable with the dip and strike of the shear zones. The veinlets average about 0.75 inch wide and are spaced at intervals of a few inches to several feet. The greatest concentration of veinlets in the deposit being developed is along the north 12- to 15-foot portion of the vein zone where they occur at average intervals of about 6 inches. Tungsten is distributed sporadically in the quartz as grains of wolframite, huebnerite, and scheelite. Associated with the tungsten minerals are appreciable amounts of muscovite, and grains of beryl, fluorite, molybdenite, and bismuthinite. Iron minerals are present in variable amounts. Hematite and limonite at the surface give way almost completely to pyrite at a depth of about 150 feet.

The following excerpt is taken from page 97 of Geological Survey Professional Paper 278:

> In 1944, Russell Samson and associates erected a 10-ton mill and a concentrating table to separate the wolframite, and Mr. Samson obtained 90 pounds of concentrate containing 30 percent WO_3 from 7 or 8 tons of mineralized rock from an open cut in the vein system south of Boulder Creek. In order to obtain additional information as to the grade, in 1944 we cut 2 channels across both mineralized zones; one sample, 8 feet long, from north of Boulder Creek contained 0.16 percent WO_3; the other sample, 11.4 feet long, from south of Boulder Creek contained 0.13 percent WO_3. These determinations were made by F. S. Grimaldi of the Geological Survey. Spectrographic analyses of the same samples, made by K. J. Murata, also of the Survey, indicate 0.05 percent BeO in the north zone and 0.2 percent BeO in the south zone. Minor constituents include lead, bismuth, molybdenum, and vanadium.
>
> Eighteen tons of mineralized rock were blasted from the exposures south of Boulder Creek by Russell Samson in 1944. The broken rock was ground in a ball mill and a 275-pound sample was split from the discharge. In a smaller split from the sample, F. S. Grimaldi found 0.21 percent WO_3, and Esther Claffy of the Survey determined the BeO content, by spectrographic analysis, to be 0.2 percent.
>
> E. G. Green has reported that the development work in 1952 revealed appreciable tonnages of higher grade WO_3 content averaging 0.3 percent. A deposit of such low-grade ore can be mined only when prices for tungsten are as high as they were in 1952. Continued high prices for tungsten and effective separation of the beryl would insure continued operations. The length of the outcrops of the tungsten-bearing veins indicates that appreciable resources of WO_3 and BeO are present.

According to Robert Bogart, former superintendent of the operations, sampling at the Tungstona was completely unreliable. Even mill samples could not be checked with any degree of accuracy. Apparently the mineralization is extremely sporadic. Bogart thought the ore which had been mined and milled contained about 0.2 percent WO_3 with BeO (beryllium oxide) content ranging from 0.05 to 0.08 percent.

Figure 25 is a flowsheet of the mill on the property. According to Bogart this mill recovered about 75 percent of the tungsten trioxide from the Tungstona ore. Except for a test run to recover muscovite, no attempt was made to recover any of the other minerals.

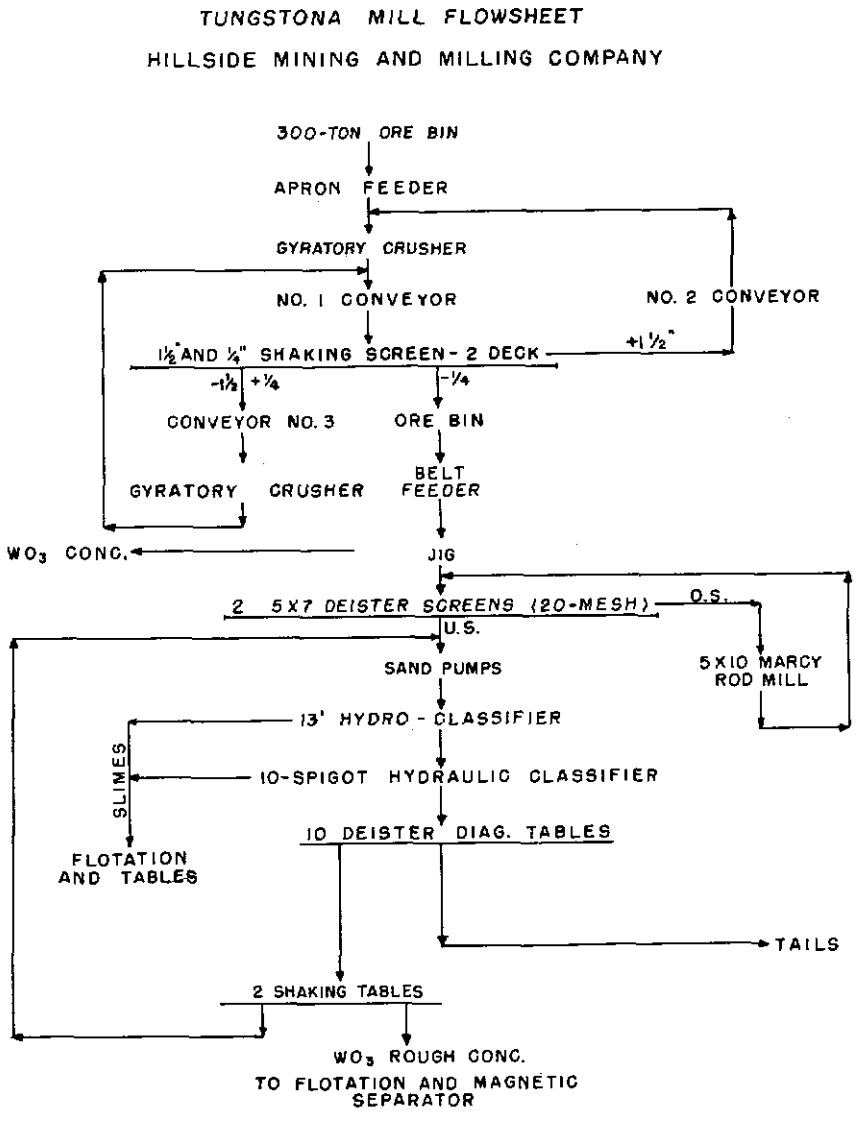


FIGURE 25. - Mill Flowsheet, Tungstona Mine, Yavapai County, Ariz.

A 13-ton sample of ore was shipped to the Bureau of Mines Experiment Station in Rapid City, S. Dak., where metallurgical tests were made to recover the beryllia. Following is a brief resume of the results.

The ore was analyzed chemically; it contained 0.060 percent BeO. Two pilot mill flotation tests were made in April 1954. In the better test, 21.7 percent of the beryllium was recovered as a flotation concentrate having 2.60 percent BeO. Considerable discrepancy existed between the chemical and microscopic analyses, probably owing to heavy mineral staining. Time did not permit more extensive testing for stain removal to improve the beryl separation.

Green Back Group

The Green Back group of four unpatented lode claims is in secs. 27 and 34, T. 14 N., R. 9 W., probably 1.25 miles southeast of Miller Mountain, shown on the Geological Survey topographical map of the Bagdad, Ariz., quadrangle. The altitude at the prospect is about 3,450 feet. The property is accessible from Bagdad by traveling southeastward 4.8 miles on the Kirkland Road, 3.8 miles southwestward on the old Kingman Road, and 1.6 miles northwestward to the adit and ore bin. (See fig. 17, p. 43.) The claims were idle when examined in September 1958. The owner is Mrs. Gladys Russell.

The claims were located in May 1953 by James L. Russell, deceased, of Wickenburg. They were leased to R. & R. Tungsten Corp. in September 1953. Apparently this corporation did not fulfill terms of the lease, for the property was again leased in July 1954 to another party. According to Dewey Clay of Congress, Ariz., who is familiar with the property, the only production was by the latter party. The production is not recorded, but it is thought to have been a few carloads of scheelite ore, grade unknown.

Workings comprise a trench, a shallow discovery shaft, an inaccessible adit, possibly 180 feet long, and several surface sample channels.

Predominant rocks on the property are a tan to silver-white schist, probably Precambrian, and a metamorphosed rock principally of quartz and biotite. Both formations strike N. 60° W. and dip about 80° E.

Scheelite is disseminated sporadically as grains and sparse fracture coatings through a vein of quartz, feldspar, and epidote. The vein is in the quartz-biotite formation and is conformable to it. The scheelite is confined almost entirely to a quartz-feldspar zone which is the central portion of the vein. This is from a few inches to about 2 feet wide. It is bordered on each side by thinner zones of predominant epidote, which is in the form of crystals and clusters of crystals. The average width of the scheelite zone is 1 foot, and the maximum width is 2 feet. The scheelite is erratically distributed along the vein for about 550 feet. According to Clay, scheelite minerals persist to the floor of the adit, a vertical depth of perhaps 50 feet. There is great diversity in the grain size of the scheelite and in its concentration in different parts of the vein. In general it is closely associated with feldspar.

Figure 26 is a geologic and assay map of the principal vein. A narrow and shorter parallel vein was not mapped.

Zannarapolis Group

There are 8 patented claims, a patented millsite, and 42 unpatented claims in the Zannarapolis group. The claims are in secs. 1, 2, 11, 12, and 14, T. 13 N., R. 10 W., on the south slope of Grayback Mountain at an average altitude of about 3,500 feet. The millsite is in T. 14 N., R. 10 W. at the junction of Bonanza Wash with Burro Creek, about 10 miles northwest of the mine. The mine is accessible from Congress Junction by traveling

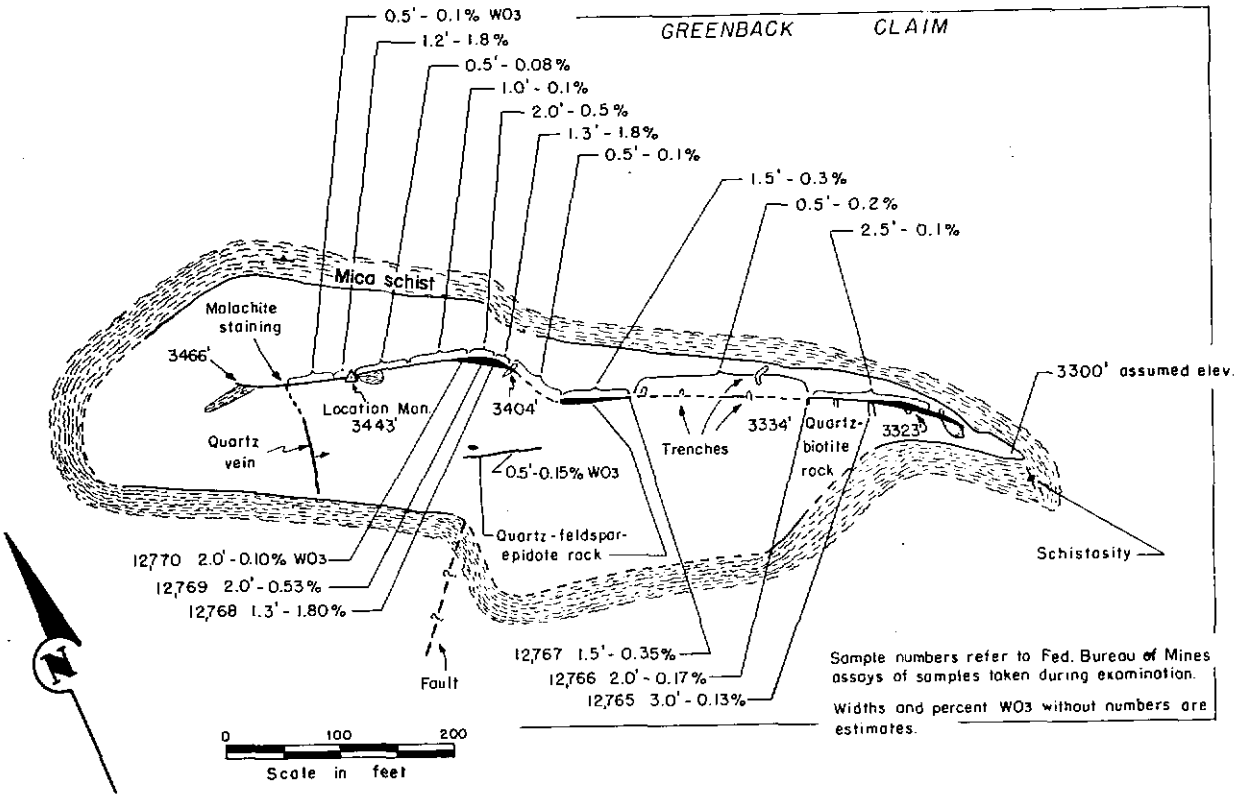


FIGURE 26. - Geologic and Assay Map, Greenback Tungsten Deposit, Yavapai County, Ariz.

6 miles southwest on State Route 71, and 27.1 miles northwest on State Route 93, then 2.7 miles north on the Bagdad Road to a junction. Keep left, and drive north 4.1 miles to the Zannarapolis camp. Keep right at all road intersections from the Bagdad Road to the campsite (fig. 17). Routes 71 and 93 are paved, and the road from Route 93 to the camp is a maintained dirt road. When the property was examined in September 1958 some work was being done on the road, and the owners were preparing to clean some custom lead molybdate concentrate at the mill on Burro Creek.

Arroyos on the property were placered for gold many years ago, perhaps with dry washers. Scheelite was discovered in 1941 by J. P. Zannaras and J. P. Robinson, Jr. Thirty-one of the claims were located by J. P. Zannaras, C. P. Zannaras, and J. P. Robinson, Jr., between October 1941 and February 1942.

Workings consist of a 200-foot shaft on Zannarapolis No. 28 claim, an open pit possibly 60 feet long and 30 feet wide with a 30-foot face on Zannarapolis No. 19 claim, and many shallow shafts, trenches, and prospect pits. There is an excellent camp on the property capable of accommodating at least 20 men. A well has been drilled at the camp, and water is available for domestic purposes.

Production has amounted to 10 tons of ore containing 1.94 percent WO_3, and, according to J. P. Zannaras, about 4,000 pounds of concentrates

containing 40 to 50 percent WO_3. This grade of ore was produced at the buyer's request.

The principal formation is Precambrian mica schist with some gneiss and granite. The foliation strikes N. 20° to 60° E., and dips are steep to vertical. There are silicated limestone stringers in the schist, some as much as 2 feet wide. One small tourmaline-bearing pegmatite dike was observed on claim No. 19 above the crushing plant. There is granite both east and west of the schist and gneiss.

The following is quoted from a previous examination:

> Scheelite is the only tungsten mineral observed and its occurrence is reported in at least 3 different modes as shown below:
>
> 1. Small grains disseminated in epidote-diopside rock.
>
> 2. Crystals up to an inch long in quartz veins.
>
> 3. Crystals up to 1/4 inch in tourmaline-bearing pegmatite.
>
> Examples of the most common mode of occurrence wherein scheelite is present in epidote-diopside rock is well exposed in many parts of the property. Small crystals are scattered through a fine-grained greenish rock usually containing quartz and probably feldspar in addition to epidote and dicpside. Patches of calcite and brown garnet appear locally. The second mode is found near the north end of the property where nominal amounts of scheelite are present as crystals ranging in size up to 1/2 inch long in quartz-biotite schist. This scheelite is intimately associated with small amounts of epidote, which is thought to represent weak hydrothermal alteration of the schist; and with veins and pods of quartz that are generally less than 3 inches wide and from several inches to a few feet long. Other minerals observed are pyrite, magnetite, garnet, calcite, fluorite, and rhodonite but the relationship of these to scheelite is not apparent.

The zone of scheelite deposition is approximately 3 miles long and 1/2 mile wide. The best concentrations observed were at the shaft on claim No. 28 and at and near the opencut bench west of the crushing plant on claim No. 19. Scheelite in tourmaline-bearing pegmatite was observed by the author in a small exposed dike immediately above the opencut bench about 100 feet west of the crushing plant coarse-ore bins. Reports show that wolframite occurrences are in the schist zone.

The shaft is situated at the north end of scheelite-bearing outcrops that extend southward for about 1,000 feet. The scheelite occurs in lenses associated with epidote and quartz. The quartz is in discontinuous veins that are seldom more than 2 feet wide. Scheelite also occurs at random

along fractures in silicified schist. According to J. P. Zannaras, scheelite minerals extend to the bottom of the 200-foot shaft. The zone containing the sporadic scheelite is probably 15 feet wide and strikes about N. 20° E.

The opencut bench has exposed a zone of silicified schist 20 feet wide that contains grains of scheelite generally less than one-eighth of an inch. Probably 30 feet west of the face of the bench is the pegmatite dike previously mentioned.

No samples were collected because the only reliable sample from a deposit such as this is a mined sample of not less than 10 tons.

The crushing plant is situated on the west side of the road below the opencut bench on claim No. 19. The plant is powered with electricity from a 187 KV.-a. (kilovolt-amper), three-phase, 60-cycle generator. The generator is powered by a 225-hp., three-cylinder, 275-r.p.m. gasoline engine. Figure 27 is a flowsheet of the plant.

The minus 20-mesh crushed product is trucked to the mill on Burro Creek. The power source is a diesel engine which transmits power to mill, tables, and classifier by pulleys and belts. Electric power operates the flotation cells and conditioner from a small generator driven by the diesel engine. Water is pumped from Burro Creek and is stored in two 7,000-gallon concrete tanks. Figure 28 is a flowsheet of the mill, which is capable of producing concentrates of 60-percent grade WO_3. This mill was in excellent condition when the property was visited.

New Hope (Good Luck) Prospect

The New Hope group of three unpatented lode claims is in sec. 22, T. 13 N., R. 10 W., at an altitude of about 3,000 feet. The property is accessible from State Route 93. From the west end of the Santa Maria bridge turn northwest 8.3 miles to a southward-branching dirt road; continue 0.5 mile to a deep canyon, and upstream, or north, 0.3 mile to a shaft on the east side of the canyon. No work was being done when the property was examined on December 17, 1958. No production has been recorded.

These claims were located about 1951 by James L. Russell and were named Good Luck. In December 1955 Gladys and Jacklyn Russell relocated the New Hope claims over the most favorable mineralization. Workings consist of four sidehill opencuts, a shaft of unknown depth but at least 30 feet deep, and a few shallow prospect pits.

Sparse, sporadic scheelite occurs in altered gneiss and schist inclusions adjacent to a granite contact. The formation is classified as Precambrian gneiss on the Geologic Map of Yavapai County prepared by the Arizona Bureau of Mines. Mineralization appears to be confined to the eastern contact of the gneiss with the granite.

Dark-colored, altered, limy schist next to the granite is the best host rock, although mineralization extends into the gneiss along a fault that

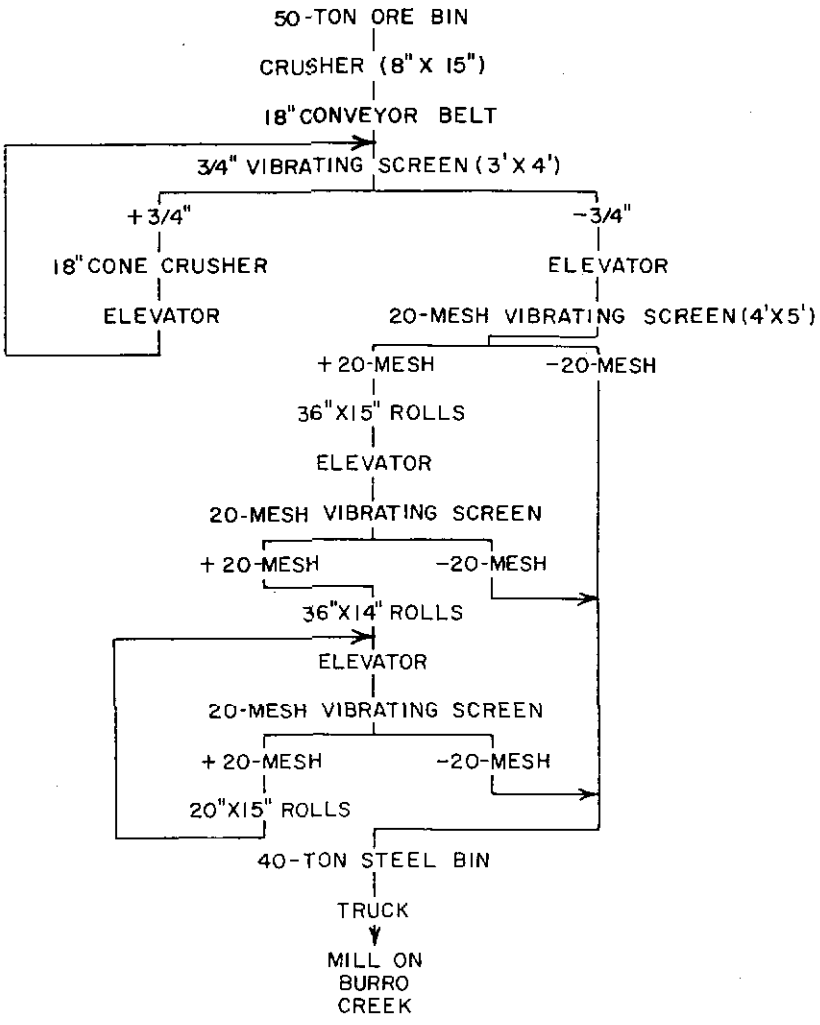


FIGURE 27. - Flowsheet, Zannarapolis Crushing Plant.

strikes N. 20° W. with 80° to 85° SW. dip. Cross fractures strike N. 70° W. and dip 70° to 75° NE., or strike N. 40° W. and dip 75° SW. Fine-grained, sparse scheelite occurs in lenses 5 feet long, as much as 2 inches wide, and 2 feet deep. These lenses occur at intersections of cross fractures with the fault.

The schist strikes N. 10° E. and dips 67° SE. White scheelits occurs sporadically in stringers ranging from paper thin to 8 inches in width. Grains and masses of scheelite to 1.5 inches in cross section occur in quartz, calcite, epidote, and garnet. It shows no preference for any of these minerals. Although no extensive workings are present in which to observe the mineralization, enriched zones appear to be very small. Very sparse scheelite extends into the schist for as much as 20 feet from the granite contact.

Most of the area is covered with detritus and only occasional outcrops can be seen. However, scheelite was traced for 750 feet south and 50 feet north of the shaft. The tactite zone extends northerly across Route 93, a distance of possibly one-quarter mile north of the shaft.

A pegmatite dike cuts the gneiss about 300 feet northwest of the shaft. The pegmatite is composed of quartz, orthoclase, plagioclase, and minor muscovite. No other minerals were observed.

Camp Verde District

Tungsten King Prospect

The Tungsten King group of 12 unpatented lode claims is in sec. 14, T. 13 N., R. 4 E., in the Black Hills southwest of Camp Verde at an altitude

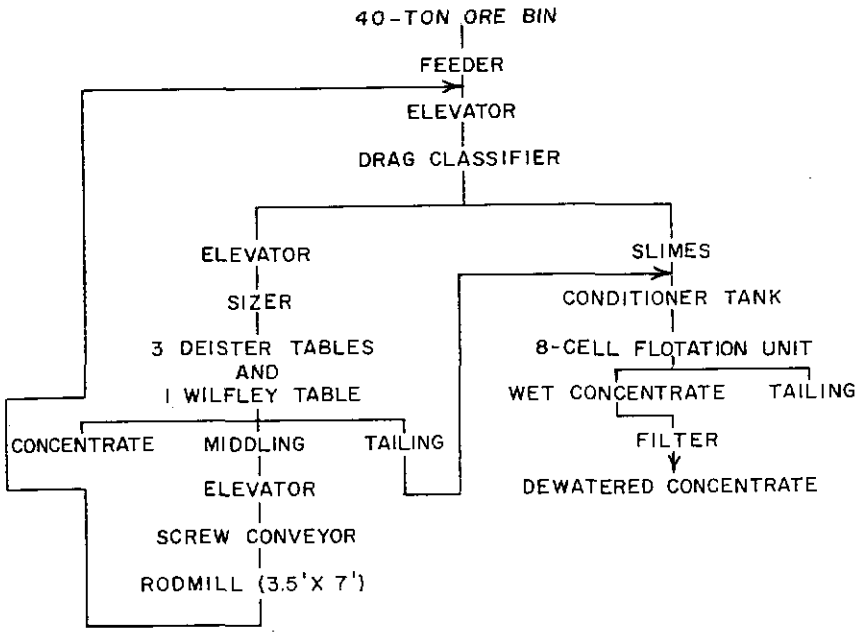


FIGURE 28. - Flowsheet, Zannarapolis Mill.

of about 4,500 feet. From the High School on the main street of Camp Verde drive south 0.6 mile, and westerly 1.6 miles to the Camp Verde salt mine, then southerly 3.0 miles to a dim bulldozer trail leading westerly. Follow this winding trail 3.4 miles to the workings on the claim (fig. 29).

The claim was idle when the property was examined on February 27, 1959. The only production had been 427 pounds of hand-sorted ore for testing purposes from which about 2 units of tungsten trioxide was recovered.

The claims were located in October 1953 by Marvin H. Cook. Later Robert E. Cook acquired half interest, and, still later, Victor Cooley acquired a small interest. They own the property at the present time. It was leased to Phillip Hoyt of Phoenix in 1956, but the price of tungsten dropped shortly afterward, so no production was made.

Workings consist of two sidehill opencuts, one of which is over 100 feet long with a 25-foot face on the dip of the vein, two inaccessible adits of unknown depth (probably not over 25 feet), a 25-foot inclined shaft, and several shallow prospect pits.

Wolframite, huebnerite, and scheelite occur in narrow, parallel quartz veins which cut an altered rock of diorite nature. Pyrite, small amounts of chalcophrite, malachite, limonite, and coatings of manganese oxides also occur in the quartz, but are not visibly associated with tungsten minerals. The quartz veins strike N. 30° to 35° E. and dip 45° to 50° SE. Few outcrops show through the overburden, but one of these veins has been prospected for a length of 250 feet.

Two sets of prominent fractures are present in the area, some of which show fault evidence and movement of unknown extent. One set strikes N. 50° to 60° W. and dips 87° NE., while the other strikes N. 35° to 40° E. and dips 67° NW. It seems that a concentration of tungsten minerals has occurred in the quartz along and on both sides of the N. 35° to 40° E. fractures. These fractures are offset by the N. 50° to 60° W. set.

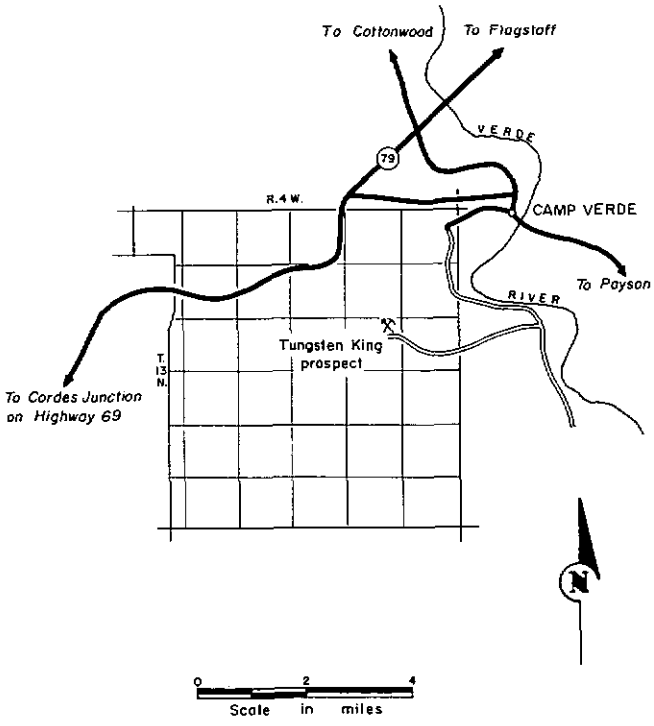


FIGURE 29. - Location Map, Tungsten King Prospect, Yavapai County, Ariz.

The author collected two samples from this property. A random grab sample was taken from a 3-ton pile of material rejected from the cobbing of high-grade ore. This sample assayed 0.18 percent WO_3. A random grab sample was taken from a 2-ton pile of ore, which according to Cook was removed from the lowest part of the vein exposed in the largest open-cut. This sample assayed 1.40 percent WO_3.

Mohave County

Tungsten in Mohave County is mentioned in Mineral Resources of the United States, 1904 edition, wherein reference is made to a deposit 60 miles south of Hackberry where 2- to 6-inch seams of wolframite occur in quartz veins 1 to 3 feet wide. A small production was recorded from the Aquarius Range each year from 1905 to 1913, excluding 1912. The first record of production of concentrates from Yucca (Boriana mine) was made in 1915. The Boriana mine was the leading producer of tungsten in Arizona in 1918, and from 1933 to 1937.

About half of the tungsten deposits are in the Hualpai Mountains. The tungsten minerals, scheelite and wolframite, are about equally divided in occurrence in either granite or gneiss and schist. The minerals are sporadic, and in general the ore occurs in small pockets and lenses which usually are related to structure. At the Bull Canyon and Boriana deposits, tungsten mineralization has been traced into an Upper Cretaceous granite. Tungsten has been found at other places in the county in or near this same granite.

Altitudes at the various occurrences range from about 3,000 feet to 6,300 feet. Roads and trails to most of the deposits are generally fair.

Accurate production records for the county are not available. Following is a table of tungsten production from Mohave County from 1951 through 1956:

Year	WO_3 produced, units
1951.....	159
1952.....	839
1953.....	1,206
1954.....	2,384
1955.....	3,903
1956.....	3,417
Total.....	11,908

The suggested total production was at least 124,300 units of tungsten trioxide from 1904 through 1956.

In Mohave County approximate reserves of tungsten ore are as follows:

Kind:	Tons	WO_3, percent
Measured..	32,500.....	0.11
Indicated.	20,000.....	.75
Inferred..	56,000.....	.96

Greenwood District

Lost Mine

The Lost Mine group of three unpatented lode claims is in sec. 29, T. 14 N., R. 12 W., N. 57° W., from Greenwood Peak at an altitude of about 3,500 feet. The mine is accessible from Wikieup by traveling 8.0 miles southerly on State Route 93 to the Signal Road, and 7.5 miles southwesterly to a left-branching road on the southeast side of the Big Sandy River. Follow this winding road up the southeast side of the Big Sandy for 1.2 miles to the Levas Ranchhouse. Continue easterly through the yard to a road that turns southerly toward Greenwood Peak. The mine is 2.5 miles by road from the Levas Ranchhouse (fig. 30). The claim was idle when the property was examined in January 1959.

This mineral deposit was discovered by Charles Lucero in 1917, and the property was subsequently leased to Jimmy Walker and associates. A small tonnage of carefully sorted ore, said to contain 40 to 60 percent WO_3, was sold in 1917 and 1918. In January 1929 the property was relocated by Epifano Levas. At that time five lode mining claims were located, but it was decided by the Government that only 40 acres was public domain and the remainder was the property of the Santa Fe railroad. In 1940 amended locations were made by the heirs of Epifano Levas to cover this 40-acre tract. The property was sold to Joe G. Lane and associates in June 1943, and was transferred to J. H. Dungan and associates in October 1943. A road was built to the mine, and an adit was started to cut the vein at depth. In the 1940's 1 ton of ore was sorted and shipped from old dumps. The sorted ore assayed 4.56 percent WO_3.

Workings consist of an 180-foot adit, a 25-foot shaft with 40 feet of drifts, an opencut 50 feet by 20 feet by 5 feet deep, and a sidehill cut 50 feet long with a 20-foot face.

The following geological and mineralogical descriptions are quoted from a previous report by Dr. E. D. Wilson.[24]

> The prevailing rocks are granite, gneiss, aplite, and pegmatite, overlain in places by Tertiary volcanic rocks.

24/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 19.

On these claims a glassy quartz vein 1 to 1-1/2 feet wide strikes S. 83° W., dips 60° N., and is traceable intermittently for a length of some 600 feet. Locally, at least, it strikes and dips conformably with the gneiss and has been offset minor amounts by faulting.

The principal development consists of a shallow pit with a 30-foot adit. As shown by these workings, the vein contains irregular disseminations and bunches of wolframite and straw-colored scheelite, together with sparse fine-grained chalcopyrite. Near the surface iron and copper stains are locally abundant. The wall rock shows strong sericitic alteration.

The following assays were taken during the course of an examination by the Bureau of Mines in 1944:

No.	Description	Width, feet	WO_3, percent
4201	Face of drift 35 feet S. 70° E. of 15-foot shaft.....	1.5	0.01
4355	5 ft. N. 70° W. from No. 4201, bottom of drift.....	1.2	1.12
4202	10 ft. N. 70° W. from 4201, top of drift.....	1.0	1.38
4354	10 ft. N. 70° W. from No. 4355, bottom of drift.....	1.5	7.88
4203	10 ft. N. 70° W. from No. 4354, bottom of drift.....	1.0	.06
4204	20 ft. N. 70° W. from No. 4202, top of drift at shaft	1.5	1.59
4353	10 ft. N. 70° W. from No. 4203, bottom of drift at shaft.....	2.1	nil
4352	10 ft. N. 70° W. from No. 4353, bottom of opencut....	1.3	nil
4205	460 ft. S. 70° E. from 15-foot shaft, face of opencut	2.5	4.23
4356	In same opencut as No. 4205.....	1.3	.24
4367	Sample picked from dump at above opencut.....		.17
4206	Grab from discard dump at 15-foot shaft.....		2.43
4351	Opencut on vein on sidehill.....	1.2	nil

It has been reported that these ores carry columbium, tantalum, and rare earth minerals, but spectrographic and chemical analysis of a number of samples failed to show their presence.

Aquarius Mountains

Williams (Wothree) Mine

The Wothree property, more generally known as the Williams mine and comprised of 10 unpatented lode claims, is in secs. 19, 20, 29, and 30, T. 16-1/2 N., R. 11 W. The claims are in the southwestern part of the Aquarius Range at an average altitude of about 5,000 feet. The property is accessible from Kingman as follows: Take State Route 93 southeasterly for 37.5 miles from its junction with U.S. Highway No. 66; then turn easterly across the Big Sandy River and drive 27.3 miles southeasterly to the mine (keep right at all road intersections) (fig. 30). Inquiries in the district indicate that no work has been done on the property in the last few years.

Many engineers and geologists have examined and reported on this property.[25, 26] Engineers from the Bureau of Mines examined it in 1941 and again in 1942, and reports were submitted by three different teams of engineers to the Defense Minerals Exploration Administration in 1951, 1953, and 1956.

The original claims were located in 1902 by Ed. Williams, Sr. From that time to 1956 no fewer than eight different individuals and companies have attempted to operate the mine. Tony Melles and R. J. Miller of Kingman claimed ownership of the property in March 1959.

Following is a list of production from the 1956 report submitted to the Defense Minerals Exploration Administration with one addition from Wilson's work:

Year:	Operator	WO_3, units
1904-15.....	To Primos Chemical Co.....	Small lots
1915-17.....	Tungsten Mines Co.....	Unknown
1917-18.....	James Townsend.....	720
1936-39.....	Unknown.....	650
1940-41.....	Continental Mining Co.....	935
1942	Roy Williams.....	212
1943-44.....	Wm. Bradbury.....	Small
1954-55.....	Wothree Mines.....	526
Total.....		3,043

Workings on the property consist of three adits on the 200-, 260-, and 280-foot levels, totaling about 1,200 feet; a 1,400-foot haulage adit ("O" level), a 40-foot raise, and a 360-foot winze connecting the haulage level with the 200-foot level; about 250 feet of drifting from the winze on the 150- and 180-foot levels; possibly 30 stopes and 4 raises; and many shallow surface pits and openings. The majority of the workings are on Tungsten No. 1 claim.

The following geological and mineralogical information is abstracted from the 1956 report (DMEA files):

The mine is situated in a shallow saddle in the Aquarius Range in an area underlain by light-colored granite containing orthoclase and quartz with lesser amounts of plagioclase, biotite, and hornblende. The granite is heterogeneous in composition and is cut by irregular dikes and masses of pegmatite and aplite. Most of the rock near the Williams mine is slightly banded, sheeted, or gneissoid. West and northwest of the mine the granite loses its gneissoid or banded appearance and grades gradually into a light-colored, massive pegmatitic granite associated with considerable aplitic material.

25/ Work cited in footnote 24 (p. 65), pp. 16-18.

26/ Hobbs, S. W., Tungsten Deposits in the Boriana District and the Aquarius Range, Mohave County, Arizona: Geol. Survey Bull. 940 - 1, 1944, pp. 260-263.

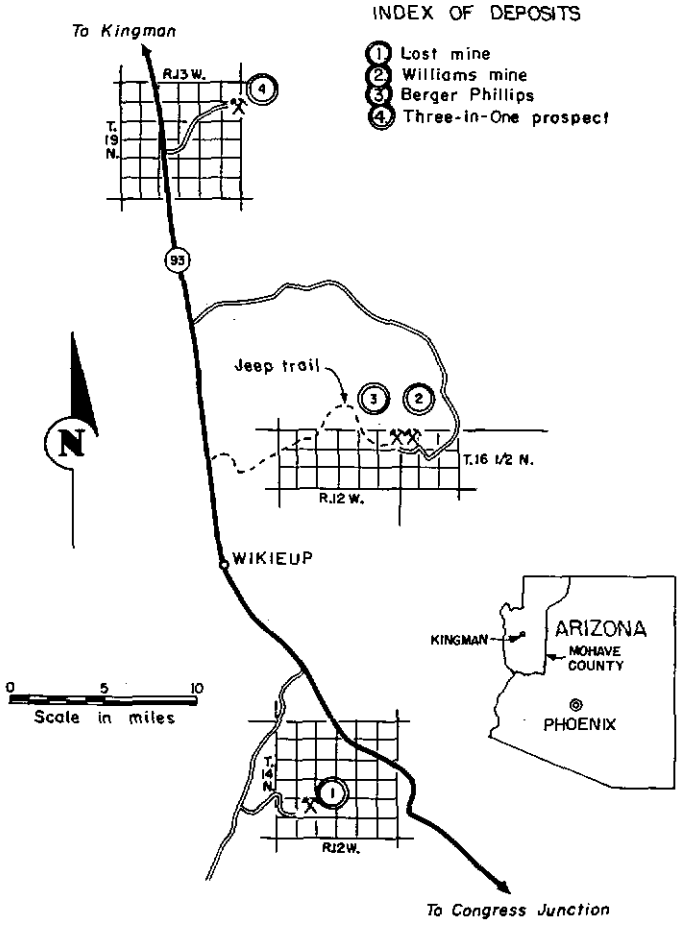


FIGURE 30. - Location Map, Lost Mine and Aquarius Range Deposits, Mohave County, Ariz.

The Williams ore deposit is a pegmatitic type of vein containing quartz, mica, wolframite or huebnerite, pyrite, and trace amounts of fluorite. Scheelite and manganiferous apatite have been reported. Sparse amounts of chalcopyrite occur in the lower part of the deposit. The ore mineral wolframite (or huebnerite) occurs chiefly as bladed crystals enclosed in quartz or in mica aggregates or veins, most of which tend to be localized along the walls of the quartz vein.

The Williams mine, and several small prospects in the vicinity, have explored many small veins which are classified into two groups on the basis of attitude. The veins in both groups strike about N. 70° W.; one group dips gently north (10° to 30°) while the other group dips steeply north. The veins that dip gently are more important. These veins, at possibly the same attitude as the banding of the host rocks, appear to be concentrated in a zone having a maximum thickness of about 200 feet. The veins are tabular deposits ranging in thickness from a few inches to a few feet and having strike lengths ranging from a few feet to nearly 500 feet. In general, they are widely spaced. Branching or feathering of the veins at the ends of oreshoots is a common feature in the Williams mine.

The Williams vein has been developed and explored by about 4,000 feet of tunnels, drifts, and winzes, principally on seven levels. The workings and shallow surface cuts have proven beyond reasonable doubt that two nearly parallel veins exist. The underground workings show that the main oreshoot on the Williams vein has a strike length of almost 200 feet and a dip length of almost 600 feet. The strike of the oreshoot is approximately N. 75° W. and the northeasterly dip ranges from probably 30° in the upper part of the deposit to about 10° in the lower part. The most productive part of the vein appears to be localized by three factors, as follows: (1) Abundant aplite; (2) zones where steeper dips are prevalent; and (3) zones where the strike is about N. 75° W. One small oreshoot has been exposed on a parallel vein.

Many faults, all of which have relatively small displacement, are exposed in the Williams mine. Some are postore and others are preore.

Berger Phillips Property (Curley Group)

The four B and P claims, owned by Henry W. Berger and Harry R. Phillips, are in the Aquarius Cliffs, in sec. 24, R. 12 W., and sec. 19, R. 11 W., T. 16-1/2 N., at an altitude from 4,500 feet to 5,000 feet. The property is accessible from State Route 93 and the Williams mine road. From the portal of the "O" level, or lower adit, at the Williams mine follow a narrow, winding mountain road northwestward for 1.6 miles to a lower adit on the claims (fig. 30).

The claims were located by Henry W. Berger and Harry R. Phillips in 1939. Little is known about the history of the property. E. A. Scholz and J. H. Cazier leased it in 1951, 1952, 1953, and 1954. Their production amounted to 253 units of tungsten trioxide from 852 tons of ore. Production was reported before 1942, but quantities are unknown.

Workings consist of a shaft 94 feet deep, an adit about 370 feet long which connects with the shaft, a winze 40 feet deep with a 50-foot drift, stopes of unknown extent, and several shallow prospect pits and trenches. An adit 576 feet long has been driven from the bottom of a deep canyon. It lacks about 300 feet of cutting the vein.

The Aquarius Cliffs where the B and P claims are located are made up of Precambrian granite and gneiss, which have been intruded by granites and dikes varying from diabase to pegmatite.

The principal vein is in a fault fissure which strikes N. 75° to 80° W. and dips 80° to 85° SW. It is well defined along the outcrop for about 450 feet and varies in width from a few inches to nearly 1 foot. Vein material consists of a hard gray-white quartz which locally contains considerable muscovite and pyrite. Vugs are common in the quartz and contain considerable cellular hematite. Wolframite is found as crystals within the quartz and also as narrow stringers along fractures within the vein.

A total of eight samples was taken by the Bureau of Mines in 1942. The assays and descriptions follow:

No.	Description	Width, feet	WO_3, percent
1	175 feet from portal, contains quartz with a fair showing of wolframite.....	1.0	0.55
2	150 feet from portal, very hard flinty quartz with mica on footwall and little wolframite showing.....	.6	14.18
3	125 feet from portal, similar to No. 1....	.7	.32
4	100 feet from portal, similar to No. 1....	.7	.09

No.	Description	Width, feet	WO_3, percent
5	75 feet from portal, similar to No. 1, but with vugs containing pyrite and cellular hematite.....	.9	.01
6	50 feet from portal, where the vein is split with a 3-foot horse. Footwall split is 0.55 feet wide and hanging-wall split is 0.45 feet wide.....		.41
7	25 feet from portal, quartz with much mica. Walls show strong sericitization.....	.85	.01
8	From opencut on surface 32 ft. west of shaft collar.....	1.0	1.42

The Scholz-Cazier production record is probably the best criterion for determining the probable grade of ore.

Three-in-One Prospect

The Three-in-One prospect is in sec 12, T. 19 N., R. 13 W., at an altitude of about 3,000 feet. It is in the northwestern foothills of the Aquarius Range, and may be reached from Kingman by traveling 28.3 miles southeasterly on State Route 93 to the Jud Bishop ranch, and easterly 0.7 mile to the Big Sandy Wash, then northeasterly on a rough trail for 4.4 miles to an old campsite. From this point the prospect is possibly 0.5 mile to the northeast. There is no road to the workings from the campsite (fig. 30).

This occurrence was located in 1937 by George Fancher and S. A. McGee, in 1939 by W. T. Chambers, and as the Three-in-One claim in 1940 by W. H. Hunt, J. A. Daley, and Robert E. Ames. Della Hubbard relocated the workings in 1956. No work has been done on the property for a number of years.

Workings consist of two shafts, one about 30 feet deep; the other about 12 feet deep, and an adit probably 25 feet deep. All workings are caved and inaccessible. Probably only a few tons of cobbed ore was produced in World War I and in 1937.

Following is a description by Wilson.[27]

> Here medium-grained gray granite includes a northeastward-trending band of black schist some 150 feet wide. This band is invaded along both walls and in the middle by irregular narrow masses of pegmatite; southwest from the workings the schist band widens, and the pegmatite splitting it attains a width of several hundred feet.

27/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, pp. 18-19.

Both the northwest and southeast contacts of the schist with the pegmatite contain glassy gray quartz veins, from less than 1 inch to 18 inches in width, that strike northeast, dip steeply northwest, and are traceable on the surface intermittently for several hundred feet. In places, apparently where intersected by quartz stringers of westward strike, these veins carry scattered small masses of wolframite and scheelite. The wall rocks show strong alteration to sericite, and in places to biotite.

Hualpai Mountains

Midway Prospect

Two unpatented lode claims comprise the Midway prospect in sec. 13, T. 18 N., R. 15 W., at an altitude of about 5,000 feet. The claims are on the upper drainage of Cane Spring Wash on the east side of the Hualpai Mountains. The property is accessible from State Route 93 as follows: At 0.1 mile north of milepost 106 (33.2 miles southeasterly from the junction of Route 93 and U.S. Highway No. 66 at Kingman) turn westerly onto a winding graded dirt road, and follow this road 12.4 miles to the workings on the claims. There are a rock house and corrals in Cane Spring Wash at the 8.6-mile point (fig. 31). No work was in operation when the property was examined in January 1959.

The claims were located in June 1952 by Lloyd Bliss and H. E. Wren. In 1953 Wren sold 14 units of WO_3, and in 1954 A. M. Short produced 21 units of tungsten trioxide from the property.

Workings consist of an opencut 10 feet wide and 50 feet long with a 20-foot face; an adit 5-feet by 7-feet by 30 feet long, a 4- by 4-foot shaft of unknown depth, and 50 feet of opencutting about 5 feet wide with a 10-foot face.

The geologic setting is Precambrian gneissic granite with a schist inclusion. One very narrow pegmatite dike was seen on the property. The gneiss is fine- to medium-grained and contains considerable muscovite. The schist is generally dark brown and micaceous. The foliation strikes generally N. 50° E. and dips 80° NW.

Wolframite occurs in quartz along a mineralized fault which strikes N. 68° E. and dips 85° SE. There is 0.5 inch of gouge along the fault. There are 2 inches of quartz on the north side of the gouge, 6 inches of quartz on the south side, next 2 feet of altered schist, and then 12 inches of quartz. The quartz carries hematite, limonite, muscovite, and crystalline masses of wolframite as much as 1 inch thick and 4 inches long. Some of the quartz is sugar textured and carries no other mineral except wolframite. The wolframite is sparsely distributed. The mineralized zone has been opened for approximately 30 feet, and has not been developed beyond these limits.

Along the north side of the road, about 400 feet northeast of, and 200 feet above the adit, is an opencut into a brecciated zone, 5 feet wide in

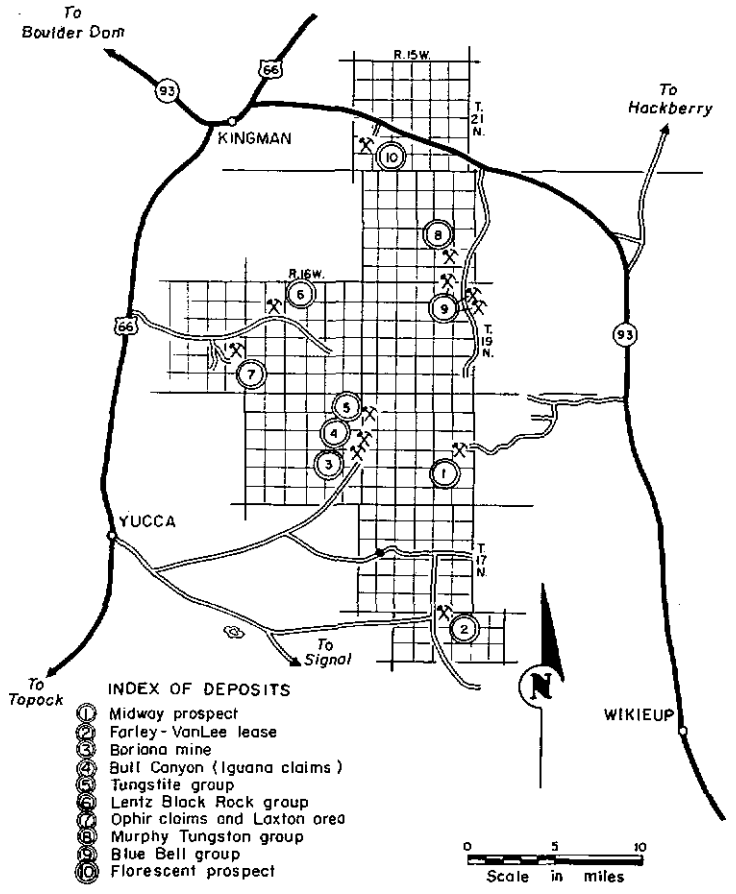


FIGURE 31. - Location Map, Deposits in the Hualpai Mountains, Mohave County, Ariz.

shattered granite, which strikes N. 35° W. and dips 52° NE. There are copper stainings and considerable limonite in evidence. The brecciated zone carries no visible tungsten minerals.

Farley-VanLee Lease

The Farley-VanLee lease was in sec. 21, T. 16-1/2 N., R. 16 W., and sec. 35, T. 17 N., R. 16 W., on land owned by the Atchison, Topeka and Santa Fe Railway Co. The extent of the Farley-VanLee lease is unknown, but the opinion is that about 440 acres were leased. The property is at the western foot of the Hualpai Mountains at a 3,200-foot altitude and is reached by traveling south from Yucca for 1.5 miles on U.S. Highway No. 66 to the southeastward branching Signal road, then 2.1 miles to a road fork. Keep right for 7.3 miles to an unimproved road that branches eastward from the Signal road; then drive 3.5 miles eastward to a north-south road intersection. Turn north for 0.4 mile to a northeastward branching trail, and continue 0.3 mile to the workings (fig. 31). No work was in operation when the claims were examined in April 1959.

Tungsten minerals were discovered about 1950 by VanLee. No production has been recorded from the property. Workings consist of an inaccessible shaft 40 feet deep with a 30-foot drift in the bottom, and three shallow surface trenches.

Scheelite occurs in a narrow fissure which strikes N. 35° E. and dips steeply northwest. The fracture is in slaty schist and gneiss. Scheelite has been traced on the surface for possibly 100 feet north of the shaft. The shaft was bulkheaded and covered with junk and debris when the property was visited; hence a description of the scheelite occurrence was obtained from the last man who worked in it. The shaft was sunk vertically for 40 feet. The upper part contains about 10 inches of good scheelite ore. The shaft

then left the mineralized inclined fissure. The fissure was not encountered in the 30-foot drift from the 40-foot level.

The scheelite is associated with garnet, epidote, quartz, and calcite. The ore carries trace amounts of copper oxides.

Boriana Mine

The Boriana group of 28 unpatented lode claims is in secs. 7, 18, and 19, R. 15 W., and secs. 12 and 13, R. 16 W., T. 18 N., ranging in altitude from 4,950 to 5,750 feet, in the central part of the Hualpai Mountains. The mine is accessible from Kingman by traveling 20 miles south on paved U.S. Highway No. 66 to Yucca, and 16 miles easterly on a county-maintained dirt road (see fig. 31). Yucca, a station on the Atchison, Topeka and Santa Fe railroad, is the nearest rail point. The property is owned by Dye and Bathrick Mining Co. of Kingman.

The Boriana deposit was discovered before 1914, and was acquired by Yucca Tunsten Co.[28] in 1915. The company worked the veins from 1915 to 1919 when metal prices declined. The mine was nonproductive from 1919 to 1929, when it was acquired by Boriana Mining Co. The company did much development work, built a mill, and maintained production to 1937 when the property was leased to Molybdenum Corp. of America. The mill burned down late in 1937, but in 1938 a new gravity-flotation mill of 150-tons capacity was built. Production was resumed in October 1939 and continued to October 1943. The equipment was sold in December 1944 and removed from the property in 1945. In 1946 Dye and Bathrick, the present operators, purchased the property. During 1951 they reequipped the mill and treated ore produced by lessees from the upper mine workings. The milling of dump ore was started in 1952, and late in the year treatment of ore produced by lessees was discontinued. The mine ore was concentrated elsewhere. This operation continued until 1957, when falling metal prices again caused it to become unprofitable.

The Boriana mine was the leading producer of tungsten in Arizona in 1918 and from 1933 to 1937. For the 2-year period, 1936-37, its output of ore averaged about 3,000 tons per month.[29] Approximately 108,000 units of tungsten trioxide was produced from about 1915 to the beginning of 1943.[30] Production for the 9 months of operation in 1943 is not known. From 1951 through 1956 production amounted to approximately 10,100 units of WO_3, the largest production from any single property in the State of Arizona during this period.

The mine is developed by nine main levels and three sublevels for a total of more than 15,500 feet of level workings. Figures 32 and 33, showing

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28/ Hobbs, S. W., Tungsten Deposits in the Boriana District and the Aquarius Range, Mohave County, Arizona: Geol. Survey Bull. 940-I, 1944, p. 248.
29/ Work cited in footnote 27 (p. 70), p. 12.
30/ Work cited in footnote 28 (p. 73), p. 257.

mine plan and longitudinal projection, are taken from plates 44 and 45 of U.S. Geological Survey Bulletin 940. It presently is filled with water to the 500 level, which was the main haulage adit with its portal near the mill. A large part of the workings above the 500 level are caved and inaccessible. Underground work during the last period of operation included mining pillars of ore between the 0 and 200 levels. The work was conducted by a lessee and a crew of five men. Daily production amounted to 4 or 5 tons of ore containing about 2.0 percent WO_3. This operation lasted only a short time.

Wallapai Mining obtained a lease from Dye and Bathrick to remove and concentrate the gob used in the stopes below the 500 level, and all gob milled was taken from the 500 level, according to Ray Dye. The cut-and-fill mining method was used in all stopes below the 500 level. The company reconditioned that level to the No. 20 shaft and removed a few thousand tons of gob from a single stope. According to Dye, the gob was estimated to have contained about 7 pounds of WO_3 per ton. While the gob was being pulled, the walls of the stope caved, and the operation was discontinued. The 500 level again is in dangerous condition and considered inaccessible.

Figure 34 shows a flowsheet of the Dye and Bathrick mill. The screening section was designed originally to process 20 tons of ore per hour and yield an estimated 10 tons of sorted ore. The capacity of the concentrator section was 10 tons of ore per hour.

In 1955 the mill was remodeled. A hammer mill and a heavy media separator were added to the circuit, and changes were made in screens. The improved circuit had a capacity of from 25 to 35 tons per hour. The mill operated on an available water supply of 7 to 10 g.p.m. Power was supplied from a 44,000-volt transmission line.

Most of the dump material was transported to the mill with an electrically powered slusher. Some of the dumps were transported by truck a maximum distance of 0.25 mile. Trucks were loaded with a front-end loader.

A total of 135,000 tons of dump material was treated by Dye and Bathrick. The mill heads during the first year of operation contained 1.7 pounds WO_3 per ton, and during the subsequent years the mill heads averaged 1.5 pounds WO_3 per ton. Tungsten concentrates contained about 50 percent WO_3 with some copper and iron minerals, and percentage recovery was reported to be in the high 80's. About 2 tons of 18 percent copper concentrates was produced per month. The mill operated 1 to $1\frac{1}{2}$ shifts a day, 6 days a week.

According to Hobbs:[31]

> The mine is an elongate belt of phyllite, striking northeastward and nearly vertical, about half a mile wide, and bordered on both sides by intrusive granite. The ore minerals, scheelite, wolframite, and chalcopyrite, occur in narrow quartz veins, which form composite lodes that follow the foliation of the phyllite.

31/ Work cited in footnote 28, (p. 73), p. 247.

Two such lodes, separated by about 125 feet of phyllite were being mined in 1943. The vein zones are continuous and the structure is simple. Minor faulting has offset the veins, and the latest movement occurred since the formation of the ore. The veins apparently originate in a small granite stock in the center of the belt of phyllite. A broad ore shoot, which contains the best ore in the mine, plunges gently toward the granite contact. Measured ore in the mine in December 1943 amounted to about 2,400 tons containing 1 to 1½ percent WO_3 and indicated ore amounted to 9,700 tons of a similar grade. It is estimated that about 44,000 tons of ore with an average content of about 1 percent WO_3 lies below the lowest level and between the present workings and the granite contact.

On Page 253 of the Hobbs report is a description of the ore deposits:

- - - These veins also contain chalcopyrite, a few other sulphides, and fluorite. Quartz veins are numerous throughout the phyllite belt, but only those within a zone about 125 feet wide in the west-central part of the belt contain significant quantities of tungsten. The tungsten mineralization is limited, moreover, to that portion of the zone northeast of the main portal of the Boriana mine, all the veins in the southwestern part of the area mapped being essentially barren.

Plate 43 (fig. 35) shows the actual outcrops of the larger veins. Many veins too small to map were seen, and many others are undoubtedly concealed by surface debris. The relatively continuous exposure of the ore-bearing veins north of the mine portal is due to their being uncovered in open cuts and surface workings.

The mine workings follow two groups of small veins, known respectively as the west veins and east veins, which are separated by 90 to 135 feet of phyllite. This intervening phyllite contains small subsidiary veins in which there is a little tungsten.

Mention is made of some beryl that was found in the veins on the 700 level and also in the veins which cut the granite on the surface.

Hobbs discusses granite on pages 251 and 252 of his report:

The largest igneous rock body in the Hualpai Mountains is a medium-to-coarse-grained biotite granite, locally porphyritic and composed essentially of feldspar, quartz, and biotite. This granite intrudes the phyllite, which apparently forms a very large roof pendant. - - - North of the ridge crest and only a stone's throw north of the end line of the Boriana claims, a tongue or embayment of granitic rock extends from the main body of granite on the west into the middle of the phyllite belt. This body, which may be called the northern body, consists of a medium-grained rock that is composed essentially of microcline, plagioclase, gray glassy quartz, and biotite. It appears to be a little more sodic than the main granite mass, but

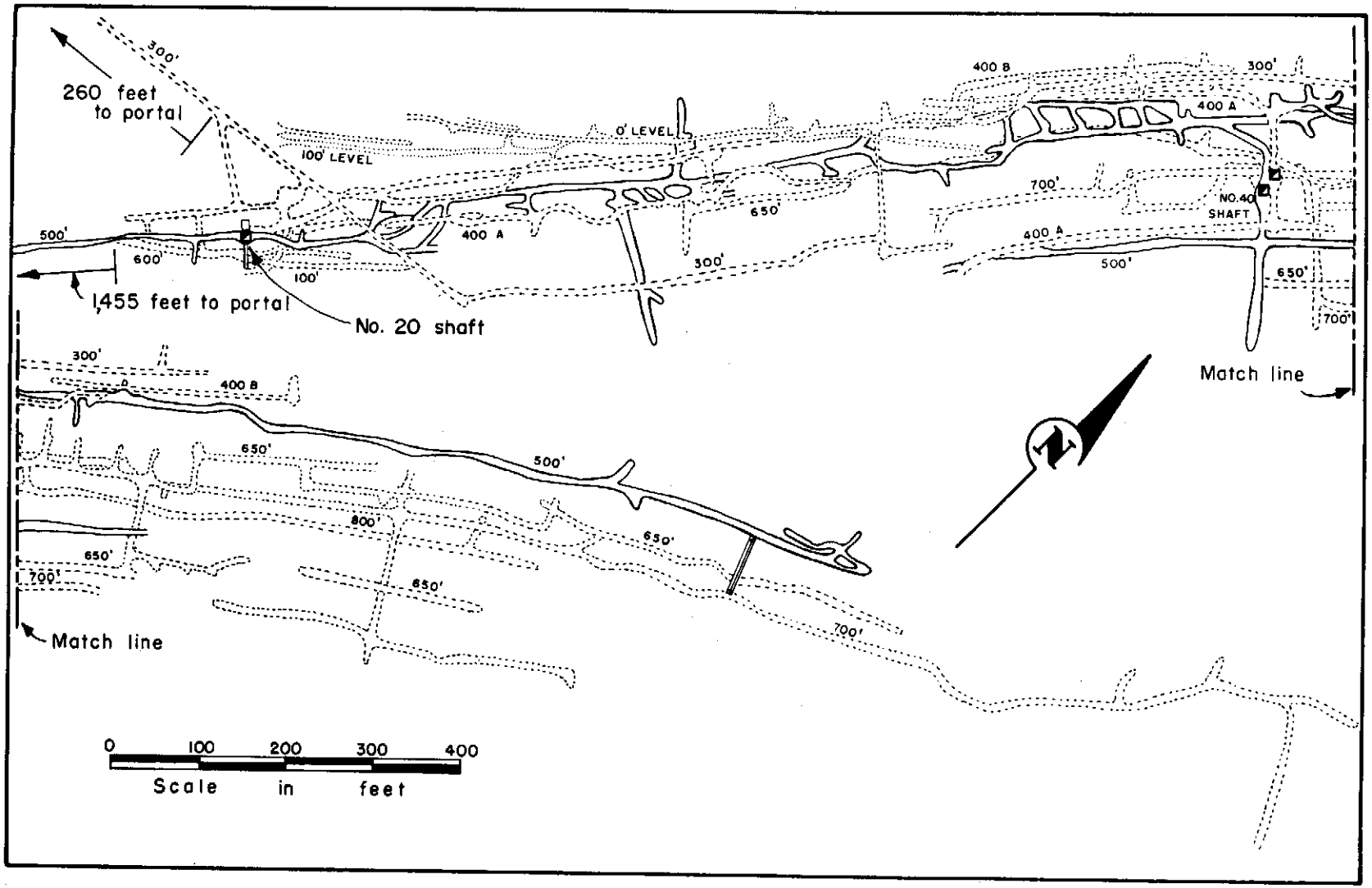

FIGURE 32. - Plan of Underground Workings, Boriana Mine.

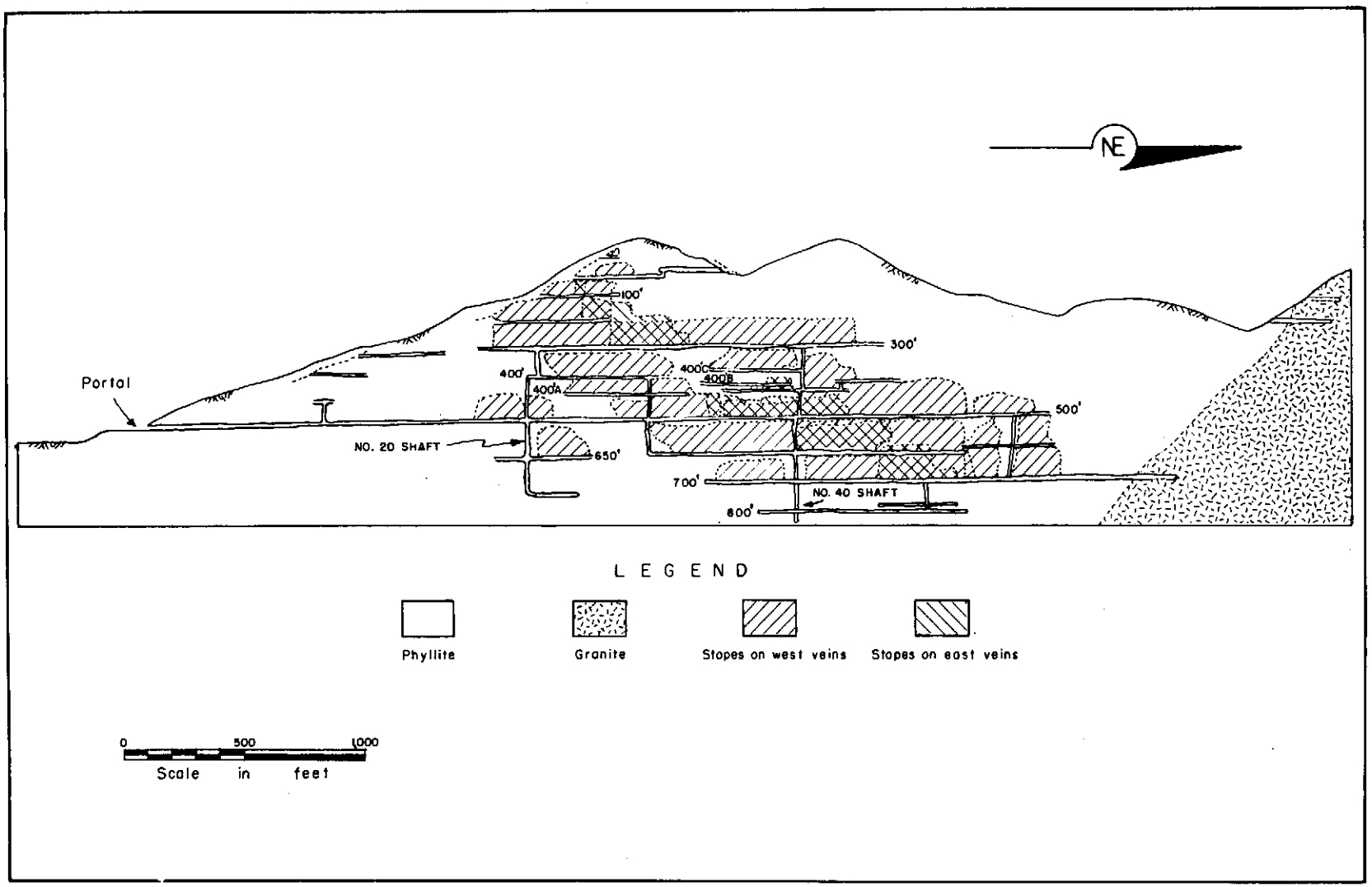

FIGURE 33. - Longitudinal Projection of Boriana Mine Workings.

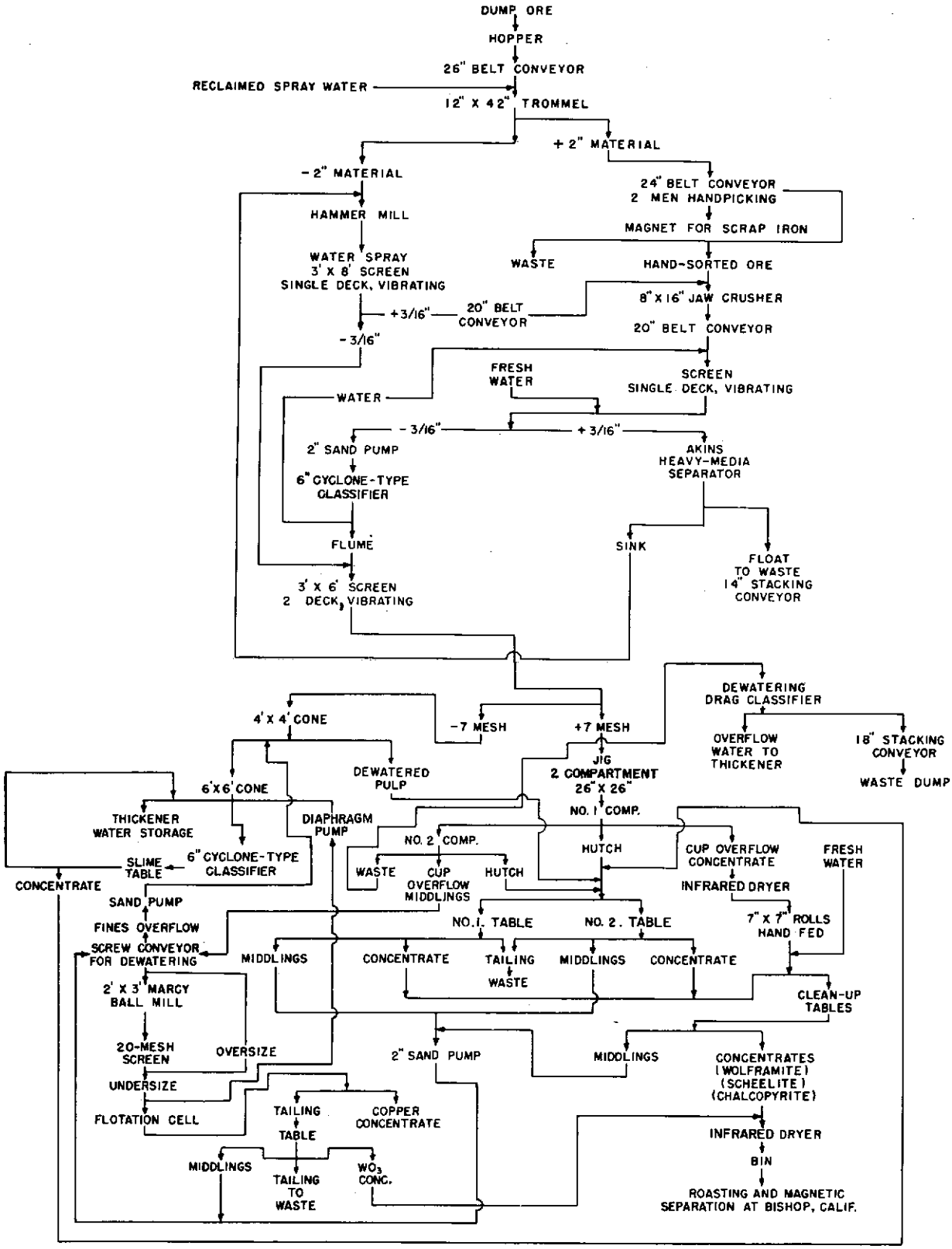

FIGURE 34. - Flowsheet, Boriana Mill.

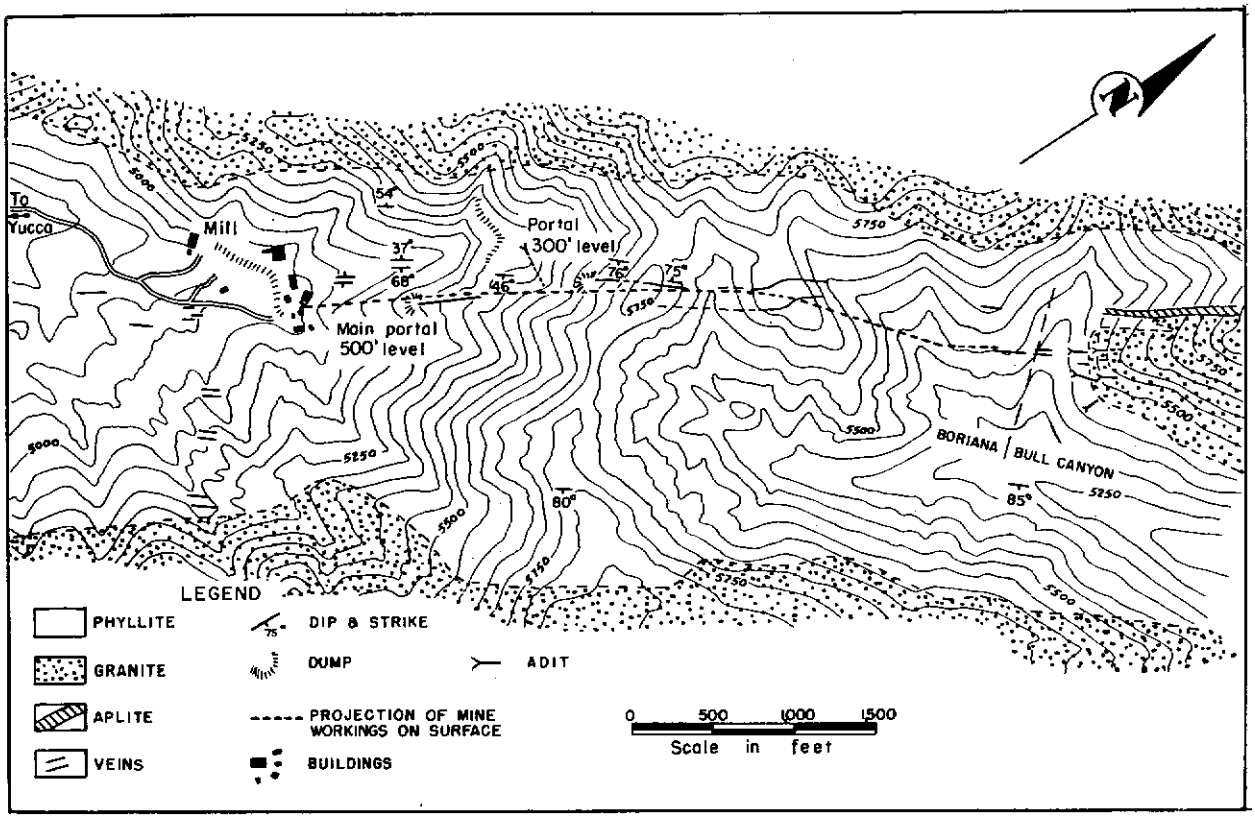

FIGURE 35. - Topographic and Geologic Map, Boriana Mine, Mohave County, Ariz.

the difference is not great enough to show that it is a distinct intrusion. This northern granite body is also exposed at the northeast end of the 700-foot level where it intrudes the phyllite as a series of tongues parallel to the foliation. - - -

The main body of granite is fairly uniform in composition and texture through large areas, but near the contact of the main body with the phyllite the rock shows considerable variation, probably caused by assimilation of phyllite, which generally increased the proportion of dark minerals and thus darkens the rock. The granite encloses numerous zenoliths of phyllite, many of which have been much recrystallized and drawn out into dark streaks. The granite embayment north of the divide, on the other hand, has lost part of its dark minerals, together with some feldspar, having been partly converted to a greisen, doubtless by fumarolic action. This granite, therefore, may represent a cupola in which the volatile constituents of the cooling magma were concentrated, a condition that would have a direct bearing on the origin of the Boriana veins, which appear to stem from this mass.

Dr. Wilson[32] recognized two distinct types of granite:

The Boriana mine is in a belt of schist, locally 1/4 to 1/2 mile wide, that strikes N. 30° to 40° E., dips from about 75° SE. to vertically and extends for several miles across the range. In the vicinity of the mine, this schist is a thinly laminated to blocky gray slate with some sandy phases; abundant fine-grained sericite and chlorite mark its parting planes.

The schist belt is intruded on both sides by coarse-grained biotite granite which grades into gneiss near its contacts. Dikes of aplite and pegmatite cut both the gneiss and schist.

A short distance northeast of the divide the schist and granite are intruded by a stock of medium-grained granitic rock consisting essentially of white feldspar, abundant glassy gray quartz, and biotite; provisionally, it may be classed as a granodiorite or sodic granite. Along its borders it has affected strong silicification and sericitization of the schist and gneiss. Locally, veinlets of quartz and purple gluorite occur in the adjacent gneiss. Here a narrow belt of "greisen," consisting of a foliated fine-grained aggregate of quartz, sericite, and muscovite, parallels the schist and is traceable intermittently for several thousand feet; apparently it represents a shear zone affected by intense hydrothermal alteration. In places this greisen contains sparse tiny veinlets of chalcopyrite and disseminated particles of wolframite, up to 1/2 inch in diameter, encased by thin layers of scheelite. It has been explored by a short adit with some 60 feet of drifts, but apparently these workings did not find the tungsten mineralization to be of commercial grade. Other similar greisen zones are found in the granodiorite.

The Geologic Map of Mohave County, Ariz., prepared by the Arizona Bureau of Mines and printed in 1959, clearly delineates the two formations. The older is a Precambrian granite and the later intrusive is an upper Cretaceous granite.

Wilson's description of the veins follows:

As exposed in the mine, the veins are lodes of composite type, made up of two to ten or even twenty parallel quartz veins and stringers, separated by schist, within widths of a few feet to 20 or more feet. Many of them consist of two veins from 4 to 10 inches, or exceptionally 4 feet, wide with narrower veins or stringers in schist between. At least four of the composite lodes have been encountered in the mine within a width of 200 feet.

32/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, pp. 11-14.

- - - Ore minerals in the Boriana mine consist of wolframite, scheelite, and chalcopyrite, together with hematite and a little gold and silver in unknown form. Associated with them, particularly in the northeast workings, are some arsenopyrite and pyrite and inconsequential amounts of molybdenite. Cuprotungstite is reported to have been found near the surface.

Kerr[33/] made a rather detailed examination of the property in 1936. His studies of the mineralogical aspects are very significant, both of this property and the Bull Canyon property which adjoins on the northeast. He states:

The Hualpai Mountains in the vicinity of Boriana contain igneous intrusives which enclose schist and thin platy slate or phyllite. The tungsten deposit is in a slate zone which extends for several miles and is in places half a mile across. The slate is bordered on either side by granite and granite gneiss. The metamorphosed sediments have been cut by quartz veins carrying wolframite and scheelite.

The slate bordering the ore body at Boriana, as shown microscopically, is finely laminated and an intimate mixture of quartz and fine mica. The mica consists of layers of pleochroic biotite interlaminated with muscovite. Occasional pleochroic haloes may be observed in the biotite surrounding minute birefringent nuclei. Apatite is present in small amounts.

The veins represent fissure fillings of varying size, striking N. 30° E. and dipping from vertical to 75° E. Fissure fillings occur either as single masses of quartz up to 3 feet thick or more frequently as a distributed network of smaller veins. The network may contain from 2 or 3 up to 10 branches spread over a thickness of 3 to 6 feet.

On rare occasions single quartz veins of minable width are found. Ordinarily, however, the vein system as mined consists of two veins 4 to 10 inches thick separated by a foot or more of slate and accompanied by several thin quartz stringers distributed through the bordering rock.

The tungsten minerals have been found along four nearly parallel veins within the Boriana mine. Veins 1, 2, and 3 are within 10 to 30 feet of each other, while vein 4 is 75 to 100 feet east. All contain scheelite and wolframite, although veins 2 and 4 appear to have more pronounced mineralization than 1 and 3. Other veins may occur to the east, but when the property was visited (1936) the region east of the main workings had not been thoroughly explored.

Along the ore shoots the amount of vein quartz mined gives a fair approximation as a basis for computing the tungsten content of

33/ Kerr, Paul F., Tungsten Mineralization in the United States: Geol. Soc. of America, Memoir 15, 1946, pp. 102-104.

the mill feed. The vein quartz also contains a small and consistent amount of titanium. Titanium assays therefore are considered an approximate index of the quartz content of the mill feed and in turn of the tungsten content.

Wolframite and scheelite are both prominent in the quartz veins and occur in disseminated grains or in masses up to several inches across. Occasional specks of chlorite occur in masses of the tungsten minerals. In places, particularly close to the tungsten minerals, fine anhedra of vein feldspar occur. In the thin sections these have indices of refraction below balsam and are free from twinning. Fluorite is occasionally associated with the ore. Chalcopyrite and molybdenite are also present.

Polished surfaces yield lathlike sections of euhedral crystals of wolframite replaced in part by scheelite. The scheelite has entered the wolframite along fractures and cleavages. Various stages may be observed from incipient alteration of small streaks to areas largely scheelite containing small remnant patches of the original wolframite.

Although chiefly suspended in quartz, the tungsten minerals are in places intimately related to vein muscovite. Interlocking boundaries between masses of scheelite and masses of muscovite are common under the microscope. Lathlike projections of the muscovite into scheelite show sharp, well-preserved boundaries. This is particularly true near the border of the vein along the micaceous slate. Recrystallization of the mica may have accompanied tungsten precipitation.

Veinlets of sericite cut the vein quartz. Sericite streaks frequently lead to tungsten-bearing areas in the vein and are concentrated near wolframite and scheelite.

In the interstices between scheelite crystals and also in veinlets are flakes of brown, slightly pleochroic mica approaching biotite. Where this mineral is in contact with coarse muscovite it appears to represent a slightly earlier and different stage of mineralization from the muscovite along the walls of the veins accompanying the sericite veinlets.

Ore has been concentrated along the veins at Boriana in a well-defined shoot (fig. 36) established by exploration throughout the mine workings from the surface to below the seventh level. The shoot extends for several hundred feet along each level and is found a considerable distance farther north on each level as the mine is deepened.

The major ore distribution is more or less parallel in the different veins of the Boriana system. The inclination of the shoot is roughly on the order of 35° N. Isolated patches of ore, somewhat

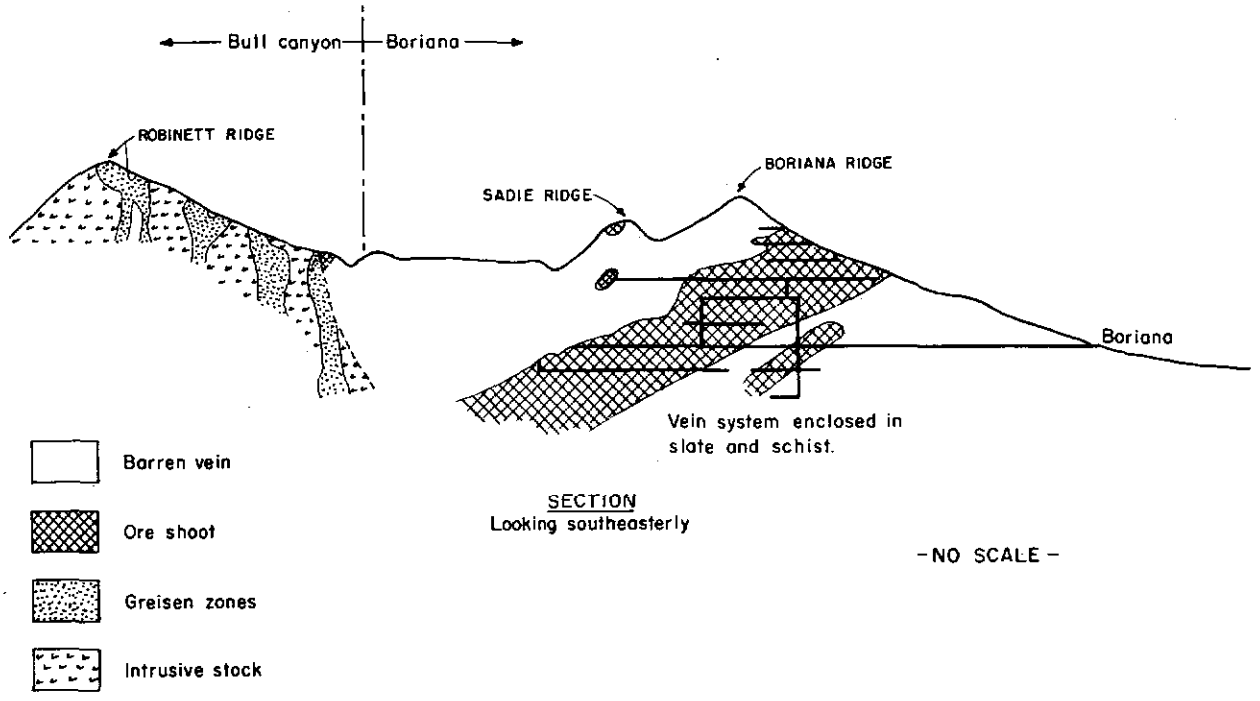

FIGURE 36. - Ore Shoot at Boriana, Ariz.

lenticular in shape, are irregularly distributed on either side of the main ore shoot. The portions of the veins between are either too thin or contain too little tungsten to justify mining.

The Neglected Vein (bordering the slate area west of Boriana). Gneissic structure is prominent in thin sections of the igneous intrusive bordering the slate on the west. Earlier augenlike patches of microcline, quartz, orthoclase, and albite with occasional coarse crystals of biotite and muscovite have been surrounded by gneissic striae of finer crystalline quartz and albite. Occasional specks of wolframite are associated with the biotite.

Not only has flow structure developed but the rock has been considerably fractured. Most of the fractures that apparently accompanied the injection and movement resulting in the formation of the gneiss are healed; most of the later fractures are unhealed. The gneissic zone is several hundred feet thick and is more prominent close to the contact with the slate. It may represent a late phase of the intrusive activity along the margin of the mass of metamorphosed sediments at Boriana.

The so-called Neglected Vein represents a zone of variable width and almost vertical continuation which extends through the gneiss roughly parallel to the contact between the gneiss and the metamorphosed sedimentary series. It is apparently not continuous, but along about the same line for a distance of several thousand feet

occasional small streaks contain grains of wolframite and scheelite. The material of these zones differs but little from the material of the surrounding gneissic zone into which the tungsten-bearing portions grade both laterally and longitudinally.

It is believed that these zones represent a concentration of the end-stage solutions carrying tungsten mineralization which was precipitated along the margin of the slate. Here destruction of the original granite as shown in thin section is more complete. Quartz is more abundant and more definitely banded. The mica is muscovite and not biotite. Most of the feldspars are replaced or destroyed. Both wolframite and scheelite are scattered in isolated grains through the quartz and muscovite; wolframite exhibits evidence of being the earlier. The boundaries of crystals appear to be controlled by the wolframite crystals replacing the earlier scheelite almost completely in many instances.

Bull Canyon Group (Iquana Claims)

The Bull Canyon group of seven unpatented lode claims is in secs. 7 and 18, T. 18 N., R. 15 W., at an average altitude of 5,300 feet. The claims are accessible from the Boriana mine by 3.5 miles of steep, narrow road (see fig. 31).

The Bull Canyon claims were located first about 1928 by Jim Craig and William Boke. Dalton Robinette acquired a two-thirds interest by purchase in 1933 or 1934, and later traded a one-third interest to R. Fetis. Boriana Mining Co. held the remaining one-third interest and later acquired the interest held by R. Fetis. In 1946 Boriana Mining Co. sold its interest to Dye and Bathrick. Since 1937, one of the claims has been worked intermittently by Robinette or by lessees. Production during the years 1941 through 1943 amounted to about 30 tons of concentrates that assayed possibly 69 percent WO_3. Production from 1951 through 1956 was 106 units of tungsten trioxide. Concentrates assayed from 59 to 65 percent WO_3.

The property was examined by the Federal Bureau of Mines in 1943 and in 1954. Following is a description from the 1954 report:

The granite exposed on the eastern portion of the Boriana property is in contact with phyllite on and near the Bull Canyon claims. The phyllite is in contact with the granite as bands that narrow as they continue to the north. Tungsten mineralization occurs in steeply dipping discontinuous quartz veins, a few inches to 2 feet wide, that are northerly extensions of the veins of the Boriana deposit. The veins are roughly parallel with a strike that changes abruptly from N. 30° to 40° E. in the phyllite to N. 50° to 60° E. in the granite. Wolframite and scheelite, the ore minerals, are irregularly distributed in the quartz. Chalcopyrite, molybdenite, and fluorite are present in minor amounts.

Most of the ore production probably has come from 3 veins, each of which has been developed by 2 adits to an average depth of possibly 75 feet. The adits range in length from about 150 feet to 300 feet. A raise and a few small stopes have been driven from the adits.

The author examined this property during the day and at night of February 18, 1959. The lowest working is an adit about 325 feet long with several hundred feet of crosscuts and a winze said to be 40 feet deep. Some stoping has been done on the narrow quartz vein. This adit has been driven through the schist and phyllite into the intrusive upper Cretaceous granite described previously under the Boriana mine description. This working is referred to as the crosscut adit.

The granite exposed on the property is shown on the recently printed Geologic Map of Mohave County, Ariz., prepared by the Arizona Bureau of Mines. There is scheelite and wolframite disseminated through the southwestern point of the granite. Heaviest concentrations appear to occur on the northwest side of the intrusive. Beryl occurs in places associated with the quartz veins, and in other places in narrow veinlets to as much as 3 inches wide and not associated with any other mineral. The visible beryl occurrences are discontinuous and very sporadic. Where the beryl was observed in association with quartz it was confined to the outer edges of the veins.

Robinette has milled several hundred tons of ore from the quartz veins. He stated that he observed beryl being discharged from concentrating tables in tailing. Most of the tailing has been washed away. Kerr[34/] made a rather intensive study of the property in 1936. His studies of the mineralogical aspects are very significant, both of this property and the Boriana mine which adjoins on the southwest. He states:

North of the main workings at Boriana is a ridge known locally as Robinet Ridge which contains scheelite. Tungsten has been concentrated at this locality under conditions closely approaching direct magmatic crystallization. Scheelite is disseminated through the igneous intrusive, and some of the boundaries between ore-bearing areas and nonore-bearing areas are at times so indistinct and irregular as to be virtually indistinguishable in the field. The only apparent megascopic features are more coarse fresh feldspar cleavage surfaces and more biotite in the nonscheelite-bearing rock. The scheelite-bearing rock is more micaceous and somewhat more stained with limonite.

In the thin section the nonscheelite-bearing rock exhibits remnant phenocrysts of orthoclase, sheared and in part replaced by fine granular quartz and later albite. The early phenocrysts also contain disseminated patches of quartz, albite, and muscovite and form a poikilitic structure. The balance of the rock is a fresh granular aggregate of quartz, microcline, orthoclase, albite, and

34/ Work cited in footnote 33, pp. 104 and 105.

muscovite with some biotite. The biotite appears to have been destroyed or altered in a number of places, some of it even going over to chlorite. Occasional grains of accessory zircon and garnet may be observed, and the feldspars are slightly cloudy due to alteration. Although the rock probably originally contained less quartz and correspondingly more feldspar making it perhaps a quartz monzonite, it is now more like a muscovite granite. Associated with biotite in the rock are a few black submetallic specks of wolframite.

In thin section the scheelite-bearing rock exhibits granular aggregates of scheelite with quartz, albite, and muscovite. Coarse-grained albite is about as abundant as quartz. Orthoclase is a minor constituent, and microcline is virtually absent. Stains radiate from former biotite layers replaced by muscovite. These, together with residual specks of wolframite, indicate that regardless of the fresh appearance of the scheelite-bearing rock it is later than the muscovite granite. The zone lacks the topaz usually associated with a greisen, is not quite so highly micaceous as would be expected, and contains more coarsely crystalline albite; otherwise it might be known as a scheelite-bearing greisen. Perhaps one would be justified in calling it a scheelite-bearing mica alaskite. Hobbs (1943) has mapped aplite near this location.

Figures 33, 35, and 36 show information pertaining to the Bull Canyon deposit.

The most recent work on the property has been done in a narrow, sheared zone on the northwest facies of the extreme southwest point of the granite, a few feet above the gneiss contact. At this point a zone about 18 feet wide has been opened for a length of 25 feet and to a depth of 15 feet. The zone strikes N. 45° E., and the dip is indefinite. Wolframite and scheelite, in a ratio of probably 1:1, are disseminated through the granite and concentrated along at least two sets of fractures in the zone. According to Robinette, 21 tons of ore was shipped from this working to a mill in Barstow, Calif. Thirty-two units of tungsten trioxide was recovered.

Seven samples were collected from this property. They are in no way representative of what may exist. The samples are described in the following tabulation:

Sample No.	Type	BeO, percent	WO_3 percent	Description
15301	Chip.....[1]	0.01	0.02	25 feet of granite at end of crosscut workings.
15302	Do.....[1]	.01	.01	From 95-foot trench on top of mountain north of adits.
15303	Grab.....[1]	.01	.02	From pile of waste north of winze in crosscut workings.

See footnote at end of table.

Sample No.	Type	BeO, percent	WO_3, percent	Description
15304	Grab.....	1/ .01	.30	From faces of four lower dumps northwest of crosscut workings.
15305	Do.....	1/ .01	1.10	From ore piled at the opencut at the southwest point of granite.
15306	Do.....	.02	.32	From faces of dumps above those sampled at 15,304.
15307	Chip.....	1/ .01	.03	From granite outcrops from top of mountain to 175 feet easterly.

1/ Less than.

Tungstite Group

The Tungstite group of 16 unpatented lode claims is mainly in sec. 7, T. 18 N., R. 15 W., at an average altitude of 4,000 feet. The claims adjoin the Bull Canyon property on the northeast, and are accessible from the Boriana mine road which passes near the Tungstite camp about one-fourth mile east of the Bull Canyon workings. Mine workings on the Tungstite property are probably one-half mile northeast of the camp at the end of a rough, winding road. (See fig. 31.) The property is owned by J. F. Moore, Box 2, Yucca, Ariz.

These claims were located probably between 1948 and 1950 when they were worked by a Mr. Watell. During 1951 lessees mined ore for a period of about 4 months. The property was acquired by the present owner on February 2, 1952, and operations were started late in 1952. A small gravity mill installed on the property was removed after treating about 100 tons of ore. An estimated 108 tons of ore treated in the Boriana mill during 1951 yielded 3,000 pounds of concentrates containing 57 percent WO_3. Reported production from 1951 through 1956 was 137 units of tungsten trioxide.

The Bureau of Mines examined the property in April 1954, and according to the report:

> Tungsten mineralization appears to be closely associated with numerous quartz stringers in a green ledge. The "green ledge" is composed of fine to coarse-grained green amphibole. It is 4 to 6 feet wide and is traceable by intermittent outcrops for several hundred feet. At the prospect workings, the ledge strikes N. 10° E. and dips about 80 degrees to the south. Tungsten is present as scattered fine-grained scheelite and as one of the wolframite group minerals.

Ore production, prior to 1952, came from an open cut about 40 feet long by an average of 4 feet wide and 14 feet deep. Since late in 1952, the owner has sunk and timbered a single-compartment shaft to a depth of 50 feet and has driven about 20 feet of drifts from the bottom of the shaft. The shaft is situated about 100 feet north of the open cut.

The author visited this property on February 18, 1959. The shaft and an adit west of the shaft were both caved and inaccessible.

The "green ledge" referred to previously is in altered schist and gneiss near a granite contact. Since the underground workings were inaccessible and few outcrops were visible, little can be added to the previous description. The scheelite is concentrated in narrow quartz veinlets seldom more than one-half inch wide. The seams are sporadic and discontinuous. The green amphibole contains very sparse, small grains of scheelite.

According to Moore a 90-foot shaft has been sunk in which vein widths range from 3 to 6 feet. He states that assays range from 4.08 to 5.39 percent WO_3.

Lentz Black Rock Group

The Black Rock group of 16 unpatented lode claims is in sec. 8, T. 19 N., R. 16 W., on the north slope of Walnut Canyon on the west side of the Hualpai Mountains. The altitude is about 3,600 feet. To reach the claims by road drive 11.9 miles south on U.S. Highway No. 66 from its intersection with State Route 93 in west Kingman, turn eastward 9.1 miles on the Walnut Canyon trail, then northward 0.3 mile to the foot of a high hill which is northwest of the intersection of a major northward-trending drainage with Walnut Canyon. There is no road to the few small pockets of scheelite ore scattered over this hill (fig. 31).

These claims were located in March 1956 by Frank Dennis and W. K. Lentz of Kingman. No work was in operation when the property was examined in April 1959.

According to Lentz 15 tons of scheelite ore was hauled from the property from which 1,200 pounds of concentrates that assayed better than 60 percent WO_3 was recovered. Workings consist of a number of shallow pits and prospect holes. None exceed 10 feet in depth.

Sparse, sporadic scheelite occurs in small pockets within usually narrow, discontinuous quartz veins. The veins generally strike N. 60° E. and dip 55° NW., and are in slaty schist and hornblende gneiss. They lie conformable to the foliation of the rocks. The schist and gneiss also are cut by pink pegmatite dikes, composed of quartz and feldspar and a little mica, which attain widths of 35 feet and can be traced for several hundred feet. The dikes generally strike N. 35° W.

The scheelite is white in color and fluoresces blue and white. It is thinly scattered in small pockets from the canyon bottoms to the top of a 250-foot hill. The scheelite is confined principally to the quartz veins. However, in one place, scheelite was observed to occur in the schist wall to a depth of about 3 inches from the quartz. The largest pocket observed was probably 4 feet long by 2 feet deep by 4 inches wide. The scheelite occurs as small grains in the quartz.

Ophir Claims

The Ophir group of six unpatented lode claims is in secs. 24 and 25, T. 19 N., R. 17 W., and sec. 30, T. 19 N., R. 16 W., on the west side of the Hualpai Mountains at an altitude of about 4,000 feet. The claims may be reached by traveling 11.9 miles south on U.S. Highway No. 66 from its intersection with State Route 93 in west Kingman, and eastward 5.0 miles to the Walnut Canyon trail, then 1.8 miles southeastward on a winding road that ends in a deep canyon. From the end of the road, walk eastward up the canyon to where it divides into the upper reaches of the mountains (fig. 31, p. 72).

This property was located in December 1956 by W. K. and Virginia Lentz. No production has been reported. No work was in operation when the claims were examined in April 1959. Workings consisted of a few shallow prospect opencuts and pits, none of which exceeded 12 feet in depth.

Geology and scheelite occurrences are essentially the same here as on the Lentz Black Rock claims. Sparse, sporadic scheelite occurs in narrow, discontinuous quartz veins which cut gneiss and slaty schist. Owing to a granite contact on the eastern part of the claims, strikes and dips are slightly different from those on the Black Rock claims. The veins and foliation of surrounding rocks strike N. 40° to 45° E., and the dips range from 50° to 70° NW.

The few pockets of scheelite that were observed measured a few feet along the strike, a few feet downdip, and less than 4 inches in width.

On Ophir No. 5 claim, about 300 feet southwest from where the canyon forks, is a narrow, altered pegmatitic type vein that strikes N. 35° E. and dips 50° NW. This vein carries bluish-green crystals and crystal fragments of microcline. This material is easily mistaken for beryl. According to assay results of two samples taken from the more brightly colored material, there was less than 0.002 percent BeO. The bluish-green material was anorthoclose; the sodium was microcline.

Murphy Tungsten Group

The Murphy group of five unpatented lode claims is in secs 25 and 26, T. 20 N., R. 15 W., in Wheeler Wash on the east slope of the Hualpai Mountains at an altitude of about 4,700 feet. The claims are accessible from Kingman by traveling 13.9 miles southeastward on State Route 93, and southward on a maintained dirt road for 5.5 miles to the Odle ranch on Wheeler Wash, then

0.8 mile west to a cabin on the property. There is no road to the mine workings. The workings are about 1,500 feet northwest of the cabin (fig. 31). Some work had been done on the claims a short time before they were examined in March 1959.

This property was located first by Hank McCasson in 1916, and was abandoned after World War I. It was relocated by James G. Moon and M. B. Lauzon in 1939. They produced 1,800 pounds of ore carrying 10 percent WO_3 and 400 pounds of concentrate assaying 65 percent WO_3. All ore was selectively mined and sorted. Frank Murphy acquired possession of the claims about 1945.

Workings consist of two 40-foot adits, a 30-foot adit, and several shallow surface openings. All of these are accessible except a winze in the 30-foot adit which is filled with water.

Sparse, sporadic wolframite and scheelite occur in a narrow quartz vein which cuts gneissic granite. Wolframite is the principal ore mineral, and two very small ore shoots have been found and removed. Considerable pyrite and scattered grains of chalcopyrite also occur in the quartz. The vein strikes N. 18° E. and dips about 85° SE. It averages 1 foot wide with a maximum observed width of 2 feet. It has been explored along the strike for probably 700 feet. The face of the upper adit, the deepest workings, is not over 25 feet from the surface.

Moon and Lauzon found a small pocket of high-grade ore at the entrance of the upper adit. A few pounds of ore was found in an opencut about 150 feet northeast of the upper adit.

The following sample results were obtained by the Bureau in 1944.

Sample No.	Description	Width of vein, feet	WO_3 percent
4369	Face of upper 40-foot adit on vein.....	2.0	0.01
4370	In above adit 10 feet N. 18° E. of No. 4369.....	1.5	.01
4371	In above adit 10 feet N. 18° E. of No. 4370.....	1.25	.98
4372	Up the hill 57 feet S. 18° W. of portal of above adit, from opencut.....	1.00	.01
4373	Downhill 60 feet N. 18 E. of portal of above adit, in lower adit at turn in vein.....	1.50	.01
4374	Downhill 150 feet from upper adit in opencut on vein to east.....	1.0	1.20

There are other narrow, widely spaced quartz veins for several hundred feet west of these workings, similar to and essentially parallel to the one described. There are a few scattered shallow surface workings on them, but no ore has been found.

Laxton Area

The following description is by Wilson.[35/] Inquiries in the vicinity indicated that no work had been done on the claims in recent years, and they were not examined during the present investigation. The claims are probably in secs. 26 and 27, T. 20 N., R. 15 W.

> The Laxton property of fourteen unpatented claims, held in 1940 by George Laxton, is in the northeastern portion of the Hualpai Mountains, in the rugged upper drainage area of Wheeler Wash. It is accessible by a few miles of trail from Odle Ranch, which is 22 miles from Kingman via the Sandy and Democrat roads.
>
> Here the prevailing rock is medium-grained granite, intruded by a large stock of granitoid rock and associated aplite dikes.
>
> About 1/2 mile east of Laxton's camp, the stock is cut by a persistent vein from 2 to 6 inches wide that strikes northward and dips 70° E. Its filling consists of coarsely crystalline iron-stained, dull-white quartz, locally with scattered small particles of wolframite and scheelite. Only a little shallow work has been done here.
>
> On the steep slope west of camp are several pyritic quartz veins up to 2 feet wide that strike N. 60° E., and dip steeply southwest. In places they contain a little molybdenite.
>
> Farther up this slope is a vein that strikes N. to N. 30° W., dips 80° E., and is traceable on the surface for a length of some 3,000 feet. Its filling consists of coarsely crystalline, banded, iron-stained, dull-white quartz, in places 2 to 4 feet wide. Much of its outcrop shows cavities after pyrite. As exposed in a few shallow pits and short adits, some portions of this vein contain abundant crystals of wolframite, generally near the hanging wall.
>
> At the time of visit, no production of tungsten had been made from the property.

Blue Bell Group

The Blue Bell group of 24 unpatented lode claims is in secs. 1, 2, and 12, T. 19 N., and sec. 36, T. 20 N., R. 15 W., in the vicinity of Jackman Wash on the east side of the Hualpai Mountains. The altitude is approximately

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35/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 15.

4,500 feet. The workings may be reached by road, traveling 13.7 miles from the intersection of U.S. Highway No. 66 and State Route 93 in east Kingman, southeastward on Route 93, and 6.6 miles southward on the Gold King and Democrat road to a frame house on the west side of the road. On following pages directions to the occurrences examined refer to this house (fig. 31). No work was performed when the property was examined in April 1959.

At least two earlier locations of a part of this group are recorded. The Nello group was located by Emery Blevins and A. B. Maddox in the early 1940's, and the Tungsten Queen was located by Ray and Jensen Ressler, also in the early 1940's. The claims were relocated in the summer of 1951 by Lion Kay, Elmer Harrison, and the brothers George and Joe Lewis.

Records show a small production from the property, all from shallow surface workings and float. Five units of tungsten trioxide were sold in 1955. A shipment of 1,355 tons of ore was sent to Hillside Mining & Milling Co. near Bagdad, Ariz. This ore assayed 7.3 percent WO_3 and 5,587 units of tungsten trioxide was recovered. No reason was given for the low recovery. Workings include a shaft of unknown depth, two adits at least 100 feet long, and many shallow shafts, opencuts, trenches, and prospect pits.

In this area Precambrian gneissic granite has been invaded by a stock of Upper Cretaceous granite, as shown on the Geologic Map of Mohave County, Ariz., prepared by the Arizona Bureau of Mines in 1959. East of the Gold King road are a number of narrow, discontinuous quartz veins in the Precambrian gneissic granite. These veins fit into a rather extensive fissuring pattern. The more prominent veins strike N. 25° to 30° W. and dip 70° to 75° SW. The minor system strikes generally north and is nearly vertical. The fissures are marked by iron-stained outcrops and coarse, flaky sericitic alteration. Both systems show local variations in strike and dip, particularly in the vicinity of intersections.

The Tripod claim is 1.6 miles south and 0.1 mile east of the frame house. A milky quartz vein on this claim strikes N. 05° W. and is vertical; its average width is less than 1 foot. Outcrops can be traced on the surface for at least 600 feet. The quartz contains pyrite and iron oxides, and traces of molybdenite, bismuthinite, huebnerite, wolframite, and scheelite. A shaft of unknown depth has been sunk on the vein. No work, other than a small amount of surface prospecting, has been done by the present owners.

South of the frame house 0.2 of a mile, a trail branches southeastwardly 0.7 of a mile to the Blue Bell No. 13 claim. Scheelite occurs in a narrow veinlet along the hanging-wall side of a fault zone about 3 feet wide. The veinlet and fault strike N. 25° W. and dip 75° SW. The veinlet is in gneiss with local remnants or patches of schist. Narrow dikes of aplitic character were observed. Scheelite occurs in a band of quartz, mica, and altered feldspar nearly 1 inch wide on the hanging-wall side of the fault. The scheelite was observed at night over a strike length of about 15 feet and downdip for about 5 feet. Some of the ore was estimated to contain 5 percent tungsten trioxide. The scheelite is white in color, fluoresces blue, and occurs as

narrow bands and small crystalline masses. In addition to scheelite, the vein material carries pyrite, hematite, and limonite, with manganese staining and sericite on the walls.

Two more occurrences, similar in all respects to the one previously described, were observed in the vicinity. Only a small amount of work had been done on them.

Up Jackman Wash about 1 mile west from the frame house is the east contact between Precambrian granite and the Cretaceous granite. Scheelite is reported to occur in quartz veins adjacent to and almost parallel to the contact. Sparsely disseminated scheelite occurs in the Cretaceous granite for a few hundred feet west of the contact. The scheelite is white, fluoresces blue, and occurs as tiny specks and thin bands. A small amount of work is reported to have been done on both slopes of Jackman Wash on a quartz vein near the contact. According to the owners there is a good showing of scheelite about 12 inches wide.

Telluride Chief

Inquiries in Kingman indicated that this property had not produced any tungsten, so it was not examined during the course of this project. Following is a description from Wilson's work.[36]

> The Telluride Chief mine is in the northeastern part of the Hualpai Mountains, 20 miles from Kingman via the Sandy and Democrat roads.
>
> This mine was prospected for gold, silver, and molybdenum during 1916-18 by the Telluride Chief Company and the Standard Minerals Company, which sank a 450-foot shaft, did some drifting, and built a gravity-flotation mill of 100 tons daily capacity to treat gold-silver-molybdenite ores. Eight of the claims, now held by W. Meyers, F. C. Walker, J. M. Cochrane, and W. E. Little, were relocated in 1935. The present owners have done considerable underground work and some surface prospecting, and shipped some gold-silver-copper ore.
>
> In this vicinity the prevailing rock is medium-grained granite, intruded by dikes of aplite and pegmatite. The granite has been broken by rather extensive fissures marked by iron-stained outcrops and coarse flaky sericitic alteration. Many of them contain quartz veins of which two systems are readily evident. Those of the more prominent system strike N. 30° W. and dip steeply southwestward. For the other system the prevailing strike is northeastward, and the dip steep southeastward. Both systems show local variations in strike and dip, particularly in the vicinity of intersections.

36/ Work cited in footnote 35 (p. 91), pp. 14-15.

The vein filling consists of coarsely crystalline dull-white quartz with outcrops locally honeycombed after pyrite and stained with oxides of iron, molybdenum, and tungsten. In places it contains pyrite and molbdenite; in other places pyrite and scattered particles or small masses of wolframite and scheelite. The tungsten minerals occur in both the vein systems but apparently most abundantly in and near the intersections of the northeast veins.

This property was worked in the early 1950's by V. C. Haynes, Frank Henderson, and Van Marl. A small pocket was found on the surface which assayed plus 1 percent WO_3. According to Haynes the ore contained too many impurities to concentrate satisfactorily. Huebnerite and stolzite, in addition to wolframite and scheelite, were identified in the ore.

The claim has been relocated recently by parties unknown.

Florescent Prospect

The Florescent unpatented lode claim is in sec. 30, T. 21 N., R. 15 W. at an altitude of about 4,300 feet. The property is accessible from State Route 93. At milepost 79.5, a distance of 7.4 miles east of Kingman, turn south onto a dirt road and continue 0.8 mile to the shaft. The deposit is at the extreme northern tip of the Hualpai Mountain Range (fig. 31). No work was in operation when the property was examined on December 16, 1958.

This claim was located on July 12, 1951, by V. C. Haynes and Wesley Curry. Production has amounted to 135 units of tungsten trioxide.

Workings consist of a shaft 100 feet deep with drifts on the 100- and 40-foot levels, an underhand stope from the surface 14 feet long by 5 feet deep, a sidehill opencut 10 feet long with a 9-foot face, and one small prospect pit.

Scheelite is present in a vein in a very small remnant of schist and gneiss surrounded by granite in which pegmatite intrusions are mixed. The scheelite is in a vein 5 to 6 feet wide which strikes N. 39° E. and dips 79° NW. Concentrations are seen along both foot and hanging walls. On the hanging wall there are from 1 to 12 inches of quartz with intermingled gneiss which contains appreciable amounts of scheelite in grains and masses as much as 3 inches in cross section. The gangue material contains much limonite. A stringer 3 to 4 inches wide which contains low-grade scheelite is also on the handing wall. The material between the two enriched zones is altered biotite-gneiss, and contains sparse fine-grained scheelite. Indications show that enrichment has occurred at the intersection of the vein with cross fractures that strike N. 55° E. and dip 25° SE.

According to Haynes the scheelite mineralization pinched out at a depth of 40 feet. In drifts at the bottom of the 100-foot shaft pegmatite dikes or coarse-grained granitic dikes were found, but they were barren of scheelite. The deposit has been opened for about 30 feet south of the shaft. Because of detritus, the vein cannot be traced beyond this limit.

Scheelite has been found 200 feet northeast of the shaft in granite. A small prospect pit has been sunk on the small deposit. There is no evidence of scheelite between the shaft and the pit, nor could any scheelite be found north of the pit.

Hackberry Area

Black Rock Prospect

The Black Rock group of four unpatented lode claims is in sec. 10, T. 22 N. R. 12 W., in the Cottonwood Cliffs area at an altitude of about 5,000 feet. The property may be reached from Hackberry by traveling east 2.1 miles on U.S. Highway No. 66, then turning south on the Wikieup road and continuing 7.9 miles to a powerline. Turn east on the powerline road and drive 4.7 miles to a road fork, bear left and drive 2.2 miles northeast to a steel water tank. The prospect shaft on the Black Rock claim is 0.3 mile east of the water tank on the north slope of a ridge (fig. 37).

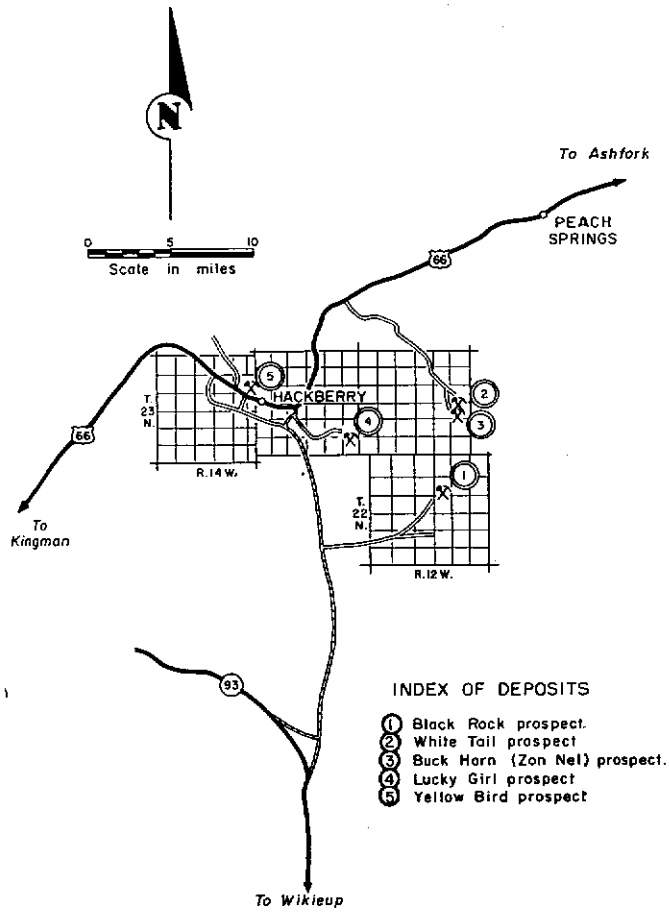

FIGURE 37. - Location Map, Tungsten Deposits Near Hackberry, Mohave County, Ariz.

The claims were located in 1951 by E. L. Ming. No production has been recorded. On September 7, 1956, R. P. Noli and John F. MacPherson relocated part of the property and named the claims Apex. No evidence of recent work was noted when the property was examined in January 1959.

Workings consist of an inclined shaft about 25 feet deep and another caved shaft about 100 feet to the east, probably 10 feet deep. About three-quarters of a mile to the north a few shallow trenches have been dug across another scheelite occurrence.

The following geological and mineralogical descriptions are abstracted from the files of the Defense Minerals Exploration Administration.

Small, scattered, irregular disseminations of scheelite occur in Precambrian schist, which forms a wide and extensive belt and is flanked on both sides by granitic rocks. This schist is clearly depicted on the Geologic Map of Mohave County, published by the

Arizona Bureau of Mines in 1959. Pegmatites intrude both the granites and schists.

On the southern claim a small inclined shaft follows a narrow mineralized zone to a depth of about 25 feet. Under ultraviolet light, specks of finely divided scheelite were observed scattered over widths of several feet, but the bulk of the mineral was confined to spots not more than 12 inches wide. The better spots appeared to be associated with minor shears that followed the foliation of the schist. Little or no vein quartz accompanied the scheelite. On the surface the lateral extent of the scheelite was evidently limited to a few tens of feet.

At the scheelite occurrence about three-quarters of a mile north of the incline a few shallow trenches had been dug across the spots showing the best fluorescence. As in the southern occurrence scheelite was found disseminated in, and apparently restricted to, a band of dark hornblende schist. No semblance of a vein or other continuously mineralized structure was evident.

White Tail Prospect

The White Tail claim is in sec. 24, T. 23 N., R. 12 W., at an altitude of about 5,250 feet. This claim adjoins the Buck Horn Claims on the north. The property is accessible from U.S. Highway No. 66 as follows: Travel 12.5 miles southwesterly from Peach Springs to a dirt road that branches southeasterly, and 1.0 mile to a railroad bridge under which the road passes; keep left at a fork at 3.0 miles; continue left at a fork at 6.5 miles, left at a fork at 7.3 miles, right at a fork at 7.9 miles and right at a fork at 9.5 miles; then keep right at a fork at 10.5 miles, and continue 0.2 mile to the White Tail shaft (fig. 37). No work was in operation when the property was examined in January 1959.

The claim was located in May 1951 by Ray Shay and C. W. Venza. Bill Brakeman of Kingman, Ariz., acquired an interest in the property sometime later. In 1957 John Bacon of Mesa, Ariz., purchased the claim. The only production was by Shay, who sold 15 units of tungsten trioxide in 1951. Workings consist of a vertical shaft with a 15-foot drift on the bottom, and an adit 10 feet long.

Very sparse, sporadic scheelite has occurred along a fracture zone in altered gneiss which strikes N. 45° E. and is nearly vertical. The scheelite is confined to a zone 2 feet wide, has been explored to a depth of about 25 feet, and may be observed along the strike for possibly 30 feet. The individual grains of scheelite are seldom more than one-quarter inch in cross section. Very little epidote, garnet, or quartz was observed.

About 100 feet east of the shaft is an adit possibly 10 feet long driven into the same formation. Two small specks of scheelite show in the adit. A very small amount of scheelite float was observed between the two workings.

Buck Horn (Zon Nel) Prospect

The Buck Horn group of two unpatented lode claims is in the SE$\frac{1}{4}$ sec. 24, T. 23 N., R. 12 W., at an altitude of about 5,250 feet. The property is

accessible from U.S. Highway No. 66 as follows: Travel 12.5 miles southwesterly from Peach Springs to a dirt road that branches southeasterly, then 1.0 mile to a railroad bridge under which the road passes; keep left at a fork at 3.0 miles, left at a fork at 6.5 miles, left at a fork 7.3 miles, right at a fork at 7.9 miles, right at a fork at 9.5 miles, and left at a fork at 10.5 miles. At 11.1 miles turn right onto a dim trail and continue 0.2 mile to the Buck Horn shaft, which is on the northeast edge of Wrights Canyon (fig. 37). No work was in operation when the property was examined in January 1959. No production is recorded.

Two claims were located in May 1943 by John L. Nelson as the Zon Nel group. Apparently ownership lapsed, because in September 1950, John L. Nelson relocated the two claims as the Buck Horn group.

Workings consist of a vertical shaft 23 feet deep, a trench 65 feet long, 3 feet wide and about 4 feet deep, a trench 20 feet long, 4 feet wide, and 10 feet deep, and several shallow prospect pits and bulldozer cuts.

Scheelite is present in a tongue of early Precambrian schist from an extensive formation shown on the Geologic Map of Mohave County published by the Arizona Bureau of Mines in 1959. The mineralization process appears to be associated with fractures conformable to the foliation of the schist.

At the shaft sparse sporadic scheelite occurs in a zone about 70 feet long and 3 feet wide which strikes N. 77° E. and is nearly vertical. It is in highly altered schist and associated with epidote, minor garnet, and a small amount of iron staining. The scheelite is very sporadic and occurs principally in a zone from a few inches to 1 foot in width. The individual crystals and grains are seldom more than one-quarter inch in cross section. There are indications that enrichment occurred at intersections with fractures striking N. 20° W. and dipping 83° SW. This mineralized zone appears to extend only a few feet beyond the workings.

About 300 feet north of the shaft a trench has been cut across a similar occurrence. The strike is N. 67° E. and nearly vertical. Very sparse scheelite can be observed for approximately 50 feet along the strike.

Northwest of the shaft about 300 feet, and on the east edge of Wrights Canyon, are two parallel pegmatite dikes separated by possibly 30 feet of schist. They strike N. 57° E. and dip 57° SW. The dikes can be seen for several hundred feet and extend west across Wrights Canyon. Along the south contact of the south dike is a narrow altered zone of schist which contains scheelite. The zone has been exposed for nearly 10 feet along the strike and to a depth of 10 feet. Sporadic scheelite occurs in widths up to 4 feet. The individual masses and grains of scheelite are as much as 2 inches in cross section, and are associated with epidote, garnet, and some tourmaline.

A small amount of ore which will assay about 1 percent WO_3 can be sorted from these deposits.

Lucky Girl Prospect

The Lucky Girl group of two unpatented lode claims is in sec. 25, T. 23 N., R. 13 W., at an altitude of about 4,500 feet. The deposit is accessible from Hackberry by traveling 2.1 miles east on U.S. Highway No. 66, and 5.0 miles easterly on a winding dirt road to a 20-foot exploratory shaft at the left edge of the road (fig. 37). The shaft is probably 0.85 mile northwest of the Copper Giant mine. No recent work was evident when the property was examined in January 1959.

The claims were located first by E. L. Ming in 1953, then relocated on February 26, 1954, by E. L. Ming and C. E. and M. D. Linn, father and son, of Kingman, Ariz. C. E. Linn sold 5 units of tungsten trioxide from the property in 1954. Workings consist of a prospect shaft about 20 feet deep.

The geologic setting is early Precambrian schist, and is shown on the Geologic Map of Mohave County published by the Arizona Bureau of Mines in 1959.

The prospect shaft is sunk in a medium-foliated dark-colored schist striking N. 55° E. and dipping about 55° SE. Alluvium obscures the schist except along the road that crosses the mineralized zone. Granite crops out boldly about one-half mile west of the property.

Scheelite is confined to stringers and pods of quartz and altered schist associated with a weak fracture that strikes N. 45° W. and dips almost vertically. The scheelite occurs irregularly as grains and specks up to 0.25 inch in cross section. The width of the mineralized zone, as exposed in the shaft, ranges from less than 1 inch to possibly 1 foot. No attempt has been made to test for extension of the mineralized zone beyond the shaft.

Yellow Bird Prospect

The Yellow Bird group of two lode claims (patents pending) is in sec. 12, T. 23 N., R. 14 W., at an altitude of approximately 3,700 feet. The claims may be reached from Hackberry as follows: Travel 0.9 mile westerly from the Hackberry store on U.S. Highway No. 66, and 0.7 mile northeasterly across Hackberry Wash to the property (fig. 37). No work was in progress when the claims were examined in February 1959. However, the claim had been worked recently.

The claims were located by Henry M. O'Connor, Hackberry, Ariz., on August 15, 1951. The property has a recorded production of 12 units made in 1955 and 1956.

Workings consist of a 50-foot adit with a 10-foot crosscut; a pit of 6 feet square by 6 feet deep; a hillside cut 50 feet long with a 10-foot face, and a shaft probably 40 feet deep. A small mill consisting of a jaw crusher, a set of rolls, and a concentrating table had been set up on the property. A small amount of ore had been run through the plant. Results are not known.

This scheelite occurrence is near a schist and gneiss contact and is possibly 1 mile west of a small stock of Upper Cretaceous granite. This is

shown on the Geologic Map of Mohave County, Ariz., prepared by the Arizona Bureau of Mines in 1959. A dark-green hornblende schist crops out extensively on the claims. It is cut by narrow pegmatite dikes of various attitudes. Two zones of tungsten mineralization are confined to the schist, the foliation of which strikes generally north and has variable dips.

One of the mineralized zones high on the south slope of a mountain has been explored by a shallow surface pit and a 50-foot adit with a 10-foot crosscut about 60 feet below the pit. Scheelite occurs in a narrow fracture in altered schist and is associated with garnet, epidote, and calcite. The fracture strikes N. 25° W. and dips about 70° SW. Scheelite is found over widths up to 10 inches as sparse grains. About 1 inch of the material contains considerable scheelite, although it does not appear to be quite so abundant in the crosscut where the fracture was cut. However, no lateral work on the mineralized zone has been done.

The other mineralized zone, several hundred feet to the southeast and near the bed of a canyon that drains south, averages 6 inches wide, and has been exposed along the strike for about 50 feet. The strike and dip are the same as that at the upper workings, and the scheelite occurrence is essentially the same as that at the other deposit.

The owner reported that representative samples from the two zones contained over 1.5 percent WO_3.

Music Mountain Tungsten Prospect

The Music Mountain tungsten prospect is in the south half of sec. 19, T. 28 N., R. 16 W., on the southern slope of Garnet Mountain in the Music Mountain Range at an altitude of about 6,300 feet. The prospect is accessible from Kingman as follows: Travel northeasterly 21 miles on U.S. Highway No 66 to the Pierce Ferry road, turn north on a maintained county road and continue 33 miles to an east-west road intersection, turn easterly and continue 12.8 miles to a southerly branching trail about 0.3 mile east of the Diamond Bar ranch house. Follow this trail southerly 7.0 miles, then westerly 1.3 miles to the workings (fig. 38).

This property has not been worked for some time. It is owned by the Atchison, Topeka and Santa Fe Railway Co.

Byron Duncan discovered the scheelite. G. T. Duncan, C. Duncan, D. M. Hogue, Bill Brakeman, and E. Graham leased the property in 1942. In 1948, V. C. Haynes bought the lease, and subsequently a Phoenix concern leased the property and sank a 50-foot shaft. In 1951, Frank Henderson and a partner leased the claim. There has been a very small, unrecorded production.

Workings consist of a hillside cut 25 feet long and 6 feet wide with a 20-foot face, and an inaccessible shaft about 50 feet deep.

Scheelite has occurred along a contact between Precambrian granite and a small remnant of highly altered schist. Nodules of unaltered biotite schist

may be seen in the granite in the immediate vicinity of the occurrence. Scheelite has been deposited along a quartz, garnet, and epidote mass about 50 feet long and 6 feet wide which strikes easterly and is vertical. Local enrichment has occurred adjacent to a fault which strikes N. 20° W. and dips 82° NE. Very sparse scheelite also is present about one-fourth mile north of these workings.

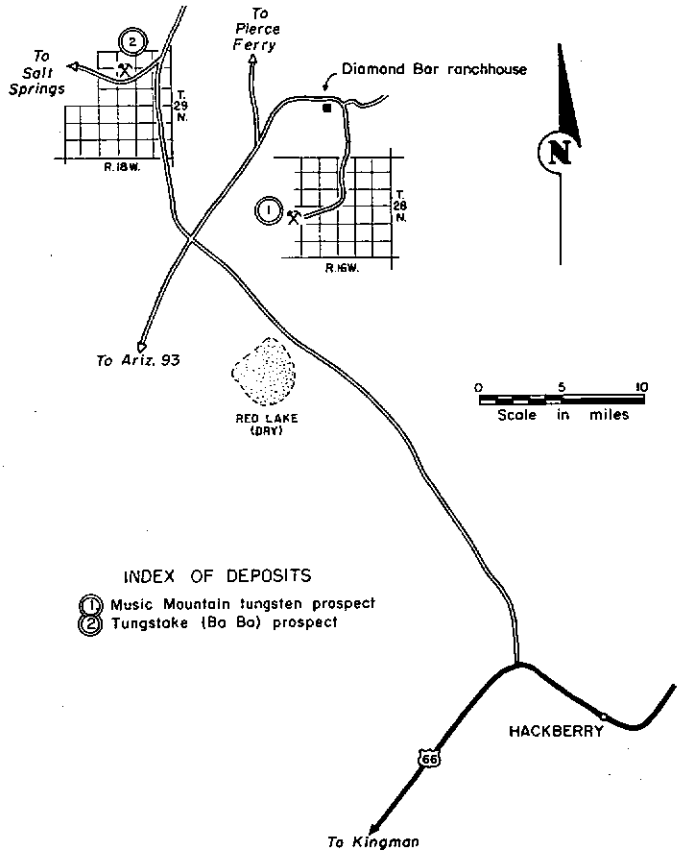

FIGURE 38. - Location Map, Music Mountain and Tungstake Prospects, Northern Mohave County, Ariz.

A vertical pegmatite dike from 3 to 5 feet wide, which strikes north, is approximately 50 feet east of the shaft.

Five samples were collected by the Bureau of Mines in 1942. The samples assayed from 0.01 to 0.36 percent WO_3 over widths ranging from 5 to 12 feet.

Tungstake (Ba Ba) Prospect

The Tungstake prospect is in sec. 10, T. 29 N., R. 18 W., west of Hualpai Wash near the Lake Mead recreational boundary at an altitude of about 3,000 feet. Road directions from Kingman are as follows: Travel 21 miles northeast from Kingman on U.S. Highway No. 66 to the Pierce Ferry road, turn north on a county-maintained road and drive 33 miles to an east-west road intersection, keep north or straight ahead for 10.5 miles to the westward-branching Salt Spring Wash road. Follow this road 4.1 miles westward to a dim trail that bears northward near the crest of a small mountain pass. Follow this trail 0.8 mile to a few shallow surface workings (fig. 38). No work was evident when the property was examined in March 1959.

Location papers found at the prospect show that C. X. Bacon and Steve Daily staked the tungsten occurrences on January 16, 1954; then J. F. Robbins and J. A. Darland staked claims on March 2, 1954. On September 2, 1954, Frank Ricca staked five Ba Ba claims over the occurrence. The last locations were eight Tungstake claims located by Esperanza Mining Corp. on July 27, 1955, and again on December 14, 1955. According to Dick Hart of Kingman, almost 10 tons of ore was shipped from the property to Bishop, Calif., and plus 1 percent WO_3 was recovered from the ore. Workings consist of a few shallow surface diggings, none over 10 feet deep.

Sparse, sporadic scheelite occurs in narrow quartz veinlets which cut hornblende schist. The scheelite is present in quartz as small grains along the intersections of narrow fractures with joint sets. The best occurrences were observed along a quartz veinlet, 2 to 3 inches wide, which strikes about N. 80° W. and dips 30° SW. This fracture can be traced along the strike for perhaps 500 feet. However, only a small part of it contains scheelite. Concentrations occur locally where vertical fractures striking N. 85° E. intersect in the veinlet with a vertical joint set striking N. 5° E. Scheelite was observed in schist along fractures adjacent to the quartz in widths of up to 12 inches.

Some of the schist is limy, and in places epidote was observed. Judging from surface float and shallow surface diggings, other small local pockets of low-grade scheelite ore exist in the area.

Mohave Mountains

Dutch Flats Tungsten Prospects

The Dutch Flats tungsten prospects are in secs. 19, 20, 29, and 30, T. 14 N., R. 18 W., on the southeast slope of Crossman Peak in the Mohave Mountains at altitudes ranging from perhaps 3,500 feet to nearly 5,000 feet. The prospects are accessible from Yucca as follows: Travel 8.4 miles southwesterly on U.S. Highway No. 66 to a southerly branching dirt road, follow this winding road to a gasline road, then drive west to a junction of two gasline roads, a distance of 1.9 miles from Highway No. 66. Turn south along a gasline road and continue 9.0 miles to a southwesterly branching trail. Follow this trail 6.9 miles to a junction, keep right and continue 12.6 miles westerly to a Dutch Flats sign painted on a high rock outcrop on the north side of a sandy canyon. Turn northerly up a steep narrow canyon and drive 6.2 miles to the Dutch Flats campsite. The last 5 miles of road are very rough (fig. 39). No work was evident when the property was examined in March 1959.

Claims in this area probably were located first about 1912 and were worked originally on a small scale for gold. A. V. Kampff worked the claims for a number of years, originally for gold and later for tungsten. He constructed a small crude mill which he used for the recovery of gold and tungsten. Recovery was poor. There have been a number of lessees on the property. In 1951 Julius Eaton owned 25 claims over the principal workings. Papers on the property showed that Z. Soldinski and L. M. Donnel of Burbank, Calif., located 10 claims over the workings on January 11 and 12, 1959. Production has amounted to at least $14,000 in gold and 300 units of WO_3.

The property contains 11 adits ranging in length from 50 to 350 feet with a few crosscuts, small stopes, and shallow winzes. The Pioneer shaft is 135 feet deep, and an inclined shaft on the Evelyn claim is at least 60 feet deep. In addition, there are many shallow shafts and prospect pits are on the property.

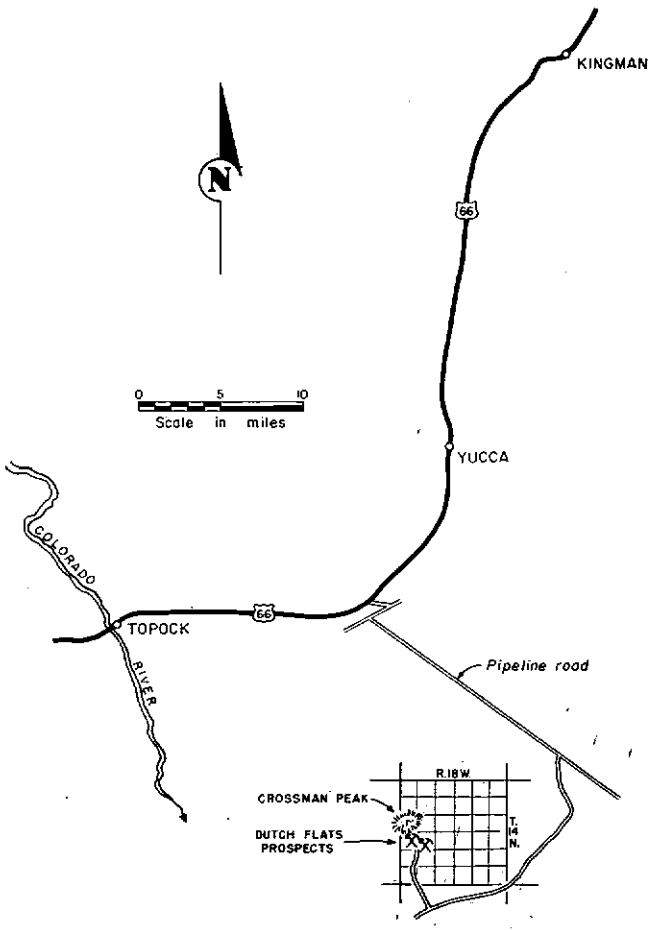

FIGURE 39. - Location Map, Dutch Flats Tungsten Prospects, Mohave County, Ariz.

The Bureau of Mines examined and sampled the property in 1942. E. D. Wilson reported on the claims in 1941, and the Defense Minerals Administration investigated a loan application in 1951. A map (fig. 40) from the Defense Minerals Administration report of 1951, with a few minor changes, represents the property as it was in 1942. No attempt was made to correlate the 1959 locations with the old ones.

According to the Mohave County Geologic Map printed in 1959 by the Arizona Bureau of Mines, the prevailing formation is older Precambrian gneiss. This formation is cut by basic felsitic intrusive dikes. The geologic map shows a small stock of Upper Cretaceous granite about 1 mile southwest of the Little Maude workings.

The following information is abstracted from the report of the Bureau of Mines examination in 1942 and from the files of the Defense Minerals Administration.

The Little Maude vein (fig. 40) is a persistent quartz fissure in schist which has been traced on the outcrop for about 2,000 feet. The vein ranges from 9 to 42 inches in width, strikes northeast, and is nearly vertical.

The Pioneer quartz vein penetrates schist and is exposed for about 1,000 feet. It strikes N. 28° W. and dips 35° SW. The Pioneer shaft has been sunk on the vein for 135 feet (fig. 40). An ultraviolet light examination of the vein in the shaft revealed that the upper 80 feet were relatively barren. At 80 to 120 feet the lamp showed scheelite. Five assays cut from 80 to 120 feet below the collar assayed only 0.01 percent tungsten trioxide.

The Evelyn (Gold Crown) vein has the greatest scheelite production. In 1941, 22 tons of ore averaging 3.11 percent WO_3 were shipped to the Boriana mill, and in 1942 a shipment of 11.82 tons which assayed 6.73 percent WO_3 was made. This vein strikes about N. 15° E. and dips about 75° SE. The vein has been exposed perhaps for 250 feet.

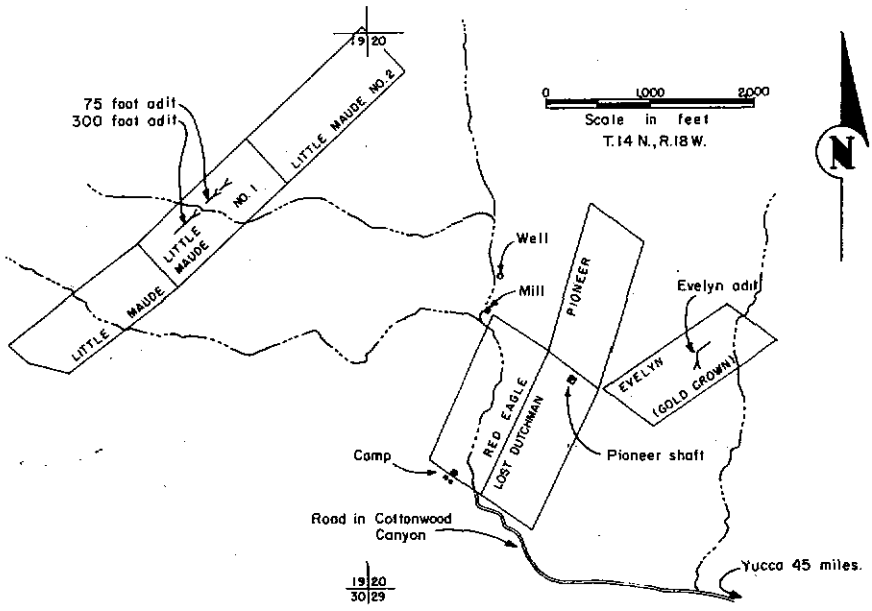

FIGURE 40.-Dutch Flats Tungsten, Partial Claim Map.

As observed under the ultraviolet lamp, small specks of scheelite are widespread within the veins, but areas containing appreciable quantities are limited to two short lenses. Small amounts of galena, pyrite, and specularite are present in the quartz, and minor quantities of gold and silver are associated with the sulphide minerals. The scheelite usually occurs as thin erratic streaks alined more or less parallel to the walls of the veins. The quartz veins range in thickness from mere stringers to short pods that attain widths of 3 feet. Regardless of the width of the vein the scheelite usually is found distributed in a band of the quartz that seldom exceeds 18 inches in thickness.

The largest tungsten ore shoot on the claims was found in the Evelyn vein where it had a maximum stope length of 50 feet. The tungsten concentration in the Little Maude vein was limited to a strike length of about 25 feet. Both ore shoots were lenticular in plan. The exploration was confined to such shallow depths that little could be observed regarding the behavior of the ore shoots along the dip.

Other Deposits

Wilson[37] states that mineralized areas similar to those on the Dutch Flat claims are present on the Charles Bly claims, 3 miles northeast of the old Mohawk mine, and on the Jupiter claims across the mountains from Dutch Flat.

According to inquiries made by the author no work had been done on these tungsten occurrences. A small amount of high-grade scheelite float was packed on burros from one of the occurrences in the 1940's.

37/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 20.

O. K. Mine

Inquiries in March 1959 disclosed that no tungsten had been produced from this property. It was not examined during the course of this project. The following is taken from Wilson's work.[37]

> The O. K. mine is in the eastern part of the White Hills, some 60 miles by road from Kingman. Its country rock is dark biotite granite.[38] The vein strikes northeastward, dips about 75° NW., and averages 18 inches in width. It is composed mainly of iron-stained gold-bearing quartz with limonite, lematite, siderite, galena, molybdenite, and wolframite.
>
> Worked from three levels of adits, the O. K. mine produced $25,000 worth of gold from 1886 to 1906. So far as known it has made no production of tungsten.

Wolframite has been reported on an adjacent property, the El Dorado mine.

38/ Description abstracted from F. C. Schrader, Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs: Geol. Survey Bull. 397, 1909, pp. 121-122.

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