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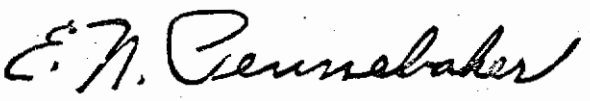

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary

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TUNGSTEN DEPOSITS OF COCHISE, PIMA, AND SANTA CRUZ COUNTIES, ARIZ.[1]

by

V. B. Dale,[2] L. A. Stewart,[3] and W. A. McKinney[4]

SUMMARY AND INTRODUCTION

This paper is one of a Federal Bureau of Mines series covering the mineral resources of the Nation. It briefly describes most of the tungsten deposits in Cochise, Pima, and Santa Cruz Counties, Ariz. Most of the descriptions are from field examinations by the two senior writers, prior to July 1957.

Wolframite first was identified in Arizona in 1896 by W. P. Blake, Territorial Geologist. Tungsten mining began about 1900 in the Little Dragoon deposits of Cochise County, and about 1901 in Las Guijas district of Pima County.

The price history of tungsten is an erratic one; consequently, production has been erratic. Prices rise during wars and periods of national preparedness. Production of tungsten ore was stimulated greatly by a Government purchasing program, announced on May 10, 1951, wherein the Government agreed to purchase standard-grade tungsten concentrates at $63 per short ton unit[5] for 5 years or until 1,468,750 units were purchased. This was later increased to 3,000,000 units, and after this amount had been purchased in June 1956, the purchase of an additional 1,500,000 units was authorized. Government purchase, however, was suspended in December 1956 before completion of this latter program, and the price of tungsten concentrates declined sharply. The price had dropped to $15 per short ton unit, duty extra,[6] by the last part of July 1957.

The word "ore" as used in this manuscript does not differentiate between submarginal tungsten-bearing material and ore that could be mined at a profit.

1/ Work on manuscript completed May 1958.
2/ Former Bureau of Mines mining engineer, Tucson, Ariz.
3/ Mining engineer, Bureau of Mines, Tucson, Ariz.
4/ Metallurgist, Bureau of Mines, Tucson, Ariz.
5/ A short ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten (W). A short ton of 60 percent WO_3 contains 951.72 pounds of tungsten.
6/ The import duty is $7.93 per short ton unit.

A look at the price history will show why it is difficult to classify tungsten-mineral-bearing material.

Average prices, taken from Bureau of Mines Minerals Yearbooks, of concentrates containing 60 percent WO_3, per short-ton unit, are as follows:

Year	Average	Year	Average	Year	Average
1900.....	$ 2.75	1919.....	$ 8.69	1938.....	$17.31
1901.....	2.58	1920.....	7.26	1939.....	17.11
1902.....	2.75	1921.....	2/ 3.15	1940.....	20.61
1903.....	2.49	1922.....	4.02	1941.....	23.41
1904.....	7.25	1923.....	8.33	1942.....	24.12
1905.....	5.57	1924.....	8.51	1943.....	25.07
1906.....	6.26	1925.....	11.07	1944.....	23.36
1907.....	9.04	1926.....	11.23	1945.....	23.21
1908.....	5.71	1927.....	10.70	1946.....	20.17
1909.....	6.32	1928.....	10.81	1947.....	25.77
1910.....	7.68	1929.....	14.76	1948.....	26.27
1911.....	5.97	1930.....	13.40	1949.....	26.38
1912.....	6.27	1931.....	11.45	1950.....	4/28.25
1913.....	7.24	1932.....	10.51	1951.....	61.02
1914.....	7.32	1933.....	11.36	1952.....	63.44
1915.....	29.30	1934.....	16.70	1953.....	62.46
1916.....	1/33.98	1935.....	16.00	1954.....	62.61
1917.....	20.85	1936.....	15.46	1955.....	61.79
1918.....	23.24	1937.....	3/21.79	1956.....	40.14

1/ Maximum for the year was $93.50.
2/ Minimum for the year was $1.50.
3/ Maximum for the year was $35.00.
4/ Minimum was $17.50 for foreign concentrates, duty paid; maximum was $56.50.

Mining activities were being carried on at only four of the properties visited during the course of this investigation. The majority of the properties contained small, sporadically mineralized, discontinuous ore deposits. However, in two localities, the Chiricahua-Dos Cabezas area of Cochise County, and the Baboquivari area of Pima County, further prospecting and testing might disclose low-grade deposits of sufficient extent to warrant small, open-pit operations during periods of high tungsten price. Virtually all of the deposits are in mountainous country, and since most of them are small, transportation and mining costs are proportionately high.

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.

Numerous rock samples were taken in the field for laboratory identification. When a sample is discussed in the text and followed by a sample

number in parentheses, the detailed petrographic description can be found by referring to that number in the Appendix.

The Appendix also contains a log of all assays made during the course of the investigation.

ACKNOWLEDGMENTS

The writers acknowledge the willing cooperation of the various owners and operators in collecting information concerning their properties and others. Acknowledgment is due Edwin A. Stone, mining geologist, for suggestions concerning the Baboquivari area, and to Leland H. Dykes, geologist, for information concerning the Chiricahua-Dos Cabezas area. The maps in figures 1, 4, 5, 6, and 7 are adapted from those of Leland H. Dykes. Figures 16 and 21 are from maps of S. C. Hu, figure 17 is from a map of the Federal Geological Survey, figure 26 is from maps of the C. G. Glasscock-Tidelands Oil Co., and figure 45 is from a map by Eldred D. Wilson, geologist of the Arizona Bureau of Mines. The history of the various deposits came partly from old-timers, but principally from Eldred D. Wilson[7/] and from unpublished reports of mine investigations in the files at the Southwest Experiment Station of the Federal Bureau of Mines in Tucson. The latter two sources have been drawn on freely and are acknowledged.

Field work was done from November 1956 to June 1957.

DESCRIPTION OF DEPOSITS

Cochise County

Paradise-Dos Cabezas Area

The occurrence of the scheelite mineralization in the Paradise area of the Chiricahua Mountains first was noted in 1945 by Leland H. Dykes and J. M. Hill, geologists. These men investigated scheelite deposits in Paleozoic limestones from Paradise to Dos Cabezas. Figure 1 shows the area in which they worked. In October 1948, brief examinations were made by a Bureau of Mines engineer to check the existence of scheelite-bearing limestones, their locations, and the tenor of ore for possible future reference. The reports of these examinations were favorable for potential scheelite-bearing tactites, so on February 25, 1957, a more thorough study of the area was undertaken.

Figure 2 shows the mines that contain scheelite mineralization without any consideration of amount or tenor of ore. Since this investigation was conducted for the purpose of locating large deposits of tungsten-bearing tactites, little or no consideration was given to small or high-grade concentrations other than to note their locations. Where records of production of tungsten ores are available, pertinent figures are given under the individual mine headings. In the Appendix will be found the results of all assays taken

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

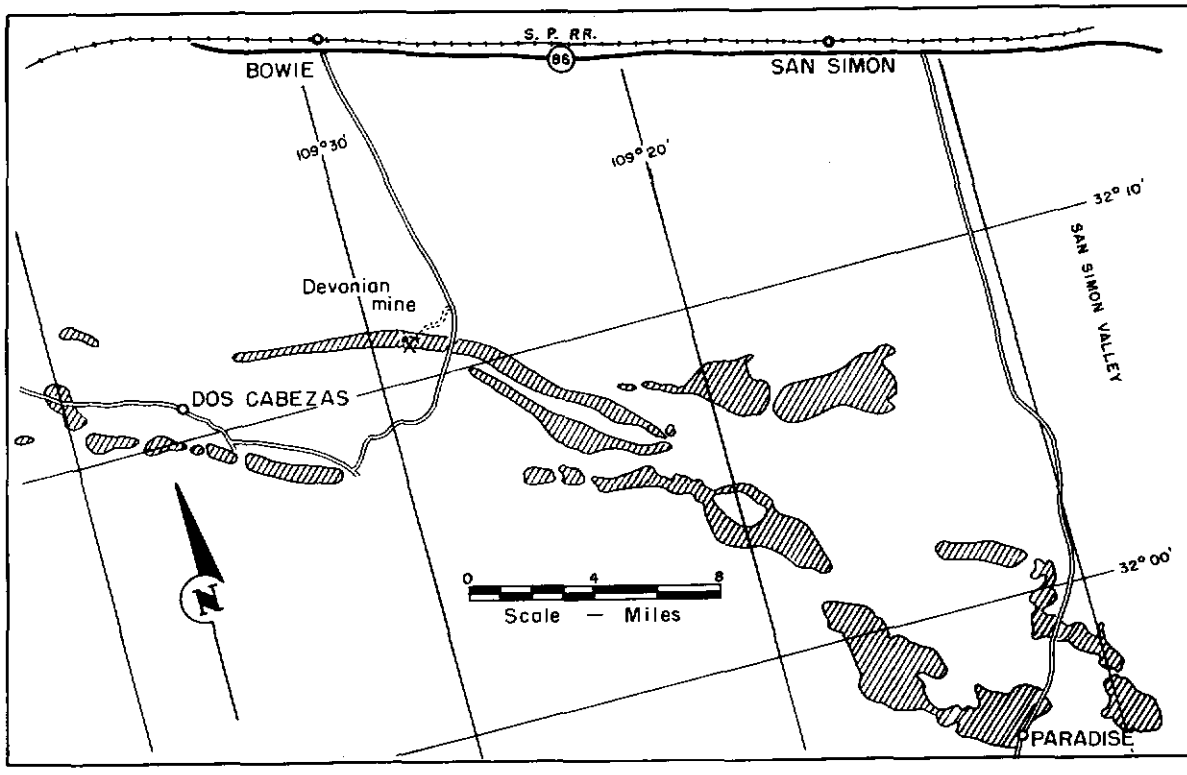

FIGURE 1. - Potentially Scheelite-Bearing Paleozoic Limestone Area in California Mining District, Cochise County, Ariz.

and a list of the various rocks that were typed in the Bureau laboratory at Tucson.

The scheelite mineralization throughout this entire area is extremely sporadic, and neither chip nor channel samples give reliable results. Probably the only reliable method is that of sampling large lots (several tons) from actual mining operations.

The Paradise area first was worked about 1878 for lead-silver deposits. According to Arizona Place Names,8/ Galeyville "sprang up in the fall of 1880 as a boom silver camp and was totally deserted by 1882." A small smelter was built there to treat lead-silver ore from mines in the vicinity. The town of Paradise, about a mile south of the old Galeyville slag dump, came into existence in the early 1900's and at one time was large enough to have had a post office. A few families still live there.

Mining in the Dos Cabezas area probably began about the same time as in the Paradise area. A post office was established there in 1879.

8/ Barnes, Will C., Arizona Place Names: University of Arizona Gen. Bull. No. 2, 1935, p. 172.

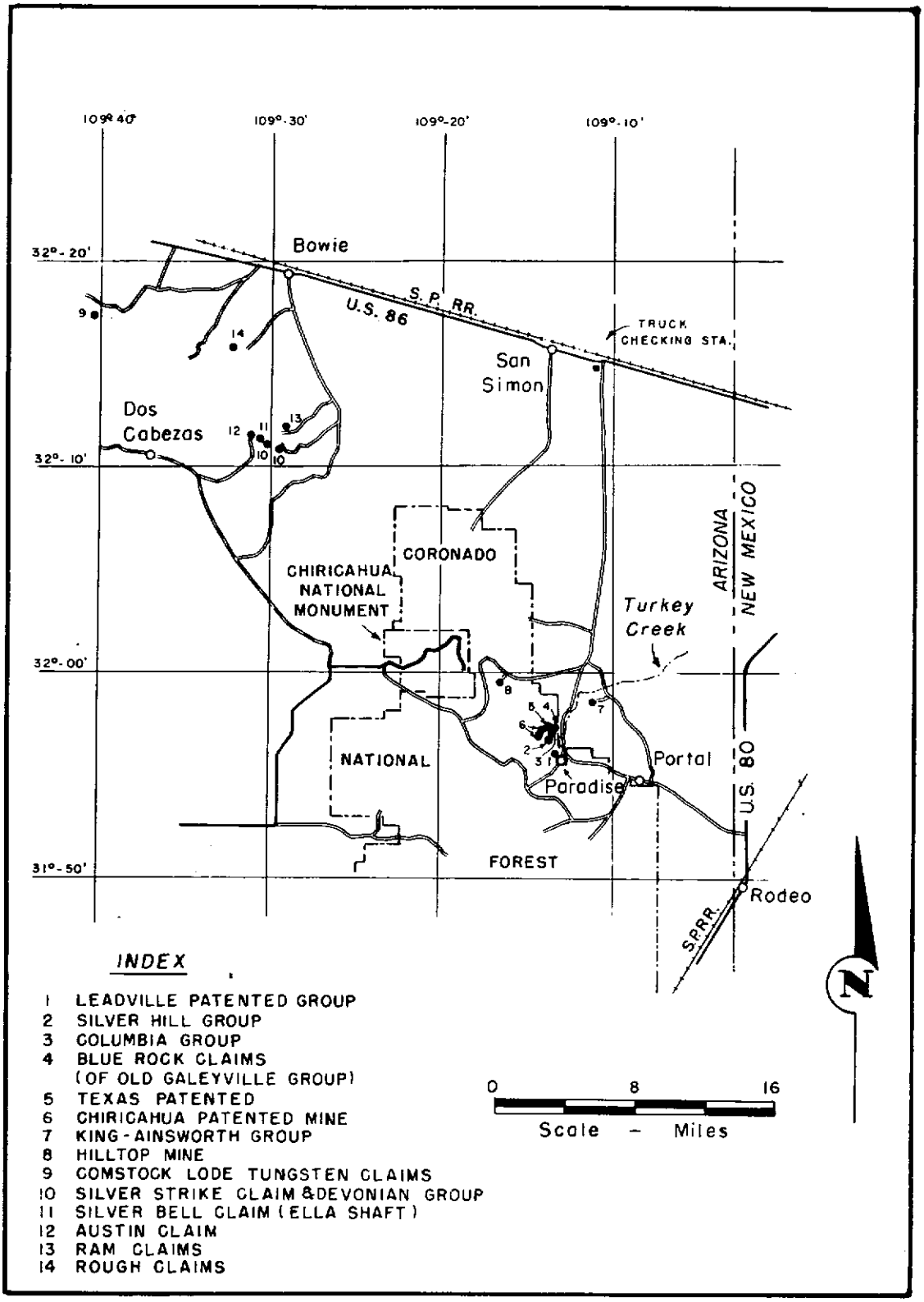

FIGURE 2. - Location Map of Paradise-Dos Cabezas Area.

The Dos Cabezas and the Chiricahua Mountains form a single continuous range; Apache Pass, at an altitude of 5,115 feet, is considered the dividing line. The mines containing scheelite range in altitude from 4,750 to 6,500 feet. The area lies principally on the northeastern slopes of the range.

Vegetation is sparse and typical of southeastern Arizona highlands. Water is scarce; however, ample water for a large mining enterprise could be developed in the San Simon valley, which adjoins the mountain range on the northeast.

Figure 2 shows the roads and trails in the area. Road distances to each individual property examined are noted under the descriptive matter. The Turkey Creek bridge in the Paradise area is only 16 miles from Rodeo, N. Mex., which is situated on the South Pacific Railroad. Ten miles of this Paradise-Portal-Rodeo road are paved with asphalt material.

There is a powerline into the Paradise area, originating from Columbus, N. Mex.

There has been very little production of tungsten ore from either the Chiricahua or the Dos Cabezas Mountains. Probably not over 50 tons of ore has been shipped from the range. There has been no development of scheelite ore, and relatively little prospecting has been done.

The scheelite from Paradise to Hilltop occurs in limestone beds that have been sheared, faulted, and altered. The ore is associated with epidote, garnet, zoisite, wollastonite, and calcite. The low-grade scheelite ore in the Dos Cabezas Mountains occurs principally in white quartz veins through limestone and quartzite beds. The higher grade ore seems to occur in epidote and quartz veinlets. The depths of deposits have not been investigated. Comments about depth of mineralization are made under the individual mine descriptions.

In the old lead-silver mines of the Chiricahua Mountains there are indicated reserves of tungsten ore of about 33,000 tons at 0.15 percent tungsten trioxide (WO_3). There are about a hundred tons of indicated ore at plus 0.75 percent WO_3. In the old lead-silver mines of the Dos Cabezas Mountains there are indicated reserves on the order of 3,000 tons at 0.12 percent WO_3, and 500 tons at plus 0.75 percent WO_3. The inferred tonnages of the low-grade ores in the Paradise-Dos Cabezas area are quite high.

It should be remembered that very little work has been done on the known scheelite occurrences. Much of the area that appears to be favorable to scheelite deposition has never been prospected for scheelite. This favorable zone is about 4 miles wide and 30 miles long.

Silver Hill Mine

The Silver Hill property comprises five unpatented, contiguous claims situated in approximate sec. 13, T. 17 S., R. 30 E., unsurveyed, at an altitude of about 6,000 feet (fig. 2). It lies within the Coronado National Forest. The mine is accessible by a maintained dirt road that runs south from

Highway 86 from a point 3 miles east of San Simon, Ariz. At the Turkey Creek bridge, 23.1 miles south of Highway 86, a vehicular trail runs westerly 0.7 mile to the mine.

The property is presently owned by E. F. Epley, Portal, Ariz. Scott and Crawford were original locators of the property, probably before 1900. Later George Walker, one of the first residents of Paradise, bought Crawford's interest. Epley leased the claims from Scott and Walker to mine high-grade lead-silver ore from the Silver Hill No. 1 claim. Scott and Walker died about 1925, and Walker's sons became owners of the property. The Walker sons let the property go delinquent, and Epley located the claims in 1927. About 1938 W. A. Hicks and E. F. Epley relocated the claims. They held the claims until 1954 when Hicks sold his interest to S. C. Hu, president of Standard Tungsten Corp., Pomerene, Ariz. In 1954 or 1955, Epley deeded his interest to a son-in-law. No assessment work was done on the claims in 1955, and on July 1, 1956, Epley again relocated them.

In 1952, Cecil Smith, associated with a west coast firm, drove the east drift in the lower adit on Silver Hill No. 1 claim to explore the scheelite mineralization (fig. 3). According to E. F. Epley, the material from this drift averaged approximately 0.5 percent WO_3. In 1954, S. C. Hu drove a connecting raise between the two adits on Silver Hill No. 1 claim. Approximately 10 tons of ore from the raise was shipped to the Standard Tungsten Corp. mill at Pomerene, Ariz. The results of this shipment are not known.

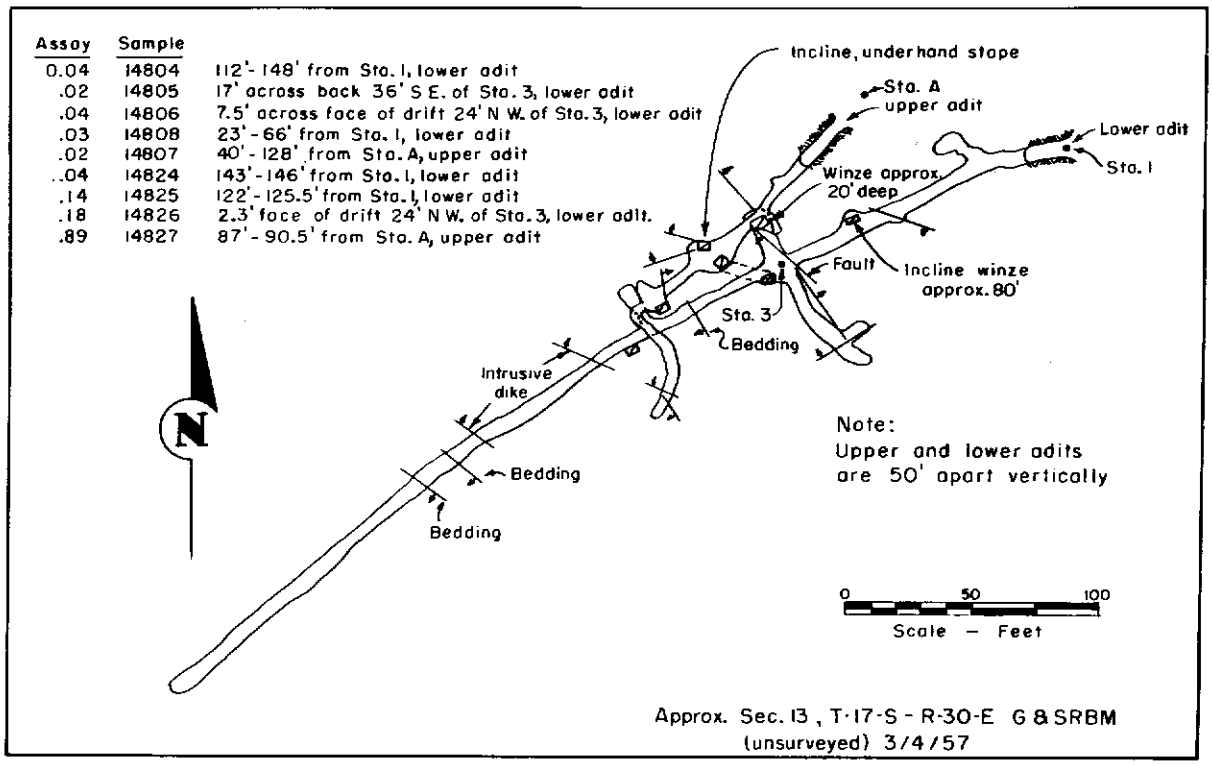

FIGURE 3. - Silver Hill Mine From Brunton Survey.

The report of the 1948 Bureau examination on the Paradise area states tha that samples were cut across a 40-foot scheelite-bearing tactite area in the old adit (upper adit on fig. 3). The weighted average assay of this 40-foot zone was 0.35 percent WO_3. Cross zones within this mass assayed 1.10 and 2.12 percent WO_3.

The dumps were not sampled. The ultraviolet lamp indicates probably 50 tons of ore in the dump at the upper adit that will assay approximately twice as much as any sample assayed. The remainder of the dump should assay about the same as sample 14807 (fig. 3). An ore bin on the lower adit dump contains approximately 15 tons of ore from the connecting raise, which should assay about the same as sample 14826. There is considerable scheelite ore in the lower dump, but it is mixed with waste from the barren limestone beds which the lower adit cuts.

Figure 3 shows the results of chip samples cut by the Bureau of Mines.

Scheelite mineralization in the Silver Hill property occurs in epidosite (rock type 14810) and silicated limestone beds (rock types 14809 and 14811). The crystals of scheelite range in size from 0.02 to 38.1 mm. The largest crystals occur in the last 40 feet of the upper adit. The general strike of the scheelite-bearing zone appears to be about N. 50° W.; the dip is about 70° SW. An altered latite porphyry dike (14812) cuts the limestone beds 206 feet from station 1, lower adit (fig. 3). This dike seems to be very irregular. In the lower adit the north contact with limestone strikes S. 67° E. and dips 73° NE. The south contact with limestone strikes S. 55° E. and dips 67° NE. There is a fault striking N. 49° W. and dipping 74° SW. through the heaviest mineralized part of the mass in the lower adit near the crosscut, 122 feet from station 1. What may happen to the scheelite mineralization as the carrier beds with the fault approach the latite porphyry dike can only be conjectured.

Approximately 1,000 feet due north of the lower adit is an old location hole showing a scheelite-bearing zone about 5 feet wide. The crystals of scheelite here range in size from a few hundredths of a millimeter to 12.7 mm. in cross section. They occur in silicated limestone associeted with copper carbonates and chalcopyrite. The ore zone is very close to a limestone and granite porphyry (rock type 14815) contact. No sample was taken here, as too little of the scheelite-bearing zone was exposed.

Figure 4 shows the geology of the Silver Hill area as interpreted and mapped by Leland H. Dykes.

Scheelite deposition occurs in favorable tactite where faulting and shearing are extensive.

Because the first five samples cut on the Silver Hill property were not satisfactory, the engineer returned to the property to cut narrow samples on the higher grade material within the zones of sporadic mineralization first sampled. Samples 14824, 14825, 14826, and 14827 on figure 3 show the results of resampling.

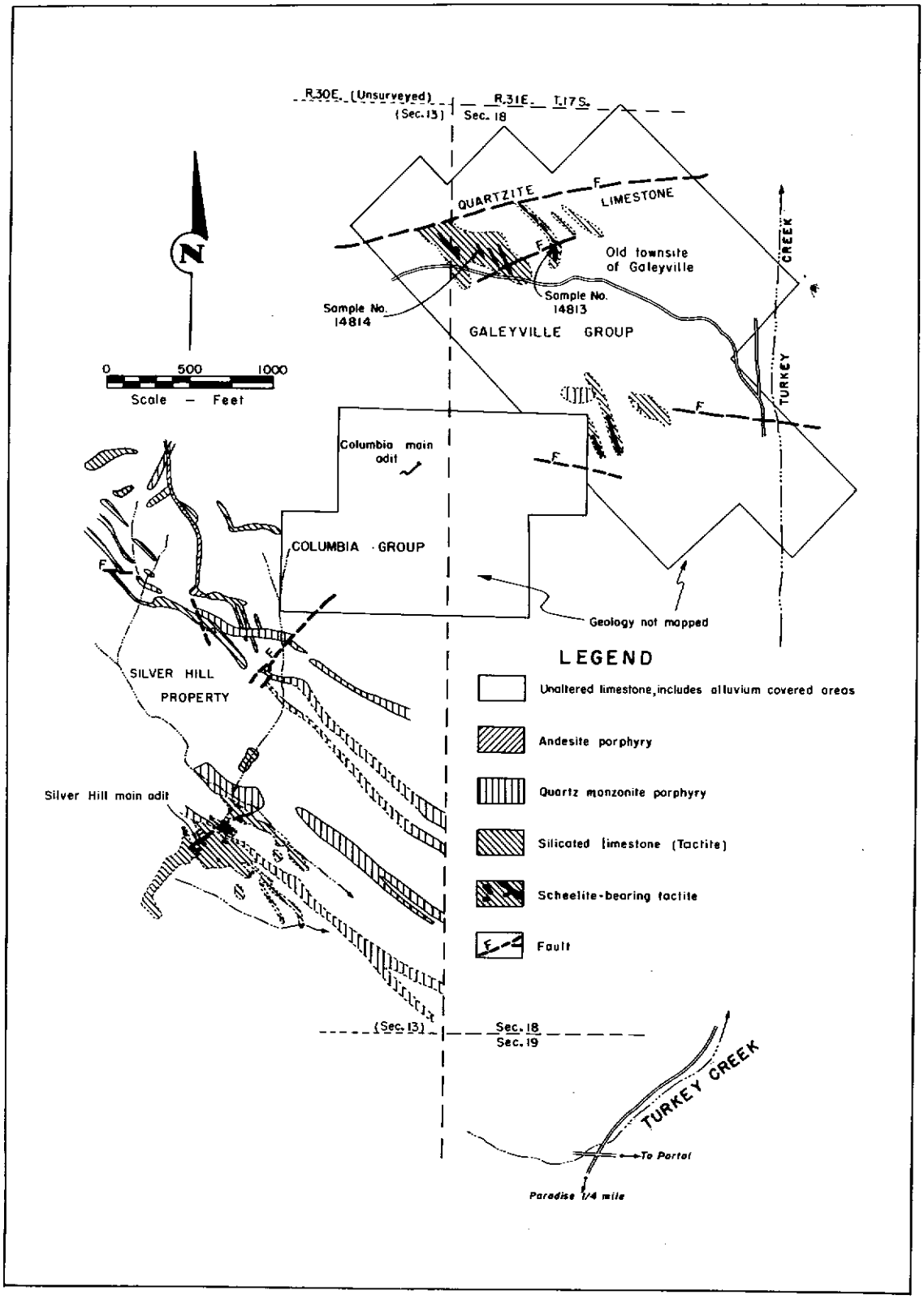

FIGURE 4. - Geologic Map of Part of the Paradise Area, Cochise County, Ariz.

The following comparisons are set up to show the reader the unreliability of conventional sampling methods in tactite scheelite deposits, other than sampling a bulk mining product of more than 10 tons.

Sample 14804 was cut 36 feet long and assayed 0.04 percent WO_3. Sample 14824 was cut 3 feet within the 36 feet covered by 14804 and assayed 0.04; sample 14825 was cut 3.5 feet within the 36 feet covered by sample 14804 and assayed 0.14 percent WO_3. The weighted assay of 6.5 feet covered by samples 14824 and 14825 is 0.10. Considering 29.5 feet as barren ground and weighting the assays from the above samples, the weighted assay of 36 feet is 0.02 percent scheelite. When this is compared to the assay of 0.04 percent WO_3 from the sample cut 36 feet long, the result seems plausible.

Sample 14806 was cut 7.5 feet across a face and assayed 0.04 percent WO_3. Sample 14826 was cut 2.3 feet within the area covered by 7.5 feet of sample 14806 and assayed 0.18 percent WO_3. The average weighted assay from sample 14826 across 7.5 feet, considering 5.2 feet as barren ground, is 0.06 percent WO_3.

Sample 14807 was cut across 88 feet and assayed 0.02 percent WO_3. Sample 14827 was cut 3.5 feet within the area of sample 14807 and assayed 0.89 percent WO_3. Considering 84.5 feet as barren ground (which is certainly not the case) and weighting the assay from sample 14827 across 88 feet, the result is an average assay of 0.04 percent WO_3.

Galeyville Group

The Galeyville group of claims is situated in sec. 18, T. 17 S., R. 31 E., and sec. 13, T. 17 S., R. 30 E., at an altitude of approximately 5,400 feet. The property is accessible from a dirt road that runs 22.1 miles south from Highway 86 to Paradise, and thence westerly 0.4 mile to the claims (figs. 2 and 4).

Galeyville first became active in 1878 when lead-silver deposits were discovered. The boomtown was established on the banks of Turkey Creek, and a smelter was built to treat ore from the mines in the vicinity. The scheelite-bearing limestone beds discovered in 1945 are within 1,000 feet of the old Galeyville townsite.

On July 11, 1947, Marion Dykes, wife of Leland Dykes, located five claims, calling them Galeyville 1, 2, 3, 4, and 5. Several shallow pits and trenches were dug into the outcrops to better expose the scheelite. In March 1953, the Tyone Mining Co., owned by Walter Smith, Box 373, Henderson, Tex., and Sam Guerin, Box 698, Tyler, Tex., leased the five claims from the Dykes. Tyone Mining Co. erected a small mill and attempted to separate the scheelite in an air concentrator. The mill did not make a successful separation, and after 1 month the mill operation was stopped. The company dug a well 105 feet deep on the west side of Turkey Creek. Electricity from a high-voltage line from Columbus, N. Mex., was used to power the pump. The pumping capacity of the well is not known.

Apparently no work was done on the property during the year 1955-56 because on August 15, 1956, L. H. Boyle and W. M. Carter relocated the scheelite outcrops.

On January 12, 1957, George Potter, Portal, Ariz., located Blue Rock No. 1 claim, and on March 7, 1957, he located Blue Rock No. 2 claim on the scheelite-bearing beds where the work by the Dykes and the Tyone Mining Co. had been done.

The old workings on these Galeyville claims consisted of a few shallow pits sunk on meager copper showings. The recent work consists of two shafts (25 and 28 feet deep), several shallow pits, and a few hundred feet of 1- to 3-foot-deep trenches.

It already has been stated that neither channel nor chip sampling will give reliable results of the scheelite-bearing ores in the Paradise area. To determine the probable tenor of ore, Dykes sank the two shafts to 25 feet and excavated numerous pits and trenches. Seven samples were mined from these various workings with the following resluts:

Width of zone, inches	Weight of sample, tons	WO_3, percent
18-52	20	0.72
14-16	10	2.88
(1/)	.5	.18
(1/)	.5	.26
48+	10	.82
(1/)	5	1.39
9.6	(1/)	1.98
42	(1/)	.08

1/ Unknown.

A zone 0.8 foot wide assaying 1.98 percent WO_3 combined with 3.2 feet of the adjacent tactite wall assaying 0.08 percent would give a weighted average assay of 0.46 percent WO_3 for a 4-foot mining width.

The above assays were obtained from 50- to 75-pound samples cut from the bulk sample by mixing, quartering, breaking up the larger chunks, and discarding the manifestly high-grade pieces.

According to a field report by T. M. Romslo, Bureau engineer, the mill erected by Tyone Mining Co. concentrated 100 tons of ore from which 1 ton of concentrate was produced that assayed 7.8 percent WO_3. Either no head assay was taken or it was not available.

The locations of samples 14813 and 14814 are indicated on figure 4. Sample 14813 was cut across silicated limestone beds for 22 feet and assayed 0.17 percent WO_3. The cut ran from the southeast corner of the timbered shaft southwestward across an opencut to the south side of a shallow pit. Sample 14814 was cut across 37 feet of silicated limestone beds (principally wollastonite) and assayed 0.01 percent WO_3. Rock type 14816 came from where sample 14814 was cut.

As on the Silver Hill property, scheelite deposition occurs where there is a large amount of shearing and faulting action through tactite.

Columbia Mine

The Columbia group consists of two unpatented claims situated on a high ridge separating the Silver Hill and Galeyville groups, and lies in sec. 13, R. 30 E., unsurveyed, and sec. 18, R. 31 E., of T. 17 S. at an altitude of about 5,800 feet. A vehicular trail branches from the road to the lower scheelite discovery on the Galeyville property and runs south 0.3 mile to an adit (figs. 2 and 4).

Probably a small amount of work was done on the oldest claim when Galeyville was a boomtown. In 1940, W. W. Sanders located one claim and held it until 1947. Sanders shipped 1 carload of high-grade lead-silver ore from the Columbia diggings. The ore was purchased by Hawley and Hawley, ore buyers in Douglas, and assayed 54 percent lead, 0.65 percent bismuth, and 86 ounces of silver per ton. In 1947, W. W. Carter, Pima, Ariz., purchased the Columbia claim from Sanders. Carter located an adjoining claim south of the one he purchased. The Tyone Mining Co. leased and optioned these two claims in March March 1953 along with the Galeyville group.

Very little work has been done on the scheelite occurrences.

There are three adits on this property, the upper being the oldest. The old adit, caved and inaccessible, appears to be about 100 feet long with a shallow underhand stope and another stope to the surface. There is a fault trending N. 65° W. and dipping 68° NE. along which lead-silver ore has been extracted. The ultraviolet lamp indicates an appreciable amount of scheelite mineralization throughout all of these upper diggings. Much silicated limestone with epidote, garnet, and tremolite is in evidence here. Remnant iron and copper minerals occur along with the scheelite, lead, and silver. Extensive shearing action has taken place here.

Another adit about 50 feet below the upper one also shows much scheelite mineralization. This adit is approximately 160 feet long. The last 25 feet of this adit shows extensive, high-grade scheelite mineralization across the strike of silicated limestone beds. The Tyone Mining Co. mined between 1.5 and 2 tons of ore from this area and shipped it to a tungsten mill south of Tucson for concentration. No weights or assays of the ore were made, but it is thought that the ore would have assayed between 2 and 3 percent WO_3. Sample 14828, cut 12 feet across the beds, assayed 0.13 percent WO_3. Figure 5 is a map of the two upper workings of the Columbia mine.

A third adit, probably 200 feet below the lower adit, was driven 300 feet into very tight, dark-colored, limestone beds. The bed carrying the scheelite ore was not cut. No mineralization except pyrite was noted in this adit.

This occurrence of scheelite is very similar to that on the Silver Hill and Galeyville properties.

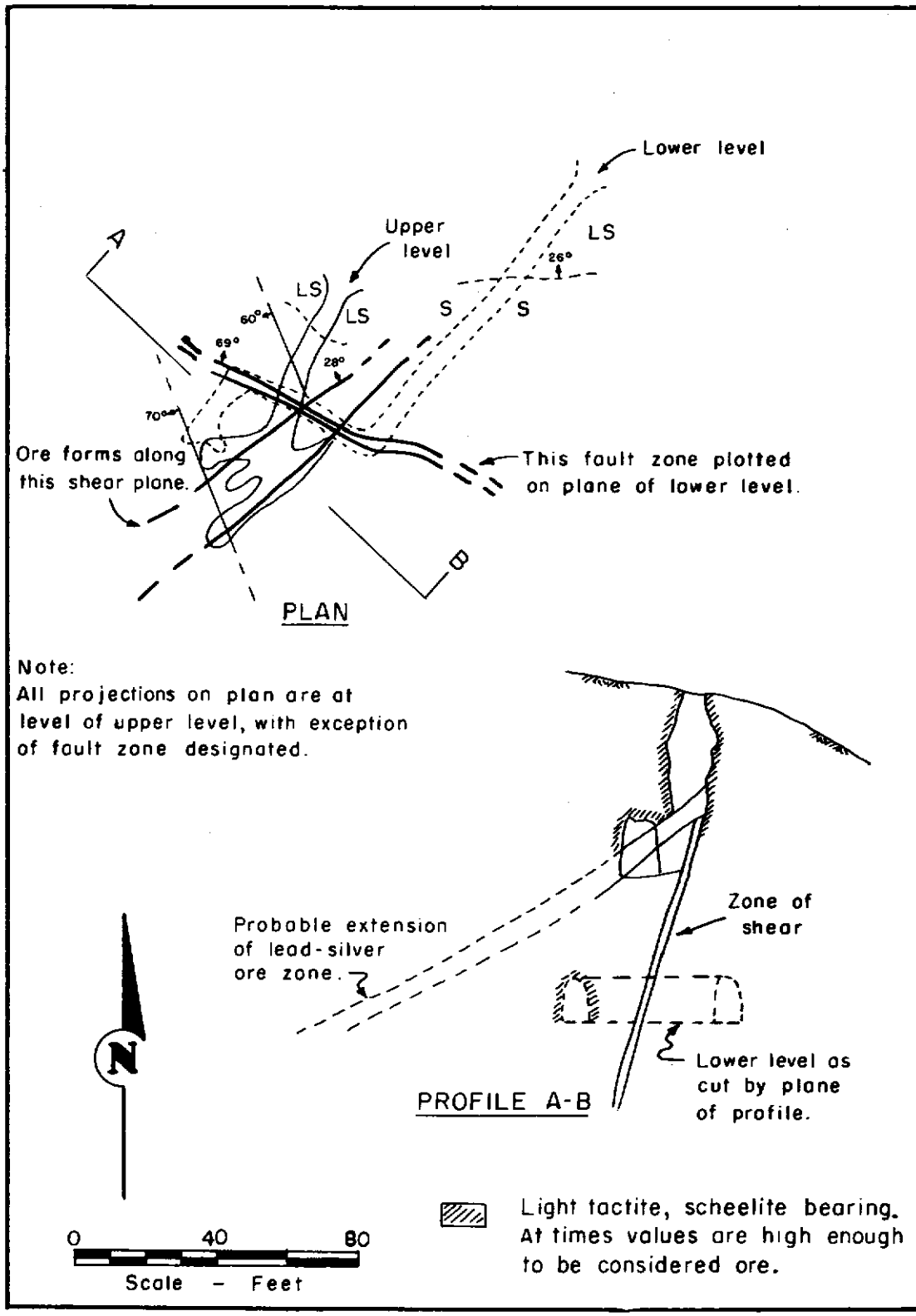

FIGURE 5. - Columbia Mine, Cochise County, Ariz.

Leadville Group

There are 7-1/2 patented mining claims in the Leadville group, owned by W. W. Sanders, Portal, Ariz.

The claims are situated in approximate sec. 24, T. 17 S., R. 30 E., unsurveyed (fig. 2). The shaft on Leadville No. 1 claim may be reached by a vehicular trail which turns westerly from the Paradise to the San Simon road 0.1 mile south of the Turkey Creek bridge and runs 0.6 mile to the mine.

The claims originally were located by George A. Walker, deceased, who patented the claims in 1905. Sanders purchased the property in 1943 from the Walker heirs. Since that time he has shipped 11 carloads of high-grade lead ore from the Leadville Nos. 1 and 2 claims.

The limestone beds in this area are similar to those on the Silver Hill and Galeyville properties. However, this area seems not to have been subjected to the extensive shearing and faulting found on the Silver Hill and Galeyville claims.

The deposit from which Sanders mined 9 carloads of ore on Leadville No. 1 claim strikes N. 69° W. and dips 49° SW. There is a 90-foot shaft with a drift on the bottom approximately 150 feet long. Sanders produced 2 carloads of lead ore from a 50-foot shaft on Leadville No. 2 claim. This shaft was sunk on a shear plane striking S. 48° W. and dipping 65° NW. The bedding planes between the two shafts strike N. 56° W. and dip 61° SW.

There are a very few sporadic crystals of scheelite scattered throughout these two workings. Scheelite mineralization appeared to be so low grade that no sampling was done. No drifts nor adits have been run through the limestone beds on this property; all work has been confined to the areas showing lead mineralization.

The Silver Gulch claim lying west of the Leadville No. 2 shows a small amount of scheelite. The dump of an inaccessible adit located in the bottom of a canyon south of Hospital Flat lamps a few isolated crystals of scheelite. Epidosite, latite porphyry, and silicated limestone, similar to the Silver Hill formations, are found on this dump.

In the bottom of the deep canyon where the old Chiricahua mine shaft is located, and about 0.25 mile west from the western boundary of the Leadville property, is a shallow, vertical shaft. On the east side of this shaft there is 3 feet of ore that lamps an appreciable amount of scheelite.

The ultraviolet lamp indicates an appreciable amount of very fine crystals of scheelite in the sand and gravel carried in the lower part of this canyon. About 0.4 mile westerly from the Paradise road, an area probably 1,500 feet long was explored at night along the bottom of the old Chiricahua mine canyon. The shallow, vertical shaft is situated within this explored area.

Kentucky Belle and Boston Belle

On these two patented claims is located the old Texas shaft. This shaft is 0.3 mile west of, and approximately 600 feet above, the Galeyville scheelite deposit. It is approximately 0.5 mile north of the Silver Hill adit in approx-

imate sec. 13, T. 17 S., R. 30 E., unsurveyed, and is within the Coronado National Forest. The lower adit on the property may be reached by a vehicular trail which continues westward from the Galeyville deposit.

This is an old property that was operated about 1880 to 1882 by the Texas Consolidated Mining & Smelting Co., John H. Galey, president. It is believed that ore from or near the old Texas shaft started the Galeyville boom.

Carroll S. Neese of Douglas, Ariz., and E. F. Vickers of Phoenix, Ariz., have owned the property for a number of years.

On this claim is situated one of the major diggings of the Galeyville boom period. The road ends at an adit approximately 450 feet long. No stoping or raising has been done here. Approximately 100 feet above this adit is another adit which connects with a shaft approximately 120 feet deep. There are several more short adits and shallow pits on the property. There are winzes, raises, and stopes from the upper adit near the shaft connection. On the east side of the shaft just above the back of the adit and approximately 250 feet from the portal, there is 3 feet of epidosite that shows an appreciable amount of scheelite. One crystal was noted that was probably 2 inches in cross section. The caved material from a stope just beyond the shaft contains a small amount of scheelite. Since the workings were mainly inaccessible and the extent of the scheelite could not be determined, no samples were cut.

The collar of the old shaft is situated near the intersection of two fault zones. Much mineralization has occurred here. One fault strikes N. 55° W. and dips 86° NE., while the other strikes E-W. and dips 58° N. The shaft is sumk on a contact between granite porphyry (rock type 14815) and silicated limestone beds. There are epidote, tremolite, garnet, manganiferous iron oxides, and copper, lead, and silver sulfides and oxides in the mineralized material.

King Ainsworth Property

This property is situated in secs. 4 and 5, T. 17 S., R. 31 E. The mine may be reached on a good dirt road by traveling south on the Paradise road 17.4 miles from Highway 86, thence 2.5 miles southeasterly, and thence 1.2 miles westerly (fig. 2). The altitude above sea level is approximately 4,900 feet.

This property has changed owners many times in the past. The Cochise Consolidated Copper Co. did extensive work on the claims prior to 1907. Portal Mines Development Co. operated the King Ainsworth group near Portal and shipped 501 tons of ore containing 4 ounces of gold, 800 ounces of silver, 2,400 pounds of copper, 60,000 pounds of lead, and 100,000 pounds of zinc to custom flotation mills in Arizona. At the present time A. F. Noland, Portal, Ariz., has a valid location of five claims over the old workings. The claims are named King Copper and King & Queen Treasurer, but the numbering is not known.

No record of ore shipments from this property could be found. Probably a few hundred tons of lead-silver ore has been shipped to custom ore buyers.

There has been a mill on the property, as a coarse tailing dump of probably 500 tons is situated on the eastern edge of the claims.

These claims are underlain by Cambrian quartzite and by silicated and marbleized limestone beds intruded by granite. Stringers and small bunches of lead-zinc-silver ores occur in fault breccias and as replacements in a bed of limestone.

Scheelite occurs in the old Treasurer Tunnel on the northeast corner of the property. This adit, approximately 900 feet long, cuts a mineralized zone in limestone containing lead, silver, and scheelite. The scheelite is confined principally to a zone conformable with the bedding that strikes N. 72° W. and dips about 42° SW. The scheelite ore ranges from 6 inches to 3 feet in width and extends approximately 175 feet along the strike. Scheelite mineralization begins in a stope about 100 feet from the portal and extends for an additional 175 feet.

A grab sample (14817) from a chute in a crosscut, 150 feet from the portal, assayed 1.70 percent scheelite. Apparently this scheelite occurrence had never been recognized. The old tailing dump mentioned previously shows an appreciable amount of scheelite under the ultraviolet lamp.

The scheelite on this property shows a marked yellow fluorescence indicating a high molybdenum content. All other deposits examined in the Chiricahua and Dos Cabezas Mountains contained scheelite that fluoresced blue.

Chiricahua Mine

The Chiricahua mine is situated in approximate secs. 14 and 23, T. 17 S., R. 30 E., unsurveyed, within the Coronado National Forest (fig. 2). It may be reached by a vehicular trail which runs 1.9 miles northwesterly from Paradise. This trail is unchanged from that shown on the Chiricahua Quadrangle map (edition of 1917). The mine is at an approximate alittude of 6,300 feet above sea level.

There are seven patented claims in the group. W. M. Boulware, Douglas, Ariz., purchased the claims in 1945.

The Chiricahua mine was worked extensively in the early 1900's by the Lake Superior Mining Co. A shaft 480 feet deep was sunk with several levels from the shaft. This work was all done on copper showings, but so far as is known no ore was marketed. About N. 35° E., a distance of approximately 0.5 mile from the old shaft, are two adits with numerous crosscuts, raises, and stopes. The work done here appears to be older than the work at the shaft. Probably some lead-copper-silver ore was produced from these two adits.

The deep shaft was inaccessible, but one adit bearing north from the collar was inspected for scheelite. None was found. The two adits northeast of the shaft contained very fine-grained scheelite. Sample 14818, assaying 0.06 percent WO_3, was cut across 4.5 feet of mineralized material in the lower adit.

The ore appears to be in a fissure in limestone and contains remnant oxides of copper and lead. It contains much pyrite and a small amount of chalcopyrite and galena. The ore occurs in a shaly, silicated limestone that has been faulted and sheared to a great extent.

Hilltop Mine

This property includes about 80 unpatented lode claims. The Hilltop mine is situated in the Coronado National Forest in approximate secs. 32 and 33, T. 16 S. and approximate secs. 3, 4, and 5, T. 17 S., R. 30 E., unsurveyed. The mine is accessible by a maintained dirt road which runs south from Highway 86 from a point 3 miles east of San Simon. At 17.8 miles south turn west on the Hilltop road and go 5.9 miles to the dump of the Rhem tunnel level (fig. 2). This dump has an altitude of approximately 6,050 feet.

The first locations in this district were made in the 1880's. The claims had numerous owners for the next 30 years. A small amount of work was done, and a small tonnage of lead ore was shipped. In 1916, the Hilltop Metals Mining Co. was organized, and the various holdings were taken over by this company. Large sums of money were raised, and over 20,000 feet of underground work was done. A comparatively small tonnage of ore was shipped. In 1926, the mine was closed down, and the property was attached by workmen for back wages. Later the back wages were paid, and the mine was taken over by officials of the company. The property then was sold to O. O. Mattox. Only assessment work was done on the property from 1926 to 1943. In 1948, Piedmont Mines, Inc. acquired the property. The extent of its work is unknown. The American Zinc, Lead & Smelting Co. leased the property about 1951. It completed purchase of the property in 1955 and owns the Hilltop mine today.

This area is underlain by Paleozoic limestones and quartzites cut by porphyry and felsite dikes. Within the limestone strata is a bed 20 to 80 feet thick in which lead, zinc, and copper ores occur. In previous reports this band had been called quartzite, and a thesis, Geology and Ore Deposits of the Eastern Portion of Hilltop Mine Area, Cochise County, Arizona, by Keith G. Papke, identifies this ore carrier band as Hilltop Quartzite. Petrographic examination within the scheelite zone, however, indicates that the band is actually a siliceous limestone. The ore occurs in repeated lenses the major axes of which generally exhibit a random parallelism; these lenses appear to be found in the stronger shear zones.

There are extensive workings on this property. There are many opencuts and short adits on and near the surface. The Kasper tunnel has been driven through the mountain at an altitude of about 6,750 feet. It is about 3,000 feet long, and about 6,000 feet of drifting, crosscutting, raising, and sinking was carried out from this level. The Gray tunnel was driven from the east side of the mountain at about 6,450 feet of altitude. It is 2,000 feet long and has about 3,000 feet of drifting, crosscutting, raising, and sinking. The Rhem tunnel was started from the east side of the mountain at an altitude of about 6,050 feet. This tunnel is about 3,700 feet long with about 3,000 feet of drifting, crosscutting, and raising. Probably 80 to 90 percent of these workings are now accessible.

Lincoln A. Stewart, Bureau engineer, spent 2 days in 1950 checking scheelite occurrences on the Hilltop property. In the Rhem level the "carrier band" had been cut at only one place. At about 3,300 feet from the portal, a small stope had exposed the band at the top of a 150-foot raise where it was about 20 feet thick. The lower 8 or 9 feet of this bed carries granular scheelite from .03937 inch to three-eighths of an inch in size and blebs on fracture planes. This stope is on what is considered the No. 3 ore shoot, which appears in the same relative position on both the Gray and Kasper levels. Unfortunately the No. 3 ore shoot was inaccessible on the Gray and Kasper levels at the time of Stewart's visit. The dump of the Gray adit was lamped, and occasional pieces of rock were found that contained scheelite.

During the present examination a sample was cut 6.3 feet across the mineralized zone at the top of the raise from the Rhem level. This sample assayed 0.23 percent WO_3. In addition to tungsten, this sample contained the following percentages: Lead, 6.98; zinc, 0.3; copper, 0.15; and 10.2 ounces silver per ton with a trace of gold.

Silver Strike (Devonian Group)

The Devonian group consists of eight full claims and one fractional claim, all held by location. The claims are situated in secs. 28, 29, and 33, T. 14 S., R. 28 E., at an altitude of about 5,200 feet. To reach the mine by road, go south on the Apache Pass road 9.4 miles from Bowie on Highway 86 and thence westerly 5 miles on a dim truck trail that ends on the dump of the Devonian lower adit (fig. 2). The workings are shown on the Cochise Head quadrangle sheet, where they are called the Silverstrike mine. The land on which the mine is located is administered under the Taylor Grazing Act.

The claims were located first about 1890, and a small tonnage of high-grade lead-silver ore was mined and transported out on pack animals. The claims were relocated and operated for a time by the Silver Strike Mining Co. It is reported that in 1919 this company mined and shipped several carloads of lead ore. The claims lapsed later, and in 1939 James B. Cawood relocated them. At his death the title passed to his son, Morris Cawood, who now resides in Tucson, Ariz. In 1948 Devonian Strategic Minerals, Inc. of southern California leased the property to explore the scheelite occurrences. About 1955 Cawood let the claims go delinquent. A man named Murray relocated them in 1955 but did not complete location. Papers were found on the property which indicated that F. W. and Pauline Clark located one claim on October 23, 1956.

The Devonian mine is on a fissure vein striking N. 62° E. and dipping 80° SE. that contains a minor lead-zinc ore body. The development of this vein is as follows: The inclined Tennessee shaft is 80 feet deep, connected at the bottom by an 85-foot adit to the surface (fig. 6); a 600-foot branching tunnel 200 feet below this adit cuts the vein in two places 25 feet apart.

On the west edge of the property near the top of a high ridge is a 300-foot vertical shaft, now inaccessible. The shaft was sunk for silver-lead ore before 1900. This ore occurs in a pluglike mass of quartz.

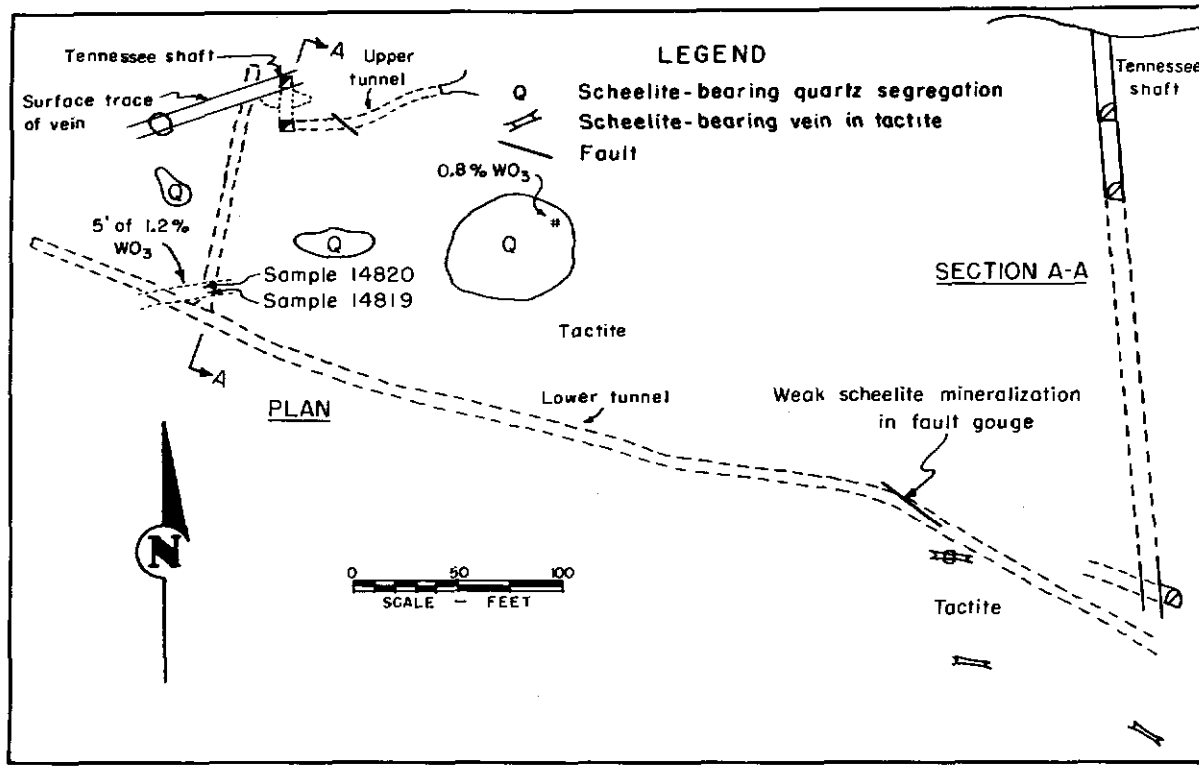

FIGURE 6. - Plan and Section, Devonian Mine, Cochise County, Ariz.

A series of Paleozoic and Cretaceous sediments (quartzite, limestone, dolomite, and shale) unconformably overlie Precambrian schist. To the west a large body of coarse-grained granite is intrusive into the metamorphic and sedimentary rocks. Vertical, northeasterly trending granite porphyry dikes, 5 to 15 feet wide and up to a mile in length, cut both sedimentary and metamorphic rocks. Smaller, irregularly shaped diorite porphyry dikes are present in the area.

On the east side of the property there is a series of dark-colored micaceous beds with definite masses of a dioritic nature. This metamorphic series apparently underlies the schist. The sediments are uptilted, with a general strike to the northwest and a dip of about 50° to the south. Over great areas the limestone has been altered to white tactite containing much wollastonite with scattered segregations of white quartz bodies.

Along the contacts with intrusive rocks there is a zone of metamorphism with the formation of tactite containing dark garnet, epidote, augite, and the fibrous series of high-temperature silicate minerals. This zone is barren of scheelite.

Scheelite mineralization occurs along shear zones in the silicated limestone well back from the contact zone and also in the quartz segregations. A narrow, scheelite-bearing epidote vein occurs in the dark-colored metamorphic

formation that underlies the schist on a wide ridge east of the sedimentary area. The epidote ore may be an altered zone of fault gouge along the plane of a low-angle thrust fault.

At the request of the owner, the Devonian group of mining claims was examined by two Bureau engineers in November 1942. The property was presented to the Bureau as a lead-zinc prospect. Of interest is one sample, cut during this examination, across 5 feet of vein material in the lower tunnel (fig. 6). The sample assayed the following percentages: Lead, 0.1; zinc, 0.5; copper, 0.02; and WO_3, 1.21.

Figures 6 and 7 show some of the work done by Leland Dykes, geologist for Devonian Strategic Minerals, Inc., in testing this property for scheelite. A pit on the Tennessee vein near the shaft shows tungsten mineralization, and a sample cut across 5 feet of vein material 250 feet below the outcrop assayed 1.2 percent WO_3, showing that scheelite mineralization persists in depth. The ultraviolet lamp showed that scheelite was disseminated throughout the 10-foot quartz vein at this place.

Three scheelite-bearing quartz segregations are shown within the area mapped. The largest of these is 60 feet in diameter. Dykes sank a test pit here; a sample from the pit assayed 0.8 percent WO_3, according to Dykes.

At about 0.5 mile east of the mine is a formation of dark-green metamorphic rock containing much actinolite. In this formation a low-angle shear contains a scheelite-bearing vein of epidote. Dykes sank a 35-foot inclined shaft on this vein, which strikes about N. 20° E. and dips 20° to 30° to the west (fig. 7). The ore follows the plane of the fault and probably is an altered section of fault gouge. It ranges from 4 to 18 inches in thickness in a series of lenses. It is reported that grab samples ran from 4 to 15 percent WO_3. To get a fair, average sample, Dykes mined a 10-ton sample of ore that contained much waste. After mixing, breaking up the chunks, and discarding the manifestly high-grade pieces, the resulting 50-pound sample assayed 6.34 percent WO_3. A cut of the bulk sample without removal of the high-grade pieces gave an assay of 7.80 percent WO_3. Dykes estimated that up to four times the volume of ore would have to be taken as waste. Therefore, on the basis of the former sample, a tungsten ore could be mined that would run about 1.3 percent WO_3.

The Bureau cut three samples on this property; these were samples 14819, 14820, and 14821. Locations of samples are shown on figures 6 and 7. Sample 14820 was cut across 5 feet of quartz with a small amount of calcite. The adjacent sample 14819 was cut across 6 feet of quartz and intermingled silicated limestone. Sample 14819 assayed 0.04 percent WO_3, and 14820 assayed 0.14 percent WO_3. Sample 14821 was cut from the narrow epidote vein approximately 2,000 feet east of the lower adit. The average width of this veinlet is 4 inches. The sample assayed 2.05 percent WO_3.

It should be pointed out that there is sparse, sporadic scheelite mineralization throughout the quartz in the upper adit which connects with the bottom of the Tennessee shaft.

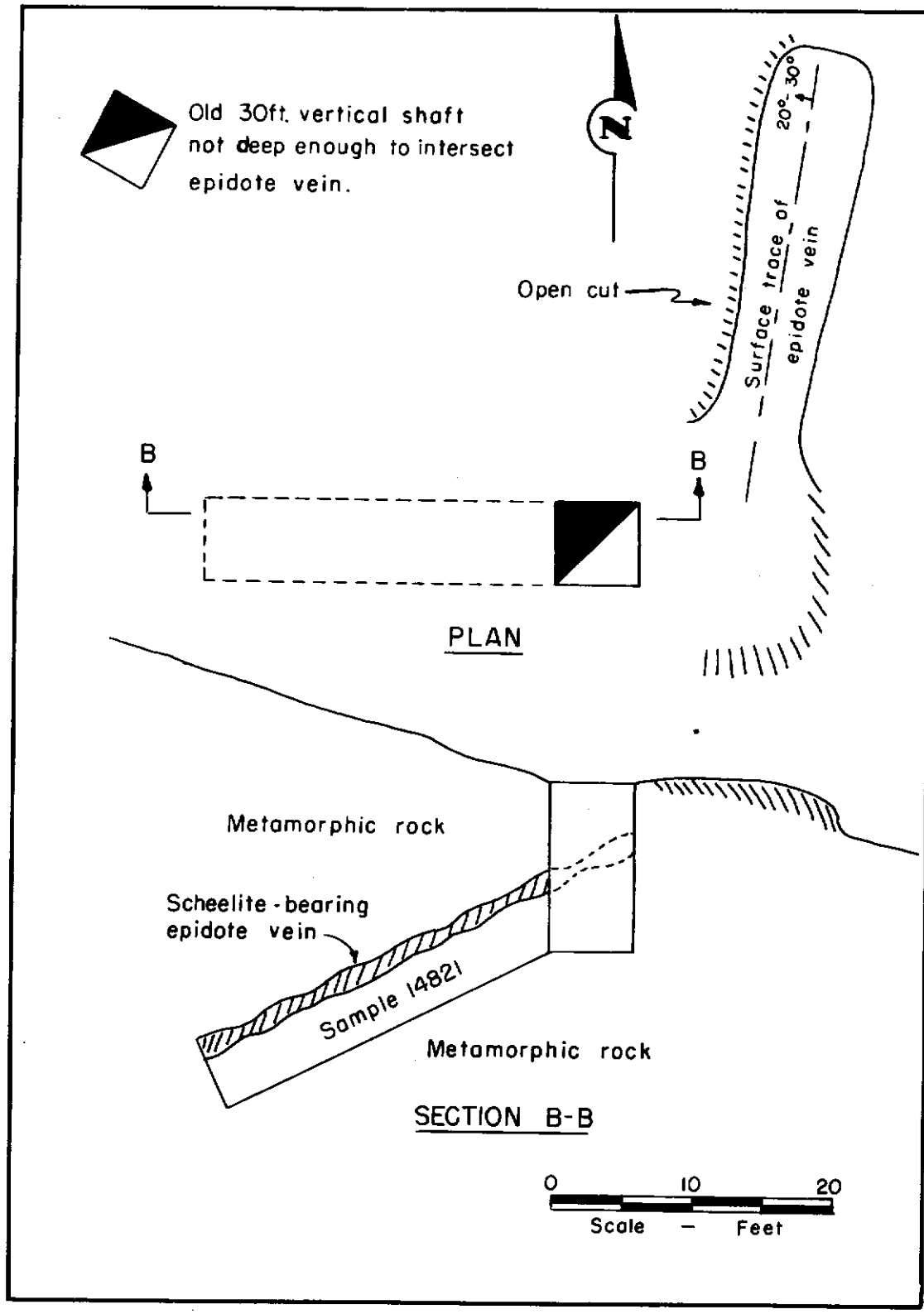

FIGURE 7. - Plan and Section of Incline Shaft on Epidote Vein, Devonian Property, Cochise County, Ariz.

On the west edge of the property near the crest of the ridge that separates the old Ella workings and the old Devonian group is a large pluglike mass of quartz that carries scheelite. A shaft, now inaccessible, has been sunk into this mass, and an adit has been driven about 60 feet into it from the bottom of a steep ravine. The ultraviolet lamp shows an appreciable amount of scheelite in the adit, and the dump at the old shaft shows scheelite. This mass of quartz is approximately 300 feet long. The width is indeterminable due to alluvium, but it is in excess of 100 feet.

There appear to be three distinct occurrences of scheelite mineralization on this property. The narrow epidote vein is in a metamorphic area, and the ore occurs along the plane of a large shear. The Tennessee shaft is sunk on a fissure-type vein. The pay shoots within this vein consist chiefly of lead and zinc sulfides. However, sporadic scheelite mineralization occurs throughout the exposed areas of the vein and in favorable, adjacent limestone beds. The third type occurs in sedimentary areas where quartz with wollastonite carries scheelite. In shape, this type of ore body is irregular and not clearly related to fissuring.

Silver Bell Claims

The Silver Bell claims are in sec. 29, T. 14 S., R. 28 E. at an altitude of approximately 6,050 feet (fig. 2). This property joins the old Devonian group on the east. The Ella shaft is located on the Silver Bell claim. The property is accessible by road. From Dos Cabezas travel 3.1 miles easterly on State Highway 186; turn left from Highway 186 and go 1.5 miles on a graded road to the Bill De Borde ranch home; thence follow a winding truck trail from the De Borde ranch home into Wood Canyon. A foot trail to the Ella shaft leaves the truck road 4.1 miles from the ranch home. The Ella shaft is situated on the northwest side of Siphon Canyon (shown on the Dos Cabezas Quadrangle sheet), about 0.5 mile from the Wood Canyon truck trail. Four unpatented claims are owned by William I. De Borde and Thomas P. Bean, both of Dos Cabezas, Ariz.

A man named Fisher (deceased) located the property (five Ella claims) about 1910 or 1911 on meager gold-silver outcrops. Fisher held the property until 1932 when De Borde bought everything owned by Fisher at a sheriff's sale. De Borde held the five claims until 1949. In 1950, he and Thomas Bean relocated four claims of the group.

The Ella shaft is sunk in a quartz vein about 4.5 feet wide. The vein at the shaft collar strikes N. 82° E. and dips steeply to the north. The shaft is inaccessible but is reported to be 192 feet deep. An adit situated 160 feet south of and 75 feet below the collar of the shaft was driven to cut the shaft. The adit lacks about 5 feet of connecting with the shaft, as shown on figure 8.

The lower adit has cut a tactite area 30 feet wide, then a quartz vein 4.5 feet wide, and then 7 feet of wollastonite. The 30-foot tactite zone south of the quartz vein shows very sparse scheelite mineralization. The quartz vein shows good mineralization. The wollastonite is sporadically

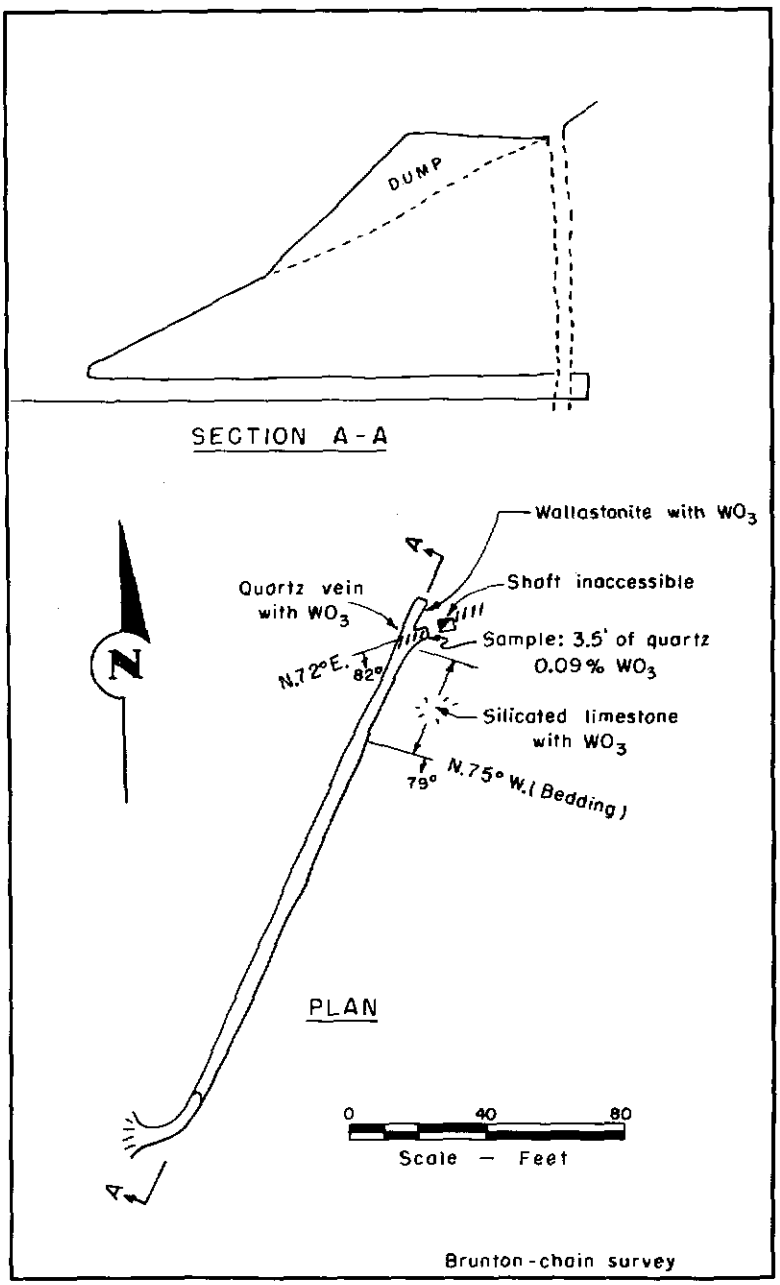

FIGURE 8. - Ella Shaft Workings, Silver Bell Claim, Cochise County, Ariz.

mineralized but is of higher tenor than the tactite zone south of the quartz vein in the adit. The vein in the adit strikes N. 72° E. and dips 82° SE; the bedding planes in the adit strike approximately N. 75° W. and dip about 80° SW.

A sample cut in the east face of the exposed quartz vein in the adit across a 3.5-foot width assayed 0.09 percent WO_3.

Austin Mine

The Austin mine is in the NE1/4 sec. 30, T. 17 S., R. 28 E. and comprises three unpatented claims: the Austin, Chance No. 7, and Chance No. 8. The property is accessible by road from Dos Cabezas, Ariz. (fig. 2). Go 3.0 miles east on State Highway 186, turn left across a cattle guard onto the De Borde ranch road, and go 1.4 miles easterly to the ranch. From the De Borde ranch a truck trail goes into Wood Canyon to the Austin mine, a distance of 4.4 miles. The mine is on the western slope of Wood Canyon.

The property is owned by George A. Kaske, Dos Cabezas, Ariz. The Austin claim originally was located by Tom Hatton in 1880. A shallow shaft and short adit were worked on a meager gold stringer. The property then remained idle until 1943 when Kaske discovered scheelite in the shaf shaft. Henry Meins owned the property at the time; Kaske bought the property from his heirs in 1949. In 1948, a sample of ore from the shaft was submitted to the Arizona Bureau of Mines for testing purposes. Gravity concentration of the sample, which contained 1.95 percent WO_3, yielded a concentrate containing

48.57 percent WO_3 and 21.5 percent lead with a recovery of 80 percent. Such a lead-tungsten concentrate was not marketable, so the property was not worked. In 1954, Kaske relocated the claims prior to doing more exploration work on the scheelite occurrence. In 1955, he obtained Defense Minerals Exploration Administration assistance to carry on the exploration work.

An adit 190 feet long cuts the bottom of a shaft 85 feet deep. A westerly trending drift from the adit is 70 feet long (fig. 9).

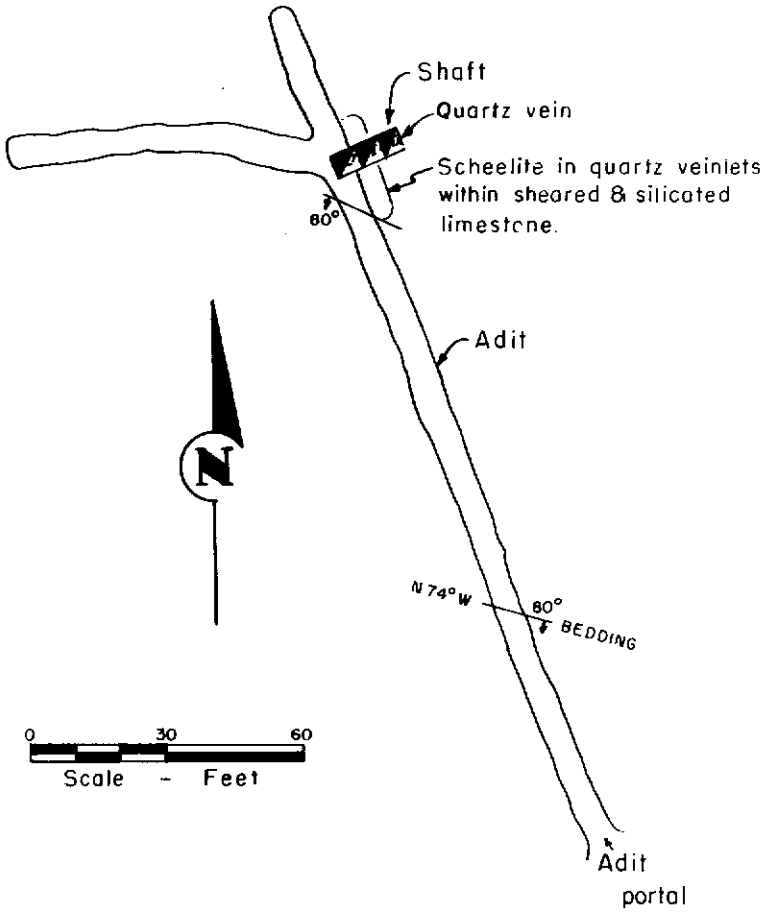

FIGURE 9. - Workings on Austin Claim, Cochise County, Ariz.

The scheelite there appears to be of the same occurrence as the fissure-type veins on the Silver Strike and the Silver Bell properties. There are schists, quartzites, limey shales, and shaly limestone on the property. There is some diorite in the area.

A steeply dipping vein of quartz, trending easterly, cuts diagonally across silicated limestone beds. The high-grade scheelite mineralization occurs in sheared and silicated limestone in and near the south side of the quartz. The scheelite is associated with galena and minor amounts of sphalerite, chalcopyrite, and pyrite. The zone containing most of the scheelite varies in width from 2 to 4 feet, and is exposed in the walls of the shaft from its collar to the adit level. The ore appears to have fingered out into narrow quartz veinlets on that level.

A sample taken from the old dump at the shaft assayed 1.83 percent WO_3, 3.3 percent lead, and 0.06 percent copper. Ten samples were cut in the shaft at depths from 34 to 78 feet. The samples assayed from 0.95 to 3.24 percent WO_3, over widths ranging from 2 to 24 inches.

A drift trending west from the adit shows sporadic scheelite mineralization. Four samples cut there assayed from 0.22 to 1.32 percent WO_3, over widths ranging from 3 to 12 inches.

Figure 9 is a map of the workings into the scheelite occurence.

Ram Claims

Five unpatented claims are situated on Federal land in sec. 21, T. 14 S., R. 28 E. at an altitude of about 5,250 feet (fig. 2). The property is accessible by road, by going 7.6 miles south on the Apache Pass road from Bowie and thence 3 miles westerly on a dim truck trail to the mine. The claims lie west of Sheep Canyon Spring on a steep, rugged slope of Sheep Canyon.

L. Nichols of Bowie, Ariz., discovered and located the scheelite occurrences in the summer of 1956. Apparently he did not complete discovery requirements, for on February 6, 1957, K. A. Nichols and Marlow Deaton located five claims over the deposit.

There has been no production from this property, and very little work has been done on the scheelite occurrences. Three shallow bulldozer cuts have been made, and a few shallow test pits have been dug.

In this area a series of metamorphosed limestone beds and schists have been cut by long, narrow felsite dikes. The schist contains amphibole and might be described as micaceous beds of a dioritic nature. The beds strike N. 62° W. and dip 60° to 70° NE. The bedding strike is normal, but the dip is reverse to that found in other parts of the Chiricahua and Dos Cabezas Mountains. The normal dip is 40° to 80° SW. The felsite dikes trend S. 40° to 50° W. and dip steeply to the NW.

Scheelite occurs in pockets and lenses of quartz and epidote which lie conformable to the bedding. The scheelite deposition is sporadic. The quartz and epidote veins vary in width from a fraction of an inch to several feet; the area containing the scheelite is several hundred feet wide. Scheelite can be found along the strike of the beds for several hundred feet.

Not enough work has been done on the property to permit extensive sampling. Much of the area is covered with alluvium. Three surface cuts have been made. The upper cut shows 3.5 feet of scheelite ore that was sampled; the sample assayed 0.79 percent WO_3. The lower cut has exposed a sizeable scheelite deposit, but not enough of the area has been exposed to determine if the scheelite occurs along a bedding plane, or along a major shear plane. Hence, it was not sampled.

Comstock Lode Tungsten Claims

This group of claims is situated in sec. 22, T. 13 S., R. 26 E., at an altitude of approximately 4,750 feet (fig. 2). The group comprises seven unpatented lode and three unpatented placer claims. The claims lie on the Monk Cattle Co. range, privately owned land. The mine is easily accessible by a good dirt road from Highway 86. This road turns southwest from Highway 86 at a point 5.9 miles west of Bowie, Ariz. It follows a winding course for 8.2 miles to the mine.

The deposit was discovered first in 1944 by F. W. Clark. Archie Cohen of Chicago is reported to have spent $60,000 on the property prior to 1954. A mill was built but was dismantled not long after its completion. In 1954, R. B. Adams relocated the claims. Tyone Mining Co. leased the claims for a few months in 1954; then Adams sold them to the present owners, Mr. and Mrs. J. R. Rogers and D. C. Rogers of Safford, Ariz., in 1956.

Only a small amount of work has been done on the property. There are two adits, each approximately 50 feet in length, one inaccessible vertical shaft of unknown depth, and numerous trenches, small pits, and opencuts.

Quartz veins and veinlets contain the scheelite. They strike generally east and dip about 30° S. The scheelite mineralization is sporadic and crystals range upward from 1 mm. in diameter. According to Rogers, the scheelite occurs in sizeable pockets in the quartz. He said a single crystal weighing 9 pounds had been extracted. Recently several weighing as much as 1 pound have been found. The main quartz vein is about 700 feet long and averages approximately 2 feet in width. It is near a contact between an altered diorite and a light-colored dike rock, probably trachyte. The quartz carries small amounts of galena and lead and iron oxides, in addition to the scheelite. Rogers said the scheelite ore extracted averaged about 0.70 percent WO_3.

The placer material on the property is of low tenor according to Rogers. It has collected from the outcrops of the lode deposits.

Rough Claims

On April 12, 1943, a Bureau engineer examined the Rough claims and wrote a report of the examination. From inquiries it was learned that little work had been done on the prospect since then; hence, the claims were not visited during this investigation. Information on the claims was taken from the 1943 report.

The Rough claims (Nos. 1 and 2) are situated about 7 miles southwest of Bowie (fig. 2). To reach the property drive south from Bowie on the Apache Pass road 1.5 miles; then turn right (southwest) on a poor dirt road and go 4 miles to a wire fence across Quail Preserve Wash. From there walk 0.75 mile up this wash to the point where the tungsten-carrying zone first is encountered. From there this zone can be traced to the northwest by leaving the main wash and proceeding up a steeper canyon to the right for nearly a half-mile to the place where the original discovery was made. The claims were held by Ben Kratzberg and Jim Cawood.

The scheelite mineralization occurs in narrow streaks and as specks of various sizes in a dark-colored, massive bed that resembles diorite, but has been classified as an amphibole schist. The specks and streaks of scheelite are in scattered patches. There is no regularity to the mineralization, but scheelite can be detected in the lower part of the schist nearly one-half mile below the discovery.

A few shots had been put into the ore at the discovery point, and a small pile of the better pieces of ore had been sorted out on the dump. A sample selected from the best of this sorted ore assayed 1,34 percent WO_3.

Huachuca Mountains Area

Records of scheelite ores being mined in the Huachuca Mountains start during the First World War. The first authentic date of record is 1916. However, many of the scheelite mines were worked for gold and silver in the 1800's. According to reports, the Tungsten Reef mine was worked for gold in the 1870's. The Lucky Strike, Jack Wakefield, Harper, Van Horn, Zaleski, and Arrow groups of claims were worked for gold and silver before any scheelite ores were mined.

The Huachuca Mountains are in the southwestern corner of Cochise County, southeastern Arizona. The intersection of N. Lat. 21° 25' and W. Long. 110° 20' is about the center of the range, which extends a few miles into Mexico.

The Benson-to-Douglas branch of the Southern Pacific Railroad serves the region. Hereford, a station on the line, is 16 miles by road east of the Tungsten Reef mine. A spur line from the Benson-to-Douglas branch line enters Fort Huachuca at the northern end of the mountains. Another spur connects Fairbank, Elgin, Sonoita, and Patagonia through Babocomari Wash, a few miles north of the range.

Blacktop highways traverse the eastern and northern sides of the range. Maintained dirt roads go around the east side and the Montezuma Pass road runs through the range near the international boundary. Figure 10 shows major and minor access roads and trails.

The scheelite mines range in altitude from 5,400 feet to 7,200 feet. With one exception the mine properties have ample timber for mining purposes. A sizeable lumber industry on the east side of the Huachuca Mountains furnished mine timbers and lumber for construction to the mining camps of Bisbee and Tombstone during the late 1880's and early 1900's.

There has been a sizeable production of scheelite ores from the Huachuca Mountains area. There are records that show that about 170 tons of concentrates containing from 60 to 78 percent WO_3 has been produced. There are no records of production from the Lucky Strike, Emerald, Western, and Arrow claim claims, nor from the ores taken surreptitiously from the Fort Huachuca Military Reservation. This production has come from local concentrations of high-grade scheelite ore in quartz veins through Paleozoic sediments and through granite. No extensive tactite deposits of scheelite ore were noted.

The scheelite ores of the Huachuca Mountains are relatively pure. The ores can be concentrated by gravity methods to better than 70 percent WO_3. Interfering minerals noted were hematite and galena. The hematite is removed by electromagnetic methods, but concentrates sometimes are penalized for very small amounts of galena.

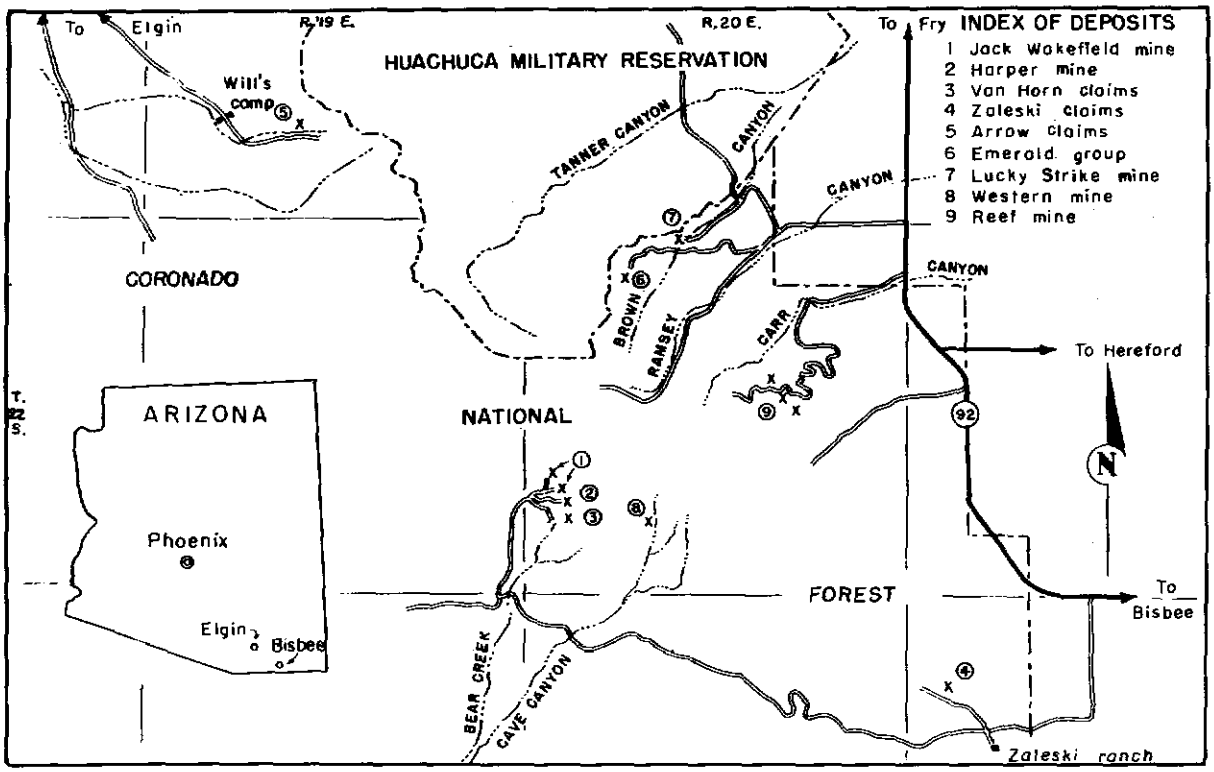

FIGURE 10. - Location Map, Huachuca Mountains Area, Cochise County, Ariz.

Known and indicated reserves of ore in the mines are small. This is not because the deposits are depleted, but because the shoots and pockets of ore have been extracted as they were encountered. In only one mine did it appear that the limits of the ore body had been reached. Nearly all of the scheelite ores extracted have occurred on or near the surface. With two exceptions, none of the scheelite deposits have been investigated more than 100 feet below the surface. There are about 21,000 tons of indicated ore at $\pm$ 1 percent, and 62,000 tons of inferred ore at less than 1 percent, WO_3 in the Huachuca Mountains. No ore on the military reservation was considered in making this estimate.

Tungsten Reef Mine

The Tungsten Reef group of nine patented claims lies in secs. 14 and 15, T. 23 S., R. 20 E. at an altitude of about 7,200 feet (fig. 10). The claims are located at the head of Carr Canyon on the east side of the Huachuca Mountains, Coronado National Forest. To reach the mine by road go 2.7 miles easterly from Fry, Ariz., on State Highway 92 to the junction of State Highways 90 and 92, and thence 7.7 miles southerly on Highway 92 to Fletcher's Roundup. Turn westerly at Fletcher's Roundup onto the Carr Canyon road and go 6.1 miles to the mine. The road rises from an elevation of about 4,850 feet at Fletcher's Roundup to an elevation of about 7,280 feet near where the road enters the Reef property. Hereford, Ariz., on the Southern Pacific Railroad is 16 miles east of the mine.

This property was worked in the 1870's for gold. A mill was built, but the operation failed, probably because of low gold and silver values. The property lay idle until about 1900, when another attempt was made to mine gold and silver. The mine was named Exposed Reef due to the many exposures of the vein. The name has stuck through the years. A 50-ton cyanide plant was built, and a considerable tonnage of ore was produced from the upper portions of the vein. Evidently values were too low grade, for the operation failed. In 1906, a 100-ton cyanide plant was built, but this operation also failed. The property was idle from 1906 to 1916, when it was first worked for tungsten.

O. T. Smith, who mined tungsten ores for the Primos Chemical Co. in the Little Dragoon Mountains, Cochise County, Ariz., became interested in the Reef mine. He is reported to have treated 12,000 tons of ore from which he shipped 63.9 tons of concentrates averaging 71.6 percent WO_3. He worked from 1916 until April 1918. In May 1918 the Tungsten Reef Mines Co. purchased the property. The demand for tungsten dropped off shortly afterward and the mine again closed down. The Vanadium Corp. sampled the property by trenching in 1930.

In 1934, J. J. Seeman and associates took a lease on the property. From 1934 to February 1942, Seeman produced 183,468 pounds of concentrates which averaged 71 percent WO_3. The tonnage of ore mined is unknown. Seeman developed and piped water to the property from springs in upper Carr Canyon. He stopped operations in 1942 because of the rising cost of labor, as the wage scale had risen in the nearby copper mine at Bisbee and in construction work at Fort Huachuca.

In 1941, the Bureau made an investigation of the property, known as Project No. 708, to which reference will be made later.

Lewis H. Seeman and his wife, Hazel, own the property today. In 1951, Seeman was preparing to reopen the property because of the Government's program to purchase scheelite concentrates at $63 per unit. Before Seeman got into production he gave a conditional sales contract on the property to the Minerals Development Corp. in January 1952. This company built a mill at the site of the old cyanide plant for sizing crushed quartz to be sold to petroleum refining interests. In 1953, 500.15 tons of this sized quartz product was sold. After this shipment was made the mill and screening plant were dismantled, and a new quartz crushing and screening plant was erected on the opposite side of a hill, about 1,600 feet east of the old site (fig. 11). From April 20 to May 25, 1954, the new plant produced 391.25 tons of sized quartz that was sold to the petroleum industry. No effort was made to mine scheelite ore. The mine shut down shortly afterward, and Seeman regained possession of the property.

Seeman discarded much of the screening plant and added a concentrating table and jig to the circuit to recover scheelite (fig. 11). During 1955 and 1956, two men produced 6,838 pounds of concentrates at 74.96 percent WO_3 from an estimated 101 tons of ore milled.

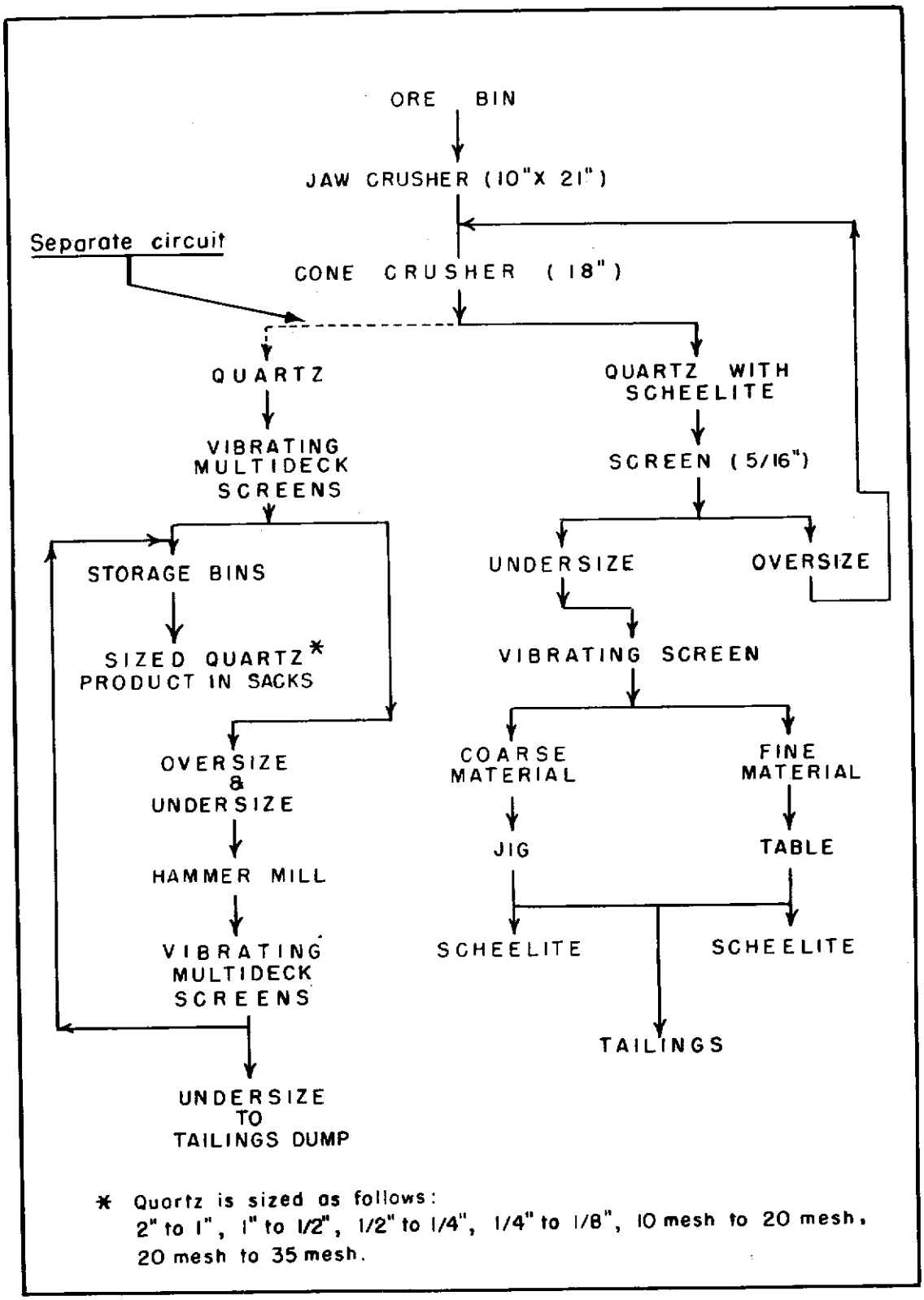

FIGURE 11. - Flowsheet, Tungsten Reef Mill, Huachuca Mountains.

Evidence of selective mining and hand sorting is present in quartz dumps on the property, which contain a few tens of thousands of tons of very low grade scheelite ore.

Several examinations of this property have been made by various engineers and geologists. Frank W. Royer, mining engineer of California, wrote a report for A. J. Clark of Hollywood, Calif. K. E. Hamblen, consulting engineer, prepared a report for Minerals Development Co. Eldred Wilson[9] described the property briefly, and R. H. Weber[10] described the property in considerable detail. The Bureau examined and sampled the property, and an unpublished report was written. Pertinent facts of history and production from this report are used in this publication.

Royer's report reads in part:

> The value of tungsten is in the mineral scheelite and this mineral comes in irregular bunches and disseminations through the quartz. The gold and silver are also very irregularly distributed, and to attempt to determine the value of this deposit in scheelite and gold is economically impossible.

Figure 12 is a general map of the property. On it are outlined four areas of exposed quartz. Less than one-third of the exposed quartz was sampled by the Bureau. Test pits were dug on an 80-foot grid. In areas 1 and 2 many high-grade ore shoots have been mined by both opencut and underground methods and were found to be small. Some of the shoots appear to be as much as 8 feet high, 20 feet across the vein, and from 20 to 50 feet long. Samples from test pits on an 80-foot grid are only indicative of the low-grade ore that may exist.

Straw-colored scheelite occurs in milky-white quartz veins near the base of the Cambrian Abrigo formation. The veins, in general are conformable with the strata of limestone. There are two principal veins, generally parallel, but the bottom one is not uniformly present throughout the area. They strike N. 5° to 10° W. and dip 10° to 15° SW. The two veins are 2 to 12 feet apart. The lower one ranges from a few inches to 6 feet and the upper from about 2 to 15 feet in width. Many small interconnecting cross veins are present.

There has been post-vein movement. The principal veins have been cut by three sets of nearly vertical joints which strike northerly, northeasterly, and northwesterly, but few, if any, of the joints displace the vein. Wilson states:[11] "There is strong suggestion that the ore shoots occur at intersections of the northwest and northerly fractures."

9/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, pp. 48-49.

10/ Weber, R. H., The Geology of the East-Central Portion of the Huachuca Mountains, Arizona: Univ. of Arizona, Ph. D. Thesis, 1950, pp. 122-150.

11/ Work cited in footnote 9 (p. 31), p. 49.

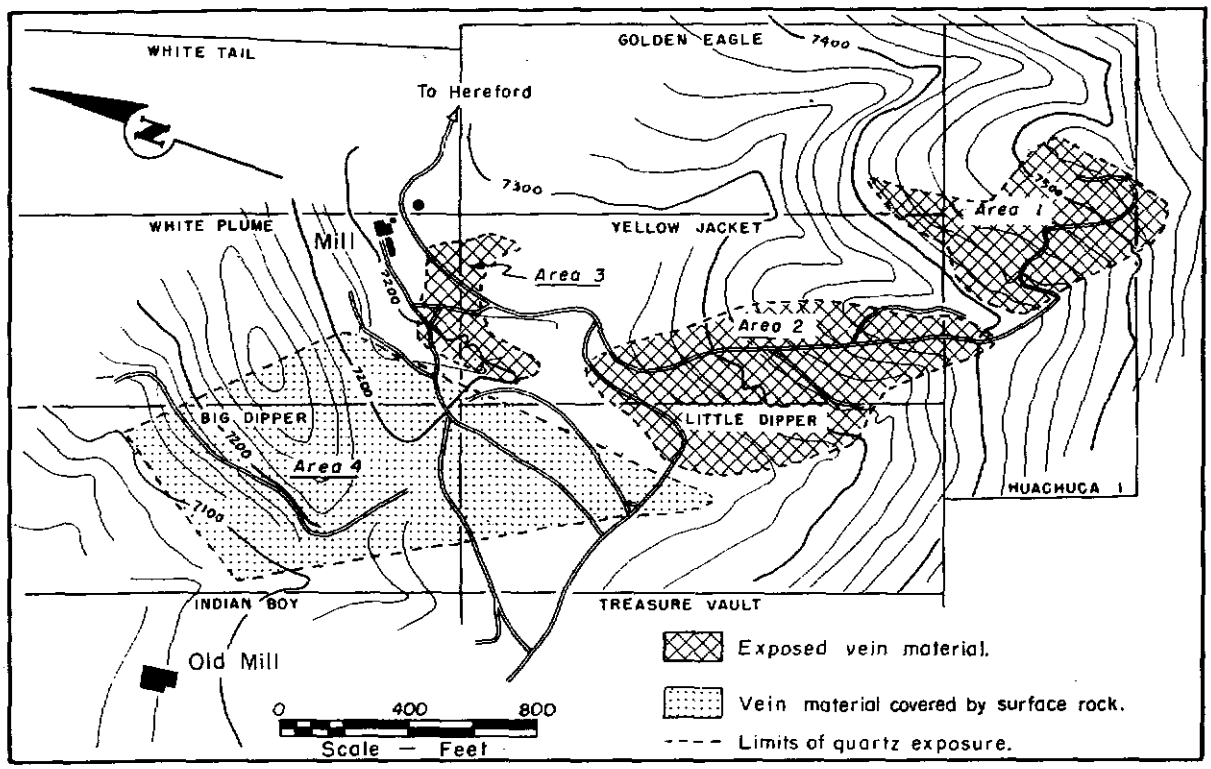

FIGURE 12. - Tungsten Reef Mine, Cochise County, Ariz.

The quartz contains sporadic irregular particles of scheelite ranging from about 0.25 inch to several inches in diameter, a small amount of gold, and sparse galena. The last concentrates shipped by Seeman contained 0.65 percent lead. Scheelite concentrations are found in all parts of the veins; that is, in the middle, top, and bottom, and sometimes across the veins. The distribution is erratic, but the lower vein is reported to be the richer.

Emerald Claims

The Emerald group of four unpatented claims lies in sec. 8, T. 23 S., R. 20 E. at an altitude of about 7,150 feet (fig. 10). The claims are at the head of Brown Canyon, Huachuca Mountains, in the Coronado National Forest, and adjoin the Fort Huachuca Military Reservation on the southeast. The property may be reached by road from Fry, Ariz., by traveling 2.7 miles easterly on State Highway 92 to the junction of Highway 90, thence 6.2 miles southerly on Highway 92 to the Ramsey Canyon road, thence 2.6 miles westerly to a road that branches northwesterly from the Ramsey Canyon road, and thence 1.8 miles into Brown Canyon. From Brown Canyon a jeep road has been bulldozed for 1.7 miles to near the mine. It ends about 500 feet below the mine, but there is a pack trail to the mine from the road. An aerial tramway has been used to transport ore from the mine to the road.

This mine was operated by James Kelley during the First World War. Kelley packed the ore on burros from the mine to a mill situated where the road now crosses Brown Canyon. The claims were abandoned after the war and

were relocated about 1927 by Harvey S. James, who made an intermittent production of concentrates with a very small gravity plant. The plant was situated on the crest of the mountain about 100 feet above the mine. The concentrates were packed on burros down the mountainside to the end of the Brown Canyon road.

James died in 1943, and the Pomona Mining Co. purchased the property from the James estate. This company built about 4 miles of road and did some trenching and open-pitting. About 200 units of approximately 60 percent WO_3 concentrates was produced in 1946 and 1947.

The property was leased to the Huachuca Mining & Milling Co., Hereford, Ariz., in August 1953. This company developed and mined an estimated 200 to 300 tons of ore at plus 1 percent WO_3.

Scheelite-bearing quartz veins occur in complexly deformed Paleozoic limestone. The main vein, an overthrust fault fissure, crops out for about 200 feet and has a width of 1.5 feet to 10 feet. It strikes N. 40° W. and dips 15° to 40° SW. A winding adit about 250 feet long with drifts and stopes has opened the ore body. Sporadic particles of straw-colored scheelite, generally larger than 1 mm., occur in the quartz and in the limestone immediately below the quartz sheet. Associated with the vein are solution cavities about 10 feet high, filled, more or less, with brown, ferruginous sandy silt and mud. Most of the mine workings driven in search of high-grade pockets were made by excavating this clay material.

The north end of the main adit shows about 2 feet of fair lead ore. The quartz containing the scheelite, however, seems not to have galena in it.

Lucky Strike Mine

The Lucky Strike mine is in sec. 4, T. 23 S., R. 20 E. at an altitude of about 5,400 feet (fig. 10). The mine lies on the north side of Brown Canyon in the Huachuca Mountains, Coronado National Forest, and is adjacent to the southeast side of the Fort Huachuca Military Reservation. Road directions to the mine are as follows: On State Highway 92 go 6.2 miles south from the junction of State Highways 90 and 92 to the Ramsey Canyon road, thence 2.1 miles westerly to a road striking northwest, and thence 1.0 mile to the mouth of Brown Canyon. Follow this road southeasterly up Brown Canyon for 1.5 miles to the mine. A road, now impassable, ran from the Lucky Strike mine to the old Kelley Mill, were the Emerald mine road crosses Brown Canyon. This distance is about 0.3 mile.

The Lucky Strike probably was worked first for gold. Old workings southeast of the scheelite vein indicate that gold ores were mined. A report of an examination by the Bureau in 1943 states that the mine produced considerable scheelite ore during the First World War. During 1935-38, the mine was operated by Gold, Silver, and Tungsten, Inc., which built a small concentrating mill about 1 mile east of the mouth of Carr Canyon. Tungsten ore from Miller Canyon also was treated in the mill.

About 1942, Gabrielson, Kaske, and Palmer located the Combination claim over the old Lucky Strike workings. They reconditioned the old inclined shaft and ran prospect drifts to the west in an effort to locate more ore. Apparently no new ore was located, for they released the property about 1945.

According to S. C. Hu, president of Standard Tungsten Corp., his company leased 6 claims of the Lucky Strike group and either bought or located an additional 19 mining claims during the latter part of 1953. Hu reported that about 4.5 tons of concentrates was produced from ore removed partly from the dump and partly from the inclined shaft adjacent to the dump.

The quartz vein, which does not crop out but is exposed in stopes off an inclined shaft reported to be 90 feet deep, occurs in a coarse-textured pink granite. It strikes N. 25° to 30° W. and dips 15° to 30° SW. There is a narrow dike of dark-green, schistose, altered rock along the hanging wall.

The vein pinches out about 60 feet north of the shaft and mineralization has stopped probably 30 feet south of the shaft. According to S. C. Hu, mineralization extends 180 feet downward on the inclination of the vein. The shaft contained water at the time of the present investigation.

Judging from the size of stopes, a few thousand tons of high-grade scheelite ore has been mined. Pillars left to support the walls indicate that the ore probably assayed in excess of 2 percent WO_3.

The vein, where exposed, is from 12 to 30 inches wide. Streaks of scheelite occur along the hanging wall and along the footwall. It is reported that the two scheelite streaks together amounted to about 12 inches in width at the best showing. The ore carried bands of galena and scattered grains of pyrite along with the streaks of scheelite.

Jack Wakefield Mine

Fifteen unpatented claims comprise the Wakefield group (fig. 10). The claims are in sec. 30, T. 23 S., R. 20 E. With the exception of steep grades over Montezuma Pass, a good, maintained road goes to the mine. From Fry, Ariz., at the main gate to Fort Huachuca, follow State Highway 92 southeast for 17.3 miles to the Montezuma Pass road. Follow the Montezuma Pass road westerly for 14.6 miles to a road that branches toward the north. This branch road leaves the Montezuma Pass road about 100 or 200 feet west of the Bear Canyon bridge. The Wakefield Camp is 1.6 miles northeast of the Montezuma Pass road; the main adit is 0.8 mile northeast of the camp. The scheelite occurrence is about 2,500 feet northwest of the main adit. A truck trail leaves the road about 0.6 mile northeast of the camp and goes northwesterly approximately 0.2 mile. A good foot trail goes from there to the scheelite occurrence. Work on the tungsten vein has been done on the west slope of a secondary drainage locally called Cottonwood Creek.

The Blue Jay claim on which the scheelite occurs lies at an approximate altitude of 6,100 feet. Northeast of the claim the mountain slope rises precipitously to the crest of the range at an altitude of about 8,500 feet.

The Wakefield claims are owned by the Jack Wakefield Mining Co. The original location was made by Jack Wakefield (deceased), about 35 years ago on a narrow quartz vein containing a lens of high-grade gold-silver ore. The principal metal was silver, and it appears to be associated with chalcopyrite.

George A. Little, a major shareholder in the company, has had the property leased for several years. It was through Little's efforts that a small production of scheelite was made in 1943 and 1944. Development of the silver-copper ore has been carried on by Little for about 10 years.

The scheelite ore has been opened by an adit and opencut with a combined length of approximately 40 feet. There are several opencuts and an old shaft 65 feet deep on the vein.

The silver-gold-copper vein has several workings on it. A short adit with a 500-foot drift on the vein was driven many years ago, and a 70-foot winze was sunk on the vein from the adit level. A 65-foot vertical shaft was sunk from the surface, and a drift was driven 30 feet to the winze. Later, an adit 905 feet long and 175 feet below the upper adit was driven to cut the vein. About 60 feet of crosscutting on the vein had been done by May 1957.

In 1944, about 10 tons of scheelite ore was shipped to the Mori mill, situated 1.8 miles southwest of the mine on Bear Creek, from which 10 units of WO_3 was recovered. A few tons of high-grade gold-silver ore with an estimated value of $20,000 was shipped from the property prior to 1940. This ore came from two small stopes in the old workings.

Paleozoic or Mesozoic sediments and volcanic rocks of probable upper Mesozoic age crop out on the Wakefield claims. The sediments are mainly sandstones, shales, and conglomerates with some limestones. Some of the shales and sandstones are calcareous. Andesite and vesicular lava crop out at several places on the property.

The scheelite occurs in a vein of white quartz between sandstone on the hanging wall and conglomerate on the footwall. The width of the quartz ranges from 3 inches to 3 feet. The scheelite mineralization is sporadic and can be traced along the strike for about 700 feet. The overall picture is one of low-grade ore, but lenses and pockets produce ore that assays up to 7 percent WO_3. In 1943, John Price, Bureau engineer, cut a sample from the face of the adit that assayed 6.64 percent WO_3. This sample was cut across the 18-inch vein. Little reported that a miner cut a sample near the 65-foot shaft that assayed in excess of 7 percent WO_3. This vein strikes N. 25° W. and dips 60° to 70° SW. in conformity with the bedding.

Harper Mine

The Harper mine comprises two patented claims, situated in sec. 30, T. 23 S., R. 20 E., approximately 0.5 mile southeast of the Wakefield camp (fig. 10). A road goes to the property from that camp. In May 1957 the road was impassable because of flood damage. The altitude at the Harper shaft (fig. 13) is approximately 6,100 feet.

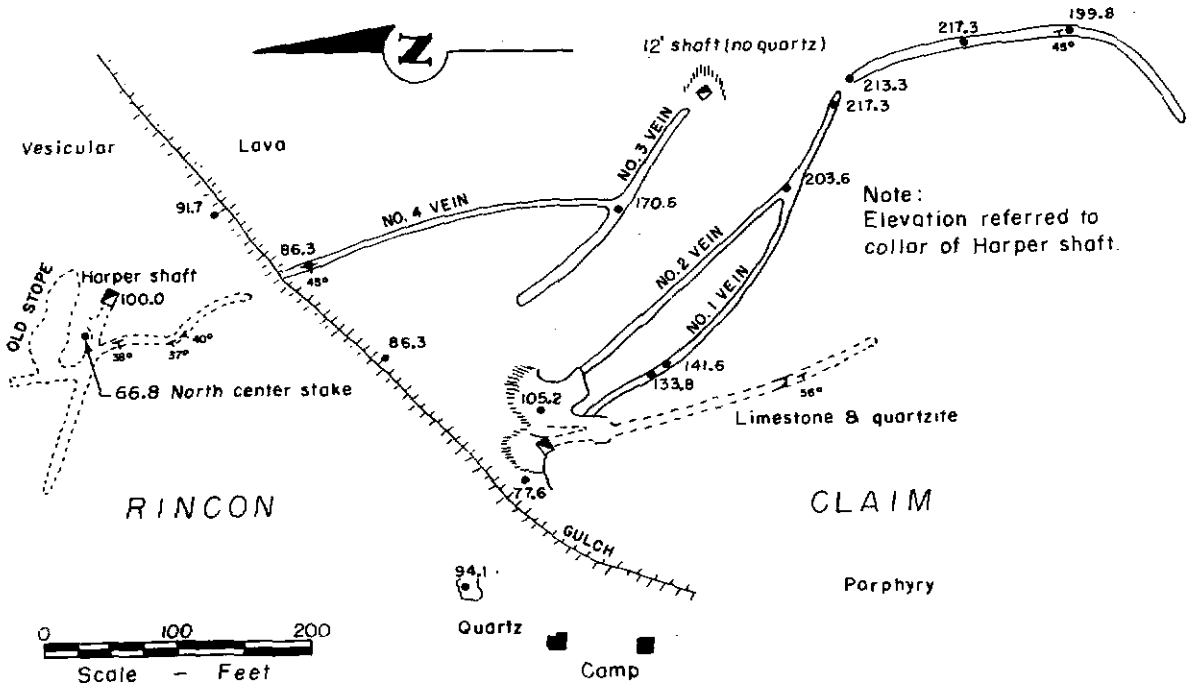

FIGURE 13. - Plan of Harper Mine From Brunton Survey.

The property is owned by Dean Mori of Belle Vernon, Pa. In 1939, the Southwest Tungsten Mining Co. purchased the claims from Mrs. Harper. It was reported that Harper was the original owner of the claims and was killed by violence on the property. Mori owned controlling interest in the Southwest Tungsten Mining Co.

Four quartz veins crop out on the Rincon claim, as shown in figure 13. Original work on the property was done at the Harper shaft on a narrow quartz vein containing gold, silver, and copper. A level was established about 60 feet from the collar, and a small amount of stoping was done from that level. Very sparse scheelite shows in this vein.

The principal tungsten workings are on No. 1 vein. Ore has been mined at two levels there, from the 260-foot main adit and from the upper adit, which is approximately 25 feet long and 25 feet above the lower adit. A small amount of stoping has been done along the fault zone between the upper and lower adits, as shown in figure 14.

Production figures from the Harper mine are not known.

Sandstones and shales crop out north and northwest of the Harper mine. Southwest-dipping limestone and quartzite crop out on the western part of the Rincon claim. The southeastern part of the claim is underlain by andesite porphyry. Vesicular lava crops out on the northeastern part of the claim.

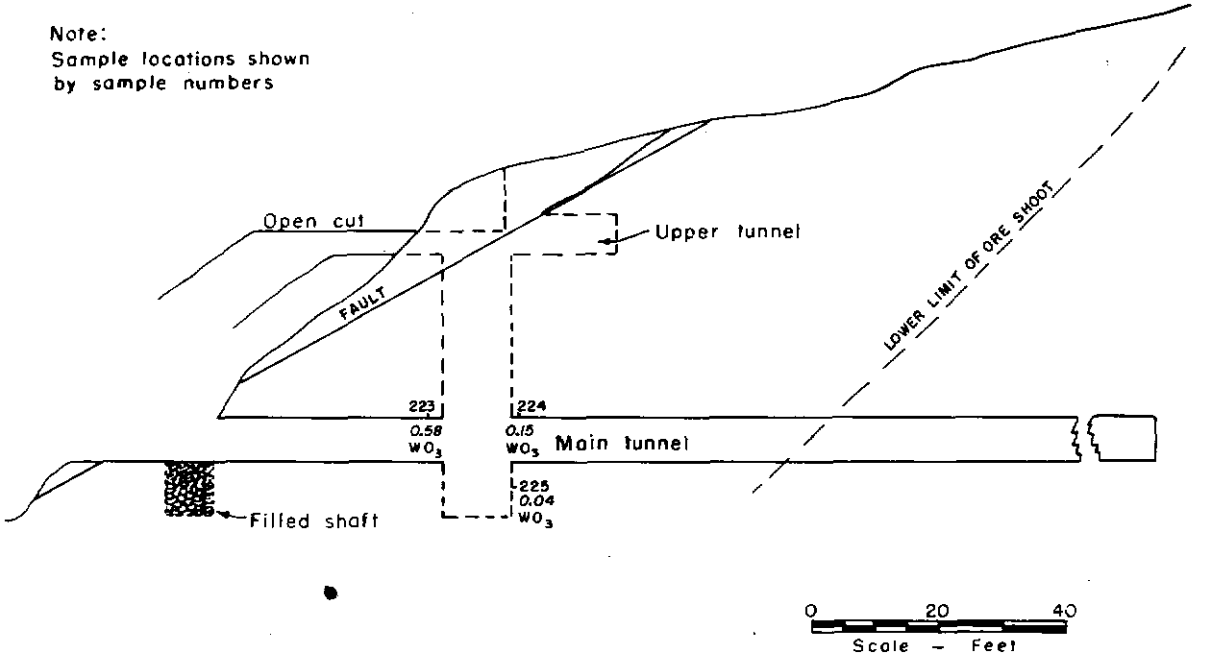

FIGURE 14. - Section of Main Tunnel, Harper Mine, Cochise County, Ariz.

The general strike of the quartz veins is about N. 25° W., and the dip varies from 30° to 60° SW. No. 1 vein, from which most of the tungsten production has come, lies in limestone and sandstone. This vein carries scheelite for about 80 feet from the portal of the lower adit. While the vein averages 2 feet in width, the ore is progressively narrower going south. At 140 feet from the portal the vein pinches to 6 inches and is barren. The vein beyond the pinch is 24 to 30 inches wide and carries sporadic, low-grade scheelite mineralization. The scheelite crystals average about 0.25 inch in diameter. A 4-foot winze below the raise (fig. 14) encountered local copper mineralization. There is good scheelite mineralization in the winze bottom. It is reported that good ore was mined from a 10-foot shaft outside the portal of the adit. Free gold occurs in sporadic vugs filled with limonite in quartz. This type of quartz is sheared and of platy structure. It is seldom more than 6 inches thick. Twelve tons of this material mined from No. 1 vein assayed 0.31 ounces of gold per ton.

No scheelite has been found in No. 2 and No. 3 veins.

No. 4 vein is of hard, glassy quartz and carries sporadic, coarse cuproscheelite in one location immediately south of the arroyo between the Harper shaft and the lower adit. This tungsten mineral is a green color and fluoresces blue under the ultraviolet lamp. It is associated with azurite and malachite.

Mori Mill

The Southwest Tungsten Mining Co. erected a mill on Bear Creek 2.3 road miles below the Harper mine. It was situated in sec. 1, T. 24 S., R. 19 E. on the Montezuma Pass road 0.2 mile southwest of the turnoff to the Wakefield Camp.

The ore was hauled by truck from the mine and dumped into a 150-ton coarse-ore bin, from which it was fed by a belt feeder to an 8- to 12-inch Blake-type jaw crusher. The crushed ore with a maximum diameter of 1 inch fell directly into a 100-ton fine-ore bin. A belt feeder delivered the ore from the fine-ore bin to a vibrating screen decked with 10-mesh square-opening woven-wire screen. The screen oversize was ground in a 4- by 4-foot Herman peripheral-discharge ball mill decked with 10-mesh square-opening woven-wire screen. The combined vibrating screen undersize and ball mill discharge were treated on two standard-size Buchart concentrating tables. These were run at 240 r.p.m. and 3/4-inch stroke. A middling cut was elevated by a small bucket elevator and reutrned to the ball mill.

The mill was sampled by Bureau engineers through a 4-hour run during February 1944. Five tons of ore was treated at a rate of 30 tons per 24 hours. The ball mill was running at about half capacity, as the rate of feed was reduced to effect a better recovery on the tables. One hundred and ten pounds of concentrate was recovered from the 4-hour run.

The mill samples assayed as follows:

	WO_3, percent
Heads	0.46
Tailing	.01
Middling	.32
Rough concentrate	39.7
Cleaned concentrate	45.8 (iron removed with an electro-magnet)

Ample water was pumped from Bear Creek near the mill. A small pump was set in a pit dug to bed rock on the upstream side of a small tailing pond in the creek bed.

This mill was sold and removed from the district in 1957, primarily because thieves were stealing a piece at a time from the plant.

Van Horn Property

There are 12 unpatented claims in the Van Horn group, situated in secs. 29 and 30, T. 23 S., R. 20 E. (fig. 10). The claims join the Mori property on the south and east. A road from the Wakefield camp goes 0.4 mile southeast to a house on the property.

Henry G. Van Horn, Star Route, Patagonia, Ariz., is owner of the property. The claims originally were located about 1905 on gold and silver outcrops. Tungsten has been found on five of the claims, and some of the scheelite ore was mined during the First World War. Van Horn acquired the property by inheritance in 1933.

Van Horn produced 25 to 30 units of WO_3 during 1943 to 1945 from a high-grade quartz vein. The ore was ground by hand in a mortar and hand-jigged to recover the scheelite. The ore is estimated to have assayed from 4 to 5 percent WO_3.

There are no extensive workings on the property. There are numerous shallow shafts, short adits, opencuts, and trenches on the claims.

Several narrow locally rich scheelite-bearing quartz veins cut Mesozoic shale, andesite, and conglomerate. The veins strike N. 20° to 40° W. and dip 45° to 75° SW. Some very narrow cross-stringers of quartz strike about N. 35° E. and also dip southwesterly.

Most of the work on the tungsten ore has been done adjacent to the Harper mine. The quartz vein system in this area appears to be of the same origin, and strikes and dips compare quite favorably. As at the Harper mine, the scheelite occurs in small, rich pockets and lenses.

Western Tungsten Mine

On February 19, 1943, two Bureau engineers examined the Western mine, and a report was written. Inquiries in the district about the property disclosed no new information, and hence the writer did not visit the mine. The following information is taken from the 1943 report.

The Western mine is in the SE1/4 sec. 29, T. 23 S., R. 20 E., near the crest of the ridge on the west side of the north fork of Cave Canyon which is on the southwest flank of the Huachuca Mountains (fig. 10). It is reached by 1 mile of fair road from the Montezuma Pass road to the D'Albini Ranch and 0.5 mile of steep, rough road from the ranch to the mine camp near the forks of the canyon at an altitude of about 6,050 feet. A trail about 1.5 miles long goes up the canyon and finally up the side of the ridge to the mine at about a 7,000-foot altitude.

Ownership and history of the property are not known. In 1943, it was leased to Neel and Kitchen of Phoenix, Ariz.

The ridge on which the mine is situated is underlain by a series of limestones, quartzites, sandstones, and shales of Lower Cretaceous age. One or two diabase dikes were noted. A high ridge of granite, which forms the core of this part of the range, rises behind the mine ridge.

The ore occurs in small lenses of quartz deposited along a low-angle thrust fault that strikes N. 20° E. and dips 33° NW. Crushed material,

16 to 24 inches wide, lies along the fault. The hanging wall is limestone and the footwall is calcareous shale.

An inclined shaft has been sunk along the fault to a depth of about 200 feet, with the inclination flatter than the dip of the vein. Short crosscuts were driven from the shaft to the vein on four levels.

It is reported that a small amount of high-grade silver ore was shipped from this shaft, and that a little copper carbonate ore, mined at the surface, was shipped during the First World War. Pieces of quartz from a small pile of ore in the lowest level contain some silver-bearing galena and a very little chalcopyrite. These pieces showed a considerable amount of scheelite when examined with the violet ray lamp.

Zaleski Claims

The three Zaleski claims are situated in sec. 7, T. 24 S., R. 21 E., at an altitude of about 5,700 feet (fig. 10). To reach the property by road go 17.3 miles southeast from Fry on State Highway 92, turn south on the Montezuma Pass road and go 4.0 miles to the Zaleski ranch, and thence turn northwest onto a dim truck trail and follow it 1.2 miles to an adit.

Not much is known of the early history of these claims. Some high-grade gold ore was mined many years ago. Scheelite was found prior to 1940. In 1941, T. Puryear leased the claims from J. Zaleski and S. Kudznu. No work has been done on the property for several years, and the claims have reverted to the public domain.

There is an adit on the property approximately 80 feet long. Near the portal is an inaccessible shaft of unknown depth.

There is no record of production, but it is thought that a few tons of scheelite ore was mined.

Several quartz veins of northwest strike and steep southwest dip crop out in granite that has been invaded by pegmatite and aplite dikes. The adit shows one of these veins that ranges from a thin streak to about 12 inches in width. The quartz contains sparse, sporadic particles of straw-colored scheelite. It was reported that a very small high-grade pocket of scheelite ore was removed from a narrow vein higher on the mountainside above the adit, but this working was not found.

Arrow Group

The Arrow group of 16 unpatented claims is in approximate sec. 28, T. 22 S., R. 18 E. in Corn Canyon on the western slope of Huachuca Peak, at an altitude of about 6,200 feet (fig. 10). To reach the mine go 10.4 miles north from the Fort Huachuca main gate on State Highway 92 to the junction of State Highway 82. Follow Highway 82 westerly for 10.7 miles to a maintained dirt road and thence go southerly on the Montezuma Pass Road through Elgin and Canelo to a road junction 19.8 miles from Highway 82 and 0.2 mile southerly

from the Canelo store. Follow the southernmost road (Montezuma Pass road) for 2.5 miles to a left-branching road to the Becker and Page Ranches, and thence go 0.2 mile to the Becker Ranch and beyond the ranch 0.6 mile to a dim truck trail branching to the right from the Page Ranch Road. Follow the trail 3.9 miles to Will's Camp. From Will's Camp a jeep trail has been bulldozed 1.2 miles to the mine.

The claims are presently owned by a partnership of Perry, Roberts, Orr, and Anthony of Victorville, Calif.

These claims are relocations of the following two old groups of scheelite claims. The Lucky Day claims were owned for many years by L. L. and W. E. Davis, both deceased, and the East Wind claims were owned in 1934 by J. M. Joiner and J. H. Hogan.

The claims were worked many years ago for gold ore. Foundations of an old mill remain in Corn Canyon. What remains of ore piles and tailing indicates that the milled ore contained appreciable amounts of scheelite. The workings from which this ore was extracted are caved and inaccessible. A small amount of high-grade scheelite ore was produced from the claims prior to 1950. The present owners have taken out about 1 ton of ore, which will assay an estimated 5 percent WO_3.

The area is underlain by a quartzite-limestone-shale series with some intrusive dikes. Fine-grained maroon shale predominates on the lower slopes. Much quartz float from narrow stringers was noted. In 1957, the owners of the claims were working a quartz vein about 10 inches wide along a contact between diorite and a limestone-quartzite-shale series. The vein strikes N. 25° W. and dips 35° to 50° SW. Pockets of rich scheelite ore seem to occur where limestone is encountered. This vein has been explored for about 70 feet along the strike and to a depth of approximately 50 feet. No limit to the mineralization has been reached. The scheelite is scattered sporadically through the quartz. A small amount of galena occurs with the scheelite.

Fort Huachuca Military Reservation

Eldred D. Wilson[12/] mentions scheelite deposits on the military reservation.

Quartz veins, carrying scheelite, occur in limestone from the Emerald group for 2 miles to the northwest in the upper reaches of Tanner Canyon (fig. 10). Other reports indicate that scheelite occurs in secs. 5, 6, 7, 8, and 18, T. 23 S., R. 20 E. on the reservation, as well as in secs. 1 and 12, T. 23 S., R. 19 E.

For a short period during World War I numerous small operators (gambucinos) worked the deposits northwest of the Emerald group. Major Schultz of

12/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 47.

the Provost Marshal's office told the senior author that gambucinos had worked the deposits again in recent years.

Little Dragoon Mountains

The Little Dragoon Mountains lie in northwestern Cochise County. The range is small, about 10 miles long by 7 miles wide. There is both good road and good railroad service to the area, as shown by the location map in figure 15.

Tungsten deposits in the Little Dragoon Mountains were among the first to be worked in this country.. Some production was reported as early as 1898, and sporadic production has been made from that time to the present. Greatest activity occurred during the First World War.

Since most of the production from this range has come from placers and small surface pockets and no records of production have been kept, only a very rough estimate of total production can be made. It is suggested that the underground workings have produced a few thousand units and that the surface cuts and placers have produced perhaps 50,000 units of WO_3.

In the northern part of the Little Dragoons, Paleozoic beds overlie Precambrian schist, and have been invaded by coarse-grained granite. Black tungsten minerals (principally huebnerite) and scheelite occur in quartz veins

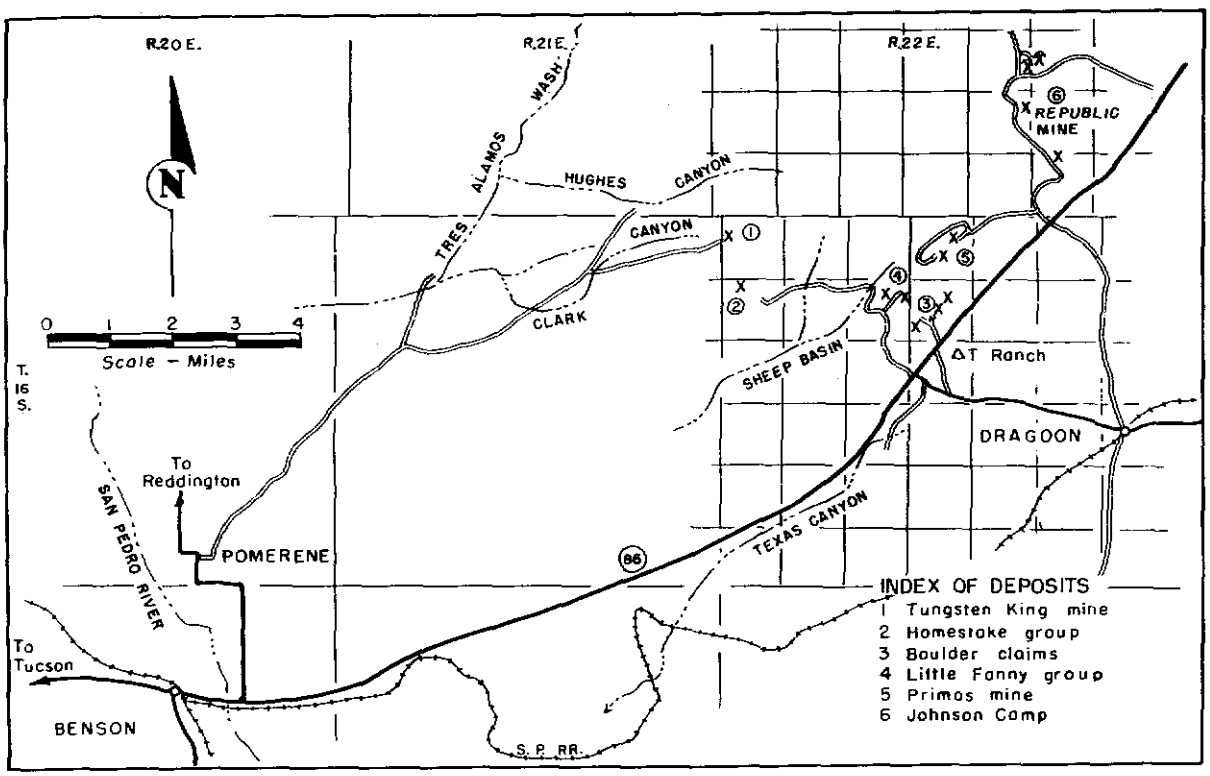

FIGURE 15. - Location Map of Little Dragoon Deposits, Cochise County, Ariz.

in granite, in schist, in Paleozoic limestone, along the granite-schist contact, and in placers. Disseminated scheelite occurs in the contact-metamorphic zone at Johnson Camp.

The ores generally are amenable to simple gravity concentration.

Ore reserves are small. There are indicated reserves of about 1,500 tons and inferred reserves of about 10,000 tons at 0.5 percent WO_3.

Tungsten King Mine

The Black Rock claims, better known as the Tungsten King mine, are situated in sec. 6, T. 16 S., R. 22 E. on Clark Canyon, a drainage on the west side of the Little Dragoon Mountains, at an altitude of about 5,250 feet. The mine may be reached by road by going east on Highway 86 for 1.0 mile from Benson, thence northerly for 3.2 miles to Pomerene, and thence 11.5 miles northeasterly over a crooked dirt road to the mine. The last quarter mile of the road has a 30-percent grade, but it has been capped with concrete and is passable in an ordinary automobile.

The Tungsten King was located in 1913 by J. J. Wien of Benson, Ariz. Wien produced 5 tons of scheelite concentrates during the First World War from surface exposures. The property was purchased in 1929 by Gold, Silver, and Tungsten Co. of Boulder, Colo. A 300-foot adit was driven which intersected the vein at a depth of about 130 feet below the best ore exposed on the outcrop. Very little, if any, production resulted from this work, and the operations were stopped in 1931. The property was not active again until 1937, when Miles M. Carpenter of Tucson, Ariz., secured a lease and produced 800 pounds of concentrates in a small mill. Operations ceased again in 1941. Apparently the property was idle until 1952, when it was acquired by Kramer Mining & Milling Co. This company constructed a small concentrator on the San Pedro River near Pomerene and is reported to have mined and milled about 400 tons of ore, from which about 2,000 pounds of concentrates was recovered. In late 1953, the Standard Tungsten Corp. of Benson, Ariz., acquired the property and produced 2,000 pounds of concentrates from 200 tons of ore. According to S. C. Hu, president of Standard Tungsten Corp., about 6-1/2 tons of concentrates has been sold from the Tungsten King since early 1954.

Originally there were 12 unpatented claims in the group. Now 22 unpatented claims exist. Considerable work has been done on this property, as shown by the mine map (fig. 16).

The Black Rock claims are underlain by Precambrian schist on the east and granite on the west. The granite is intrusive into the schist. At the Tungsten King mine the contact between schist and granite is mineralized fault zone along which there have been repeated movements. The contact zone strikes northerly and dips easterly 45° to 50°. Lamprophyre dikes and quartz veins crop out intermittently for several thousand feet along the contact zone.

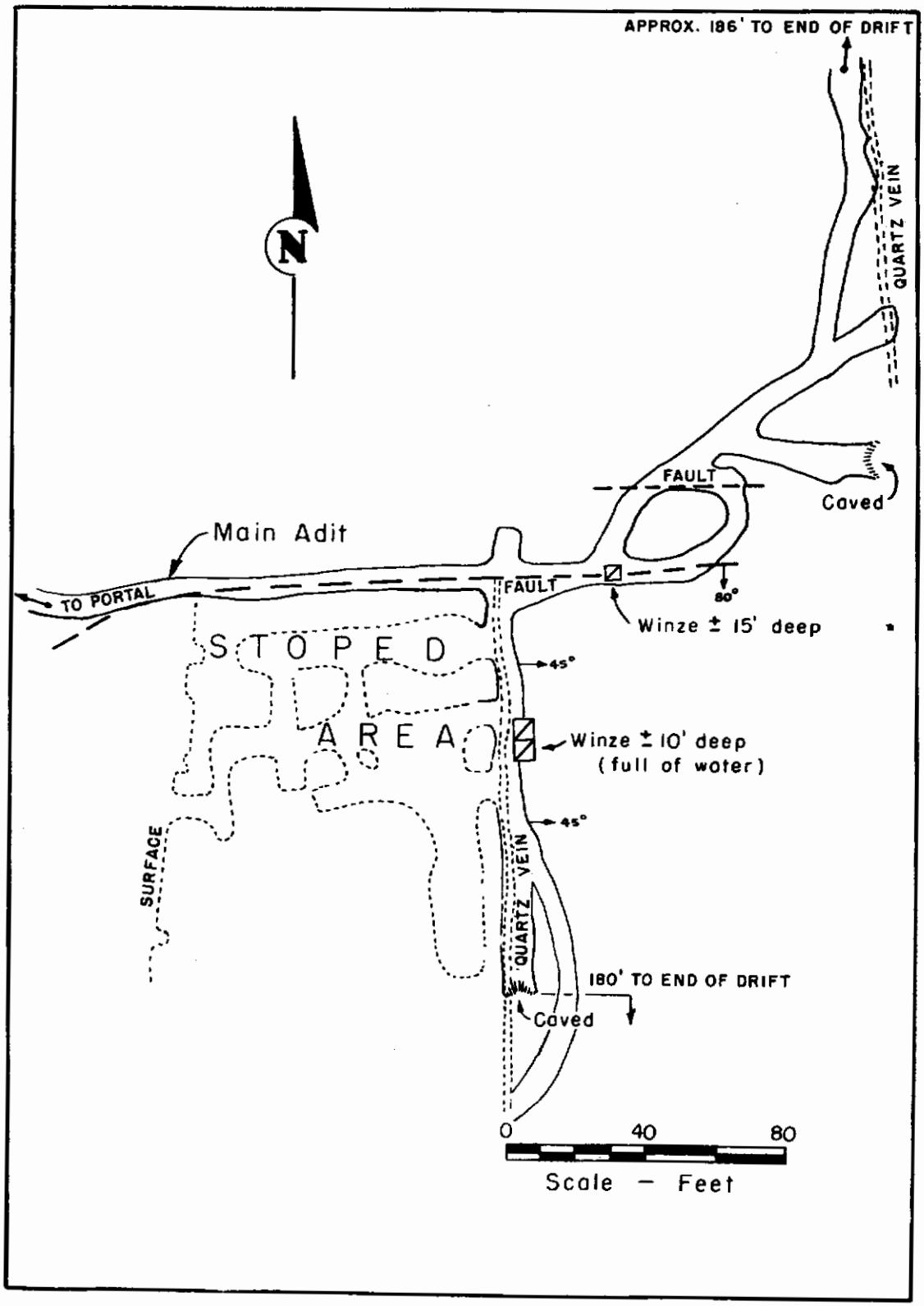

FIGURE 16. - Tungsten King Mine, Little Dragoon Mountains.

Wilson[13] states in part:

> These veins form eastward-dipping lenticular segments from a few inches to 6 feet wide and locally several hundred feet long, which have been offset in places by faults. Their coarsely crystalline, dull-white quartz contains a little pyrite, chalcopyrite, and galena, and, where oxidized, sparse iron oxide, copper stain, and wulfenite. Scheelite, generally detectable only by panning or by short-wave ultraviolet light, occurs as irregularly distributed small particles at various places in the vein and to a minor extent in the adjacent walls.

In the stope that has produced most of the ore, just south of the main adit, it appears that about 50 percent of the ore was of minable width and grade. Production records and sampling results from two Bureau examinations (in 1940 and 1941) show that the grade of ore, where mined, averaged from about 0.3 to 0.6 percent WO_3.

A 335-foot adit was driven easterly through a contact zone along which the quartz-scheelite vein was formed. A drift, with a stope above it, explored the vein about 180 feet south of the adit. Faulted segments of the vein have been explored by drifts and crosscuts for about 260 feet north of the adit (fig. 16). On the surface there are several shallow shafts, opencuts, and short adits.

Standard Tungsten Mill at Pomerene, Ariz.

The Standard Tungsten Corp. mill is 0.5 mile west of Pomerene, Ariz., on the east bank of the San Pedro River.

The mill has a 30-ton primary-ore bin, a 1,000-ton coarse-ore bin, and a 70-ton fine-ore bin. The crushing unit consists of a jaw crusher (9 by 36 inches) and a set of rolls (16 by 16 inches). A two deck screen is placed between the crusher and rolls, and a second screen is located below the rolls. The concentrating unit consists of a classifier, two sand tables, a slime table, a scalping jig, and a sludge pump, which returns middlings to the classifier. There is no grinding unit in the concentrating circuit.

According to S. C. Hu, president of Standard Tungsten Corp., the mill has produced about 41,842 pounds of concentrates. It is reported that some of the tailings have been stockpiled for further treatment. This reported production has come from the Tungsten King mine in the Little Dragoon Mountains, the Silver Hill mine in the Chiricahua Mountains, the Lucky Strike mine in the Huachuca Mountains, the Taylor group of claims in the Santa Catalina Mountains, the Black Prince claims in the Dragoon Mountains, the Evening Star group in the Whetstone Mountains, and the Baker Standard mine in western New Mexico.

13/ Work cited in footnote 12 (p. 41), p. 43.

Primos Group

The Primos group of 21 patented claims is in sec. 3, T. 16 S., R. 22 E. on the south end of the Little Dragoon Mountains at an altitude of approximately 5,350 feet. There is a good road to the property. From Benson, go 16.8 miles east on Highway 86 to the old Johnson Camp road and thence 0.2 mile northerly to a fork in the road. Take the left fork and go westerly 0.3 mile to another fork in the road; the right fork of this road winds around and up Bluebird Hill to the main workings, a distance of 0.9 mile.

This group of claims has been held by the Primos Chemical Co. since 1903 and has been extensively worked. A gravity mill of 5-tons-per-hour capacity was built in 1915 and operated during the First World War.

There is no complete record of production, but it is estimated that the Primos property has produced several thousand units of WO_3. The few remaining records of shipments indicate that the concentrates ran between 60 and 70 percent WO_3.

In 1940, some 32 lessees were working on the property. In 1943, Elmer Walker, a lessee, had built a small plant to mill dump material. Ray Fernstrom (deceased) worked the property from 1948 to 1953 under a bond and lease. In March 1953, Elmer Walker again leased the property and produced about 2,500 pounds of concentrates during 1953-54. Very little work has been done on the property since 1954.

Principal workings on Bluebird Hill include about 1,500 feet of drifts, 400 feet of crosscuts, several winzes and raises, and stopes from which several thousand tons of ore have been removed. Bluebird Hill and the surrounding terrain have numerous shallow opencuts and trenches (fig. 17).

Granite has been broken by fissures striking northwest, north, and northeast. The northeast fissures carry tungsten-bearing quartz. These fissures strike generally N. 30° E. and dip generally 50° SE. The veins are narrow and irregular in width and occur in a belt about 600 feet wide. They often pinch out along the strike and branch into tiny stringers. They appear to narrow with depth. A winze, sunk on one of the larger veins from an adit about 50 feet below the crest of the ridge, shows that the vein pinches from 2 feet in the tunnel down to 1 inch at a depth of 15 feet below the tunnel level. The average width of stoped ore was probably about 6 or 8 inches.

Huebnerite is the most common tungsten mineral. Its crystals are often rimmed and cut by fine-grained scheelite. The ultraviolet light shows occasional scheelite crystals in granite near the vein. Pyrite and chalcopyrite occur in small amounts. Huebnerite is distributed sporadically through the quartz, although much of the quartz is barren. Locally, rich huebnerite ore occurs in pockets and streaks.

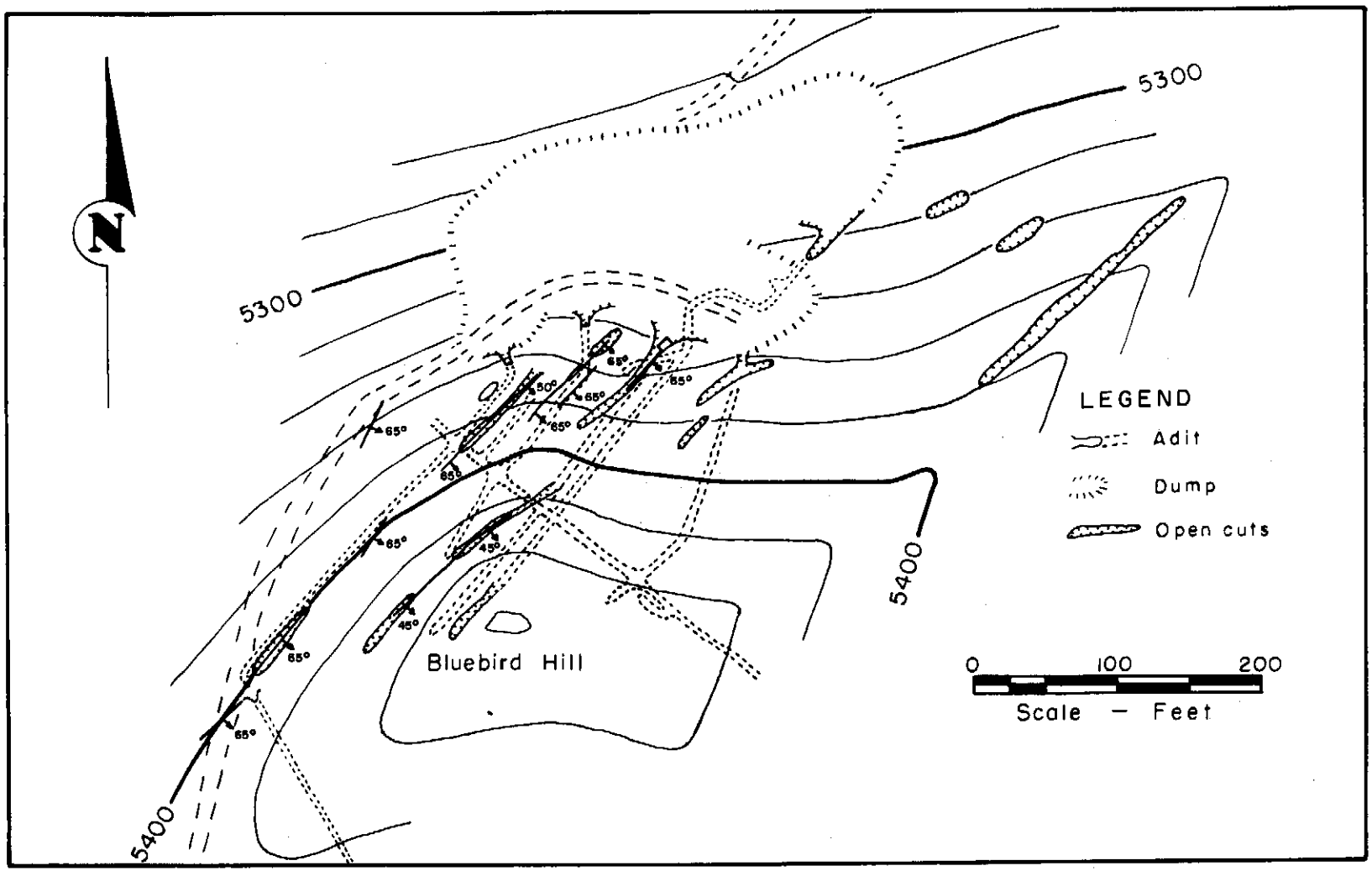

FIGURE 17. - Primos Mine, Little Dragoon Mountains.

Little Fanny Group

The Little Fanny group of 14 unpatented mining claims formerly adjoined the Primos ground on the southwest. Today only one claim exists over the main workings of the old group. The property is in sec. 9, T. 16 S., R. 22 E. at an altitude of about 5,000 feet. It lies on a patented homestead. To reach the property by road, go 13.6 miles easterly from Benson on Highway 86, and thence northerly on a dirt road for 1.7 miles to the main workings of the Fanny group. Wilson[14/] gives some history of the property:

> These claims were actively worked during the World War. During 1934-38, lessees are reported to have produced 55,000 pounds of concentrates from them. Development consists of extensive surface workings and also some 1,600 or more feet of adit tunnels. The group was acquired by the Dragoon Mining Corporation in 1938. Production by this company and by lessees from June, 1937, to October, 1939, amounted to approximately 8,000 pounds of concentrates.

The property was idle from 1941 to 1945 when Mat Lee, Dragoon, Ariz., located several claims of the group and put lessees to work for about 3 months. About 500 or 600 pounds of concentrates was produced. The property again was idle until 1948 when Joe Robles, Tombstone, Ariz., relocated five claims and started mining remnants of high-grade pockets and picking up float and high-grade rejects on dumps. It is reported that Robles sold about 1,000 pounds of tungsten concentrates from the property.

Apparently Robles let the property go delinquent for in 1955 or 1956 Dick Glenn, Benson, Ariz., located the Last Chance claim over the main workings of the group. He has made no production from the claim.

Geology on the Little Fanny group is very little different from that at the Primos property. Quartz is less abundant, and fractures with strikes from north-south to N. 30° E. are more prominent. Very little ore is visible in the tunnels; the stopes are nearly all caved. Figure 18 is a map of the workings when they were accessible, made during a Bureau examination in 1940.

The belt containing the ore is about 150 feet wide. The strongest mineralization, ascertained from the old workings, appears to be limited to about 1,200 feet of length. The quartz veins are of irregular width, varying from 1/2 to 18 inches, with perhaps 4 to 6 inches as an average width.

The ore minerals are huebnerite and a small amount of scheelite; other minerals present are fluorite and a little pyrite and galena.

Boulder Claims

Two claims, Boulder No. 1 and Boulder No. 2, have been relocated over part of the old Hawk group of five claims and the old Hillside group of four claims. The property is in sec. 10, T. 16 S., R. 22 E. at an altitude of

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14/ Work cited in footnote 12, p. 41

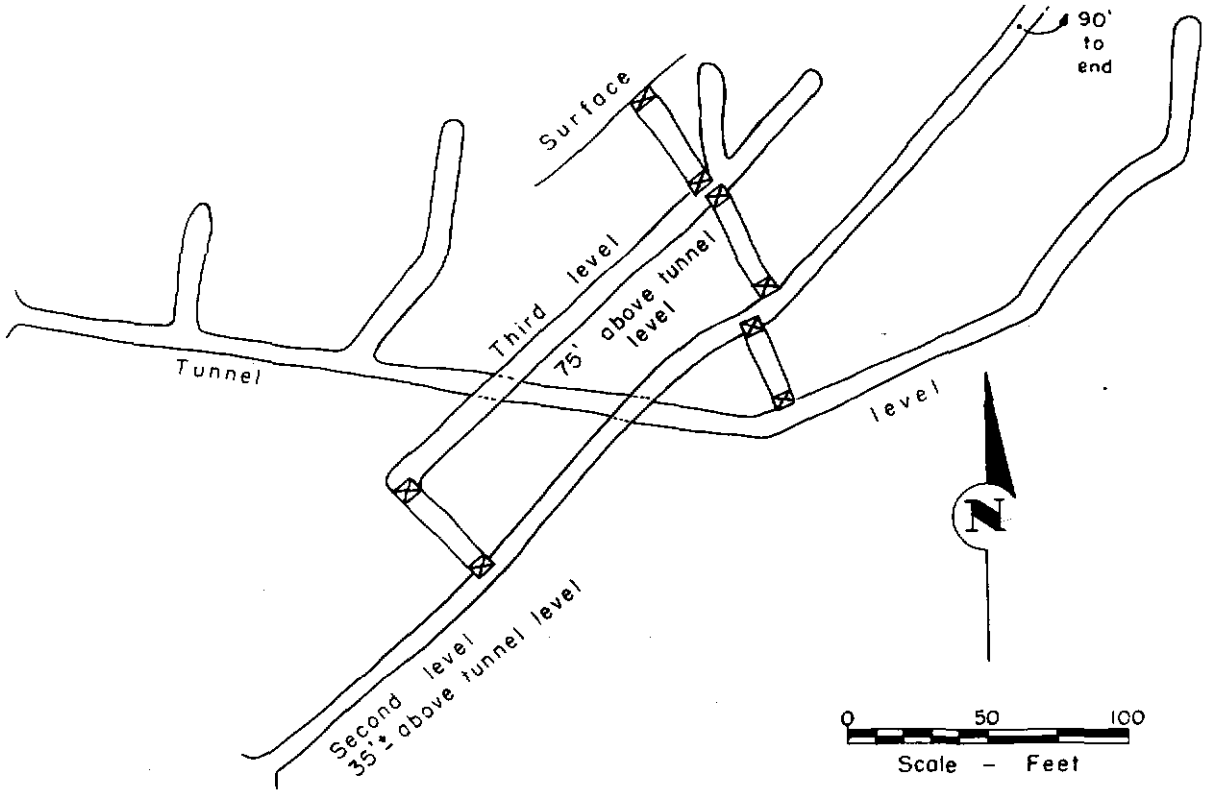

FIGURE 18. - Sketch Map of Little Fanny Mine, Little Dragoon Mountains.

about 4,850 feet, and lies on a patented homestead. The claims are reached by traveling eastward from Benson for 14.0 miles on Highway 86, thence southerly 0.1 mile to a road that turns northerly through a bridge beneath Highway 86, and thence 0.6 mile to the mine.

Wilson[15/] states:

> When visited in January, 1940 they (The Hawk and Hillside group groups) were held by J. J. Wien who states that they were located in 1898 by Asa Walker and worked by P. M. Sebring during the World War. Developments consist of a series of shallow cuts and short adits distributed over a length of 4,500 feet. According to Mr. Wien, production from 1933 through 1939 amounted to about 5 tons of concentrates and lessees were producing 500 pounds of concentrates per week in January, 1940.

In April 1954, J. J. Wien in an interview with T. M. Romslo, Bureau engineer, reported that about 10 tons of concentrates assaying 67 percent WO_3 was produced from 1940 to 1949. From assessment work for the years 1949 to

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15/ Work cited in footnote 12 (p. 41), p. 43.

1954, about 400 pounds of concentrates was produced that assayed from 60 to 70 percent WO_3.

About 1955 or 1956, Zabel, Knott, Knott, and Williams purchased the two claims from Wien. Only a few pounds of concentrates has been produced since they bought the property.

The geology is essentially the same as that found on the Primos property about one-half mile to the northeast. Narrow, discontinuous quartz veins occur in muscovite granite. The principal veins occur in a belt about 100 feet wide and approximately 3,000 feet long. They range in width from mere fractures to 12 inches, strike N. 30° to 50° E., and dip steeply southeast. No accessible opeining into the veins is more than 75 feet from the surface. The principal ore mineral is huebnerite with small amounts of scheelite, occurring sporadically and locally within the quartz. Small amounts of pyrite were noted.

Burrell Claim

Inquiries in the area indicated that little work had been done on these claims since 1942; hence the claims were not visited by the writer. For historical reasons a 1941 report by Eldred Wilson[16/] is included here.

> The Gilbert claims, in 1940 held by the Burrell brothers and worked by B. E. Gilbert, are 1.5 miles by road west of Dragoon and a short distance north of the Southern Pacific Railway.
>
> These claims were originally located for copper. During the World War about 100 pounds of tungsten ore were shipped from an old dump on the property. Up to December, 1940, the present operator had shipped approximately $1,500 worth of hand-sorted ore.
>
> This area is a pediment, largely covered by alluvium, at the southeastern base of the Little Dragoon Mountains. A small outcrop of Paleozoic limestone is cut by narrow altered dark porphyry dikes of N. 30° E. strike and by a quartz vein that strikes N. 50° E. and dips 80° NW. The outcrop of this vein is 4 to 12 inches wide and traceable for a length of about 200 feet. When visited early in 1940, it had been opened by surface cuts, a 40-foot shaft, and some 50 feet of drifts. As shown by these workings, the vein consists of coarsely crystalline grayish-white quartz, together with some lime and iron carbonates and irregular particles of straw-colored scheelite. In the western portion lead and copper sulphides and carbonates are locally abundant; here some of the scheelite has partially altered to cuprotungstite.

16/ Work cited in footnote 12 (p. 41), p. 44.

Homestake Group

Another property not visited by the writer is the Homestake group. An account by Wilson[17] follows:

> Across the ridge southeast of the Tungsten King ground is the Homestake group of four unpatented claims. This area is accessible by a mile of trail from the end of 4 miles of rough road that branches northwestward from the Willcox highway at the school house, 15 miles east of Benson. These claims were located about 1930 by J. J. Wien and the late A. H. Yaegley. When visited in October 1939, they were held by R. C. Wise
>
> Here the prevailing rock is pre-Cambrian schist of northeastward strike and steep northwestward dip, intruded about 1/2 mile farther south by granite.
>
> At various places fissures parallel to the schistosity, have been mineralized for widths of a few inches to a foot with quartz epidote, and disseminations of scheelite. A little gold and oxidized copper minerals are locally present.
>
> These veins have been opened by a few shallow cuts, short adits, and shallow shafts.

Johnson Camp

At Johnson Camp, tactite bodies 2 miles long and 50 feet thick, containing ore pockets across 300 feet, were reported in 1918 by E. S. Larsen.[18] Some scheelite occurs in the tactite.

Johnson Camp is in the eastern foothills of the Little Dragoon Mountains in secs. 23, 24, 25, and 26, T. 15 S., R. 22 E., at an altitude of about 5,000 feet.

The following history, production, and geology were abstracted from a recent report[19] of this property.

Copper ore was discovered in the Johnson Camp area before 1881. The ore deposits were worked intermittently and by several companies from 1882 to 1920. Mines in the district were closed from 1920 to 1941 because of the low price of copper. Copper-zinc ore was shipped from the Republic mine in 1941 and

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17/ Work cited in footnote 12 (p. 41), p. 44.

18/ Hess, F. L., and Larsen, E. S., Contact-Metamorphic Tungsten Deposits of the United States: Geol. Survey Bull. 725-d, 1922, p. 260.

19/ Hardwick, W. R., and Sierakoski, J., Mining Methods and Practices at the Johnson Camp Copper-Zinc Mine, Coronado Copper & Zinc Co., Cochise County, Ariz.: Bureau of Mines Inf. Circ. 7788, 1957, pp. 1-5.

1942. In 1942, the Coronado Copper & Zinc Co. obtained a lease and option on the property, and later purchased the consolidated property from Roy Wilson and Samuel Traylor. After proving a substantial amount of ore, the Coronado company erected a 150-ton flotation plant that was completed in 1945. Since that date the company has been producing copper-zinc ore, making a copper concentrate and a zinc concentrate, except for about a year from 1949 to 1950, when the mine was closed because of the low price of zinc.

Total production from the Johnson Camp area to the end of 1955 was approximately 53,473,400 pounds of copper and 60,205,500 pounds of zinc, with some lead and silver.

The ore bodies in the Johnson Camp area occur in limestone beds in the lower part of a thick Paleozoic section; these beds dip 20° to 45° NE. The Cambrian Abrigo limestone is the most productive formation, with the Pennsylvanian Naco limestone second. The ore bodies occur at or near the intersection of mineralized fractures with these beds and along anticlinal flexures in the beds. Some ore bodies are irregular tabular deposits parallel to the beds, 3 to 15 feet thick, and several hundred feet across. The largest ore bodies are chimney type and more or less oval in cross section.

The primary ore consits of varying amounts of chalcopyrite, sphalerite, and bornite, with pyrite and small amounts of molybdenite and scheelite. The gangue is composed of lime-silicates (mostly garnet, diopside, and epidote), potash feldspar, quartz, and calcite.

In 1952, the company made a study of the low-grade scheelite mineralization in the tailing dump at the Republic mill. Assays were made of 6-month tailing-composite samples from March 1946 to December 1951. The individual assays ran from 0.14 to 0.08 percent WO_3. The average was 0.10 percent WO_3.

Preliminary test work indicated that it was possible to obtain a flotation recovery of 80 percent of the WO_3 at a concentration ratio of 20:1 and a concentrate grade of 1.38 percent WO_3.

In June 1957, large samples were cut from the tailing dump with a 4-inch auger for metallurgical testing purposes. Wet tabling and flotation tests were made on a composite of three auger samples to determine the grade and recovery of tungsten concentrate that could be obtained. The sample weighed about 250 pounds and assayed 0.11 percent WO_3, 0.25 percent Zn, and 0.10 percent Cu. The sample contained scheelite associated with epidote, calcite, garnet, diopside, quartz, and pyrite. About 65 percent of the scheelite was finer than 325-mesh.

The impounded tailing sample was pulped and tabled, but because of the extreme fineness of the scheelite only a small quantity was recovered. The table concentrate assayed 0.39 percent WO_3 and accounted for a tungsten recovery of only 5 percent. In view of the poor results obtained by tabling, no other method of gravity concentration was investigated.

A number of selective flotation tests were made on the impounded tailing sample to determine the best procedure for recovering the scheelite. Optimum results were obtained by floating the pyrite with xanthate collector followed by flotation of the scheelite with fatty acid. Preliminary to the flotation step, mild attrition scrubbing and washing of the tailing to a pH of about 8 was necessary to remove the soluble calcium hydroxide that had been added to the milling step to retard the pyrite during copper-zinc flotation. About 80 percent of the scheelite was recovered in a rougher concentrate assaying 1.60 percent WO_3. In another test, a rougher concentrate assaying 2.78 percent WO_3 was obtained, but the recovery dropped to 47 percent. The pyrite froths produced in the different tests assayed about 0.004 percent WO_3 and accounted for tungsten losses of less than 0.5 percent. The grade of the scheelite concentrate was low because of the presence of calcite, eipdote, and residual pyrite, which persisted in floating with the scheelite.

In a typical test, the pyrite was floated at a pH of 8.3 using 0.6 pound of Na_2S per ton of dry tailing as an activator; the collector and frother requirements per ton of tailing were 0.16 pound of potassium amyl xanthate, 0.16 pound of mercaptobenzothiazole, and 0.04 pound of pine oil. After removal of the pyrite, the flotation pulp was conditioned with 6.0 pounds of soda ash, 3.0 pounds of sodium silicate, and 0.2 pound per ton of quebracho. The scheelite was floated from a dispersed pulp at a pH of 9.5; 1.5 pounds of oleic acid was used per ton of tailing.

Cleaning tests on rougher flotation concentrates were not made because of the small amount of froth available. It is doubtful, however, that products assaying higher than 20 percent WO_3 could be produced. A combination method of flotation and some means of hydrometallurgical treatment probably would be required to obtain good recovery of a marketable-grade scheelite product from the Johnson Camp impounded tailing.

Placers

Tungsten placer deposits occur from Sheep Canyon to Texas Canyon on the southern and southwestern parts of the Little Dragoons, and on the western foothill pediment. Many thousands of pounds of black tungsten and some scheelite were produced before 1919. The more important placers were derived from quartz veins in the granite area, where rich fragments and boulders of float were gathered.

Various attempts have been made to work the placers on a large scale.[20/]

Whetstone Mountains

The Whetstone Mountains are in west-central Cochise County, Ariz.

Scheelite occurrences on the east-central side of the range are accessible from San Juan, a siding on the Tucson-Douglas branch of the Southern

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20/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 45.

Pacific Railroad. Black tungsten minerals with small amounts of scheelite occur in narrow quartz veins running through granite near contacts of the granite with Pinal schist on the east and Paleozoic sediments on the south.

Production records of the Whetstone deposits are not available. It is doubtful if more than 1,000 units of WO_3 was produced.

There is no measurable ore in the mines today. The indicated reserves are small and inferred reserves probably will not exceed 1,000 tons of ore at 0.5 percent WO_3.

Chadwick Claims

The Houston and the East Evening Star and West Evening Star claims have been located over the old Chadwick claims. They are in sec. 26, T. 18 S., R. 19 E. at an altitude of about 5,300 feet. The claims are along the north side of Middle Canyon about 1 mile southeast of McGrew Spring on the east side of the Whetstone Mountains, Coronado National Forest. The mine is reached by traveling 5.5 miles southerly on U. S. Highway 80 from the junction of U. S. Highway 80 and State Highway 86 at Benson to the Apache Powder Plant road, thence 1.0 mile southwesterly on a paved highway to the Middle Canyon road, thence 3.0 miles southwesterly on a dirt road to the San Juan siding on the Southern Pacific Railroad, and thence 2.3 miles westerly on a dirt road to a narrow truck trail. Follow the trail southwesterly 3.5 miles to a fork in the road. The mine is located 0.3 mile northwest of this fork (fig. 19).

Present ownership of the old workings is in litigation. Both Standard Tungsten Corp. and McDaniel, James, Drake, and Fry located claims in the area. Standard Tungsten Corp. has held the rights to a group of 22 claims known as the East Evening Star and West Evening Star claims since 1954, according to S. C. Hu, president. McDaniel, James, Drake, and Fry located the Houston No. 1 claim over most of the eastern portion of the old workings on March 16, 1955. They staked out a block of nine claims, four of which overlap with the southeastern portion of the East Evening Star claims, according to Hu. So far as is known, no production has been made by either party.

The Chadwick claims were worked prior to 1909 and had yielded a few tons of concentrate.[21] A considerable amount of work was done during the First World War. Dewey Chadwick, (deceased) and associates acquired the claims before 1939. Chadwick built a small gravity mill on the property. The date that Chadwick quit working the deposit is not known. The production record is not known, but production was small. It is estimated that 60 to 80 units of WO_3 was mined and milled during 1943-44.

In 1952, Minerals Development Corp. leased and optioned to buy claims. After trenching, sampling, and mapping the property the corporation released its option.

21/ Hess, F. L., Note on a Wolframite Deposit in the Whetstone Mountains, Ariz.: Geol. Survey Bull. 380, 1909, pp. 164-165.

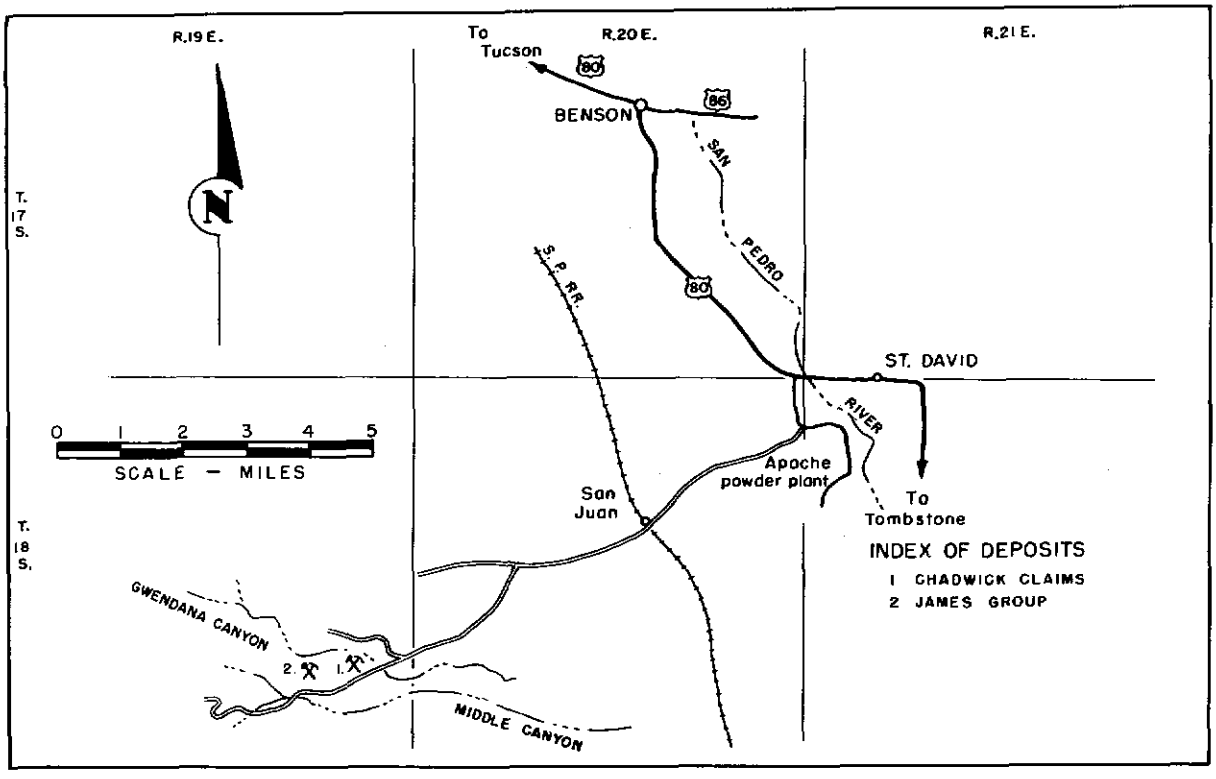

FIGURE 19. - Location Map of Whetstone Mountains Deposits.

In 1953, Del Webb Construction Co. built a road on the property, excavated some open pits, and shipped 3 carloads of ore to the Hillside tungsten mill, according to J. M. Wilson, St. David, Ariz. The ore did not pay its way, so Webb released his option on the property.

Quartz veins that strike S. 60° to 80° W. and dip 70° to 30° NW. occur in medium-grained muscovite granite. The granite is in contact with Precambrian schist along Middle Canyon a short distance south of the quartz veins. The veins range in width from a few inches to 2 feet and are traceable for several hundred feet along the south side of a high ridge of granite.

James (Nunnelley) Claims

The Nunnelley claims have been relocated and are now called the Ricky Dale claims, owned by George R. James, Dragoon, Ariz.

The claims are in sec. 26, T. 18 S., R. 19 E. at an altitude of about 5,500 feet. They lie on the north side of a ridge between Middle and Gwendana Canyons on the east side of the Whetstone Mountains, Coronado National Forest. The property may be reached by walking on a road impassable for cars up Gwendana Canyon about 1.2 miles westerly from the old Chadwick millsite on the Houston claims (fig. 19).

Little of the early history of these claims is known. E. C. Nunnelley (deceased) owned them prior to 1943. In 1943, two men named Hill and Graybill were mining and sorting about 200 pounds per shift of tungsten ore that assayed plus 2 percent WO_3. The ore was packed 1 mile on burros and then hauled 9.3 miles to Nunnelley's mill on the west bank of the San Pedro River just south of the highway bridge about 0.75 mile west of St. David, Ariz. Several hundred pounds of concentrates was produced during 1943 and 1944. Nunnelley's mill was a small, simple gravity plant.

Nunnelley died about 1945, and the claims have been relocated several times. The date that James relocated the claims is not known.

The mine workings are on the east side of a steep gulch that comes down from the south where the course of Gwendana Canyon changes from south to east about 1.25 miles above its mouth. A medium-grained muscovite granite contacts a tongue of Precambrian schist in this gulch (Also seen in this area were biotite-muscovite granite and pegmatite). The ore occurs in several narrow quartz veins in the muscovite granite a short distance east of the granite-schist contact. The veins are very narrow and can be traced by outcrops for a few hundred feet. The ore mineral is principally wolframite with small amounts of scheelite. This deposit appears to ba an extension of the deposit on the Chadwick claims.

Evening Star Claims

Tungsten claims were located a short distance west of the Chadwick and Nunnelley groups in 1937. This property has not been investigated recently, but it is included here for historical reasons. Eldred Wilson[22/] examined this prospect in January 1940, and his description follows:

> The Evening Star group of five unpatented claims, held since 1937 by J. Christie, is accessible by 2 miles of road that leads west from Chadwick's claims.
>
> This property was worked in a small way during the (first) World War and has yielded a few thousand pounds of tungsten ore since 1937.
>
> The principal veins are in schist on the northern flank of an eastward-draining canyon, some 400 feet above camp. This schist strikes N. 10° W., dips 80° SE., and is intruded on the southeast by granite. Trending N. 20° to 30° E. through the granite and schist are several pegmatite dikes up to 15 or more feet wide. Quartz stringers in the pegmatite and other quartz stringers of N. 10° E. and N. 45° W. strike carry a little wolframite. Some of these stringers intersect the main vein, which strikes N. 50° E., dips 30° NW., and ranges from 5 inches to about 2 feet in thickness. This vein shows tungsten mineralization at several places within a length of 300 feet. When visited in January, 1940, it had been

22/ Work cited in footnote 20 (p. 53), p. 46.

opened by several shallow cuts and a 32-foot incline. It consists of coarsely crystalline grayish-white quartz with small scattered particles of wolframite, iron oxide, and pyrite. Mr. Christie states that a few feet below the collar of the incline the vein contained from 1.5 to 1.9 percent WO_3.

The wall rocks of the vein and of the quartz stringers have been strongly sericitized.

Dragoon Mountains

Black Prince and Johnnie Boy Group

The Black Prince and Johnnie Boy group of nine unpatented lode claims is in secs. 13, 14, 23, and 24, T. 18 S., R. 23 E., at an elevation of about 5,300 feet. The claims are situated on the west drainage of the Dragoon Mountains about 1 mile north of the west point of Black Diamond Peak. The property may be reached by road from Tombstone. Go northerly from Tombstone 1.8 miles on U. S. Highway 80 to the Pearce road via Middlemarch Canyon. Follow the Pearce road northeasterly for 13.4 miles and thence drive northerly on a dim truck trail 0.2 mile to the end of the trail at the mine workings (fig. 20).

Little is known of the history and production record of this property. In 1950, John F. Kreis was interested in the Johnnie Boy group. In July 1953, Standard Tungsten Corp. leased five mining claims and located or bought four additional claims. According to S. C. Hu, president, about 1.5 tons of concentrates was sold from ore taken from the Black Prince by contractors and lessees.

The area is underlain by a series of limestones and quartzites. Harquilla limestone overlies Escabrosa limestone. There also is Bolsa quartzite and Abrigo limestone in the area. Quartz monzonite shows about 0.75 mile to the southeast.[23/]

A shallow cut has been made along a fault contact where intense alteration of the limestone has taken place. The fault strikes N. 45° E. and dips 67° SE. There has been much shearing action. Along the fault are sparse copper and iron oxides. Straw-colored coarse-grained scheelite occurs sporadically in the silicated limestone for at least 8 feet north of the fault (This is the width of the cut). The area surrounding the cut is covered with alluvium, so the extent of the deposit is not known.

Two shallow shafts have been sunk on a shear in the limestone about 150 feet and 250 feet northeast of the cut, respectively. Copper and iron oxides and scheelite occur along the shear plane, which strikes northerly and dips about 55° E.

23/ Gilluly, J., General Geology of Central Cochise County, Ariz.: Geol. Survey Prof. Paper 281, 1956, 169 pp.

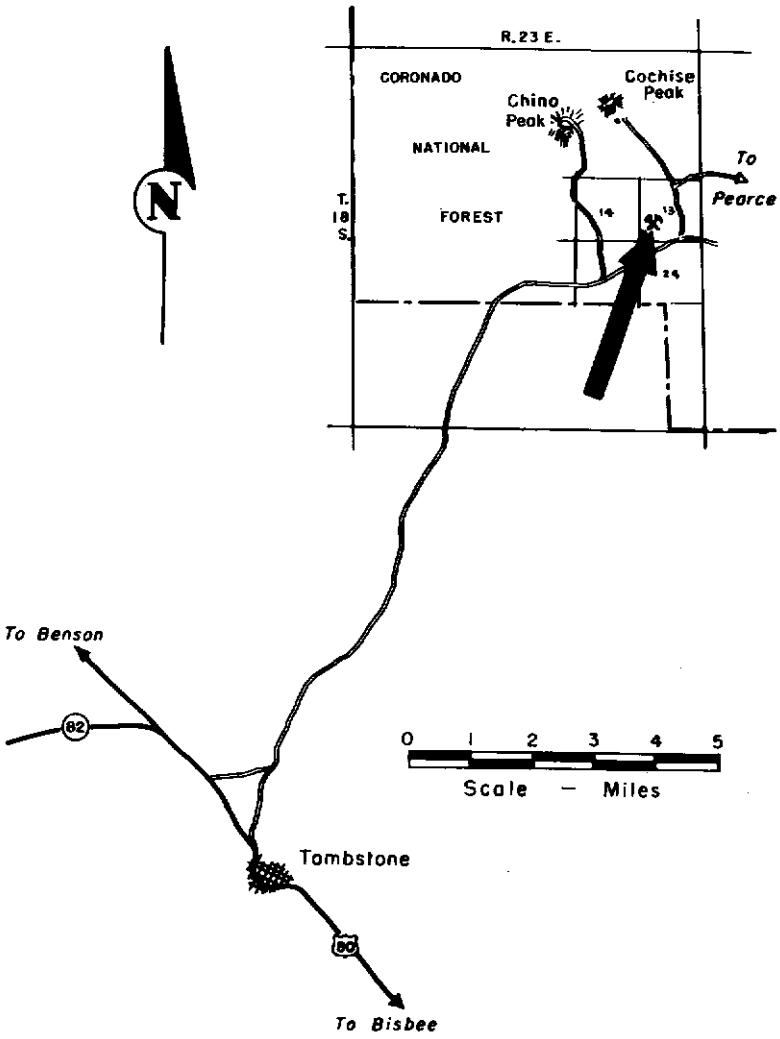

FIGURE 20. - Location Map of Black Prince and Johnnie Boy Group, Dragoon Mountains.

Not enough of the scheelite deposit showed to warrant sampling.

Figure 21 is a sketch map of the claims showing major faults and scheelite mineralization.

Swisshelm Mountains

Big Four and Valley View Claims

During the couse of this investigation, 2 days were spent in an unsuccessful attempt to locate this group of claims. The location and early history of the claims, and the mine workings, geology, and sample results are abstracted from an unpublished 1942 report by the Bureau.

The property is situated in the Swisshelm Mountains about 8 miles east of Elfrida, Ariz. The Big Four claims cover the top and east side of the ridge on a spur of the mountains. The Valley View claims are on the western slope of the same ridge and overlook the Sulphur Springs Valley.

There is a good road east from Elfrida for 4 miles. From there the road is fair for 3 miles to the foothills of the range. A road has been graded 1.5 miles farther to the lower workings of the property. This is in need of repair but could be put in serviceable condition with a small amount of work.

These claims first were located about 1890 by a man named Paiser, who prospected them for copper and drove the No. 1 adit. Several other short adits, opencuts, and shallow shafts also were dug by Paiser in his search for copper. In 1914 a group of men acquired the property, drove No. 2 adit, and built the road. The claims then were abandoned for years. They were relocated in 1942 by Theodore Williamson after he had discovered the presence of scheelite. Williamson held the property until his death in 1948. The claims

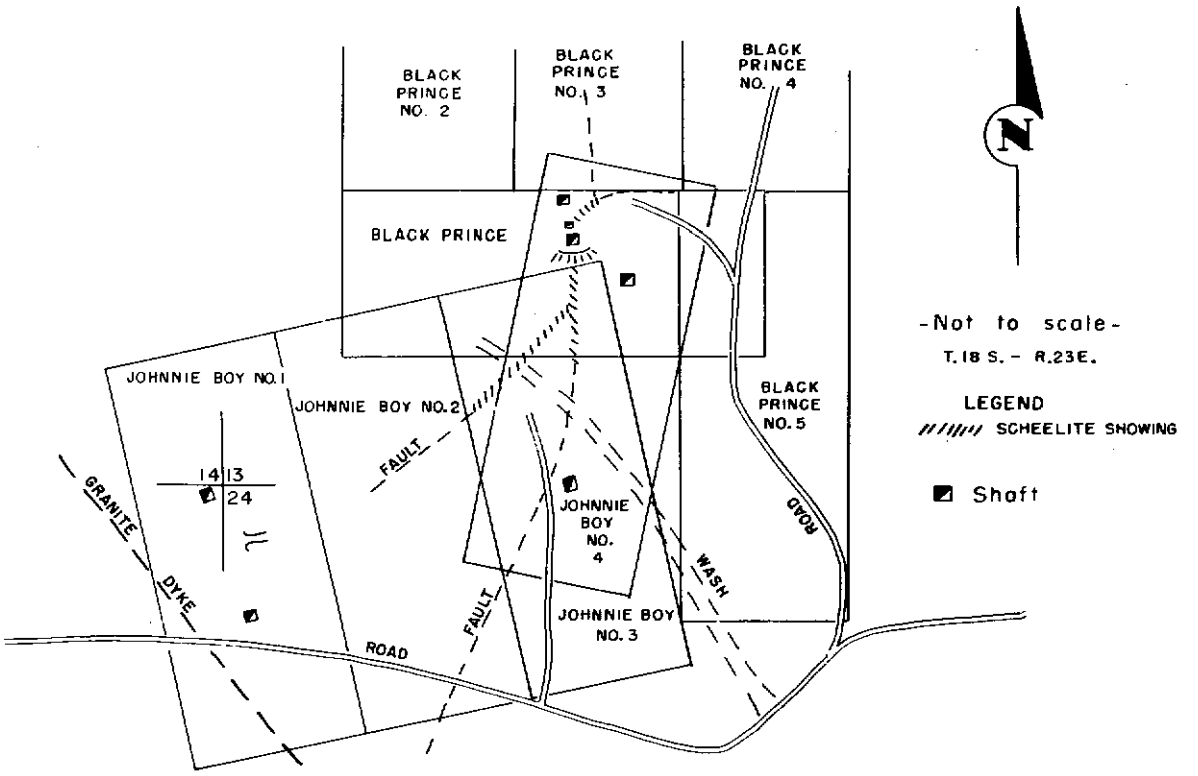

FIGURE 21. - Black Prince and Johnnie Boy Claims, Dragoon Mountains.

were relocated again in 1949 and held until 1952 by an unknown party. In October 1953, Claude Hampton relocated them.

There is no available production record, and it is doubtful if any ore has been shipped from the property.

No. 1 adit is 347 feet long, and other branching drifts total 277 feet in length. This adit has cut 44 feet of the ore body. No. 2 adit is 500 feet long, but it did not cut the ore zone although the face has passed the point vertically beneath the outcrop. The last 5 feet of the adit is in diorite (fig 22).

An intrusion of monzonite has uplifted and broken the limestone and shales, and effected extensive metamorphism along contacts with blocks of the sedimentary rocks. The tungsten occurs in the contact zones as scheelite, which is evenly distributed in the hard, siliceous, garnet-bearing rock. There are several outcrops of this material, which vary from a few inches to 30 feet in width.

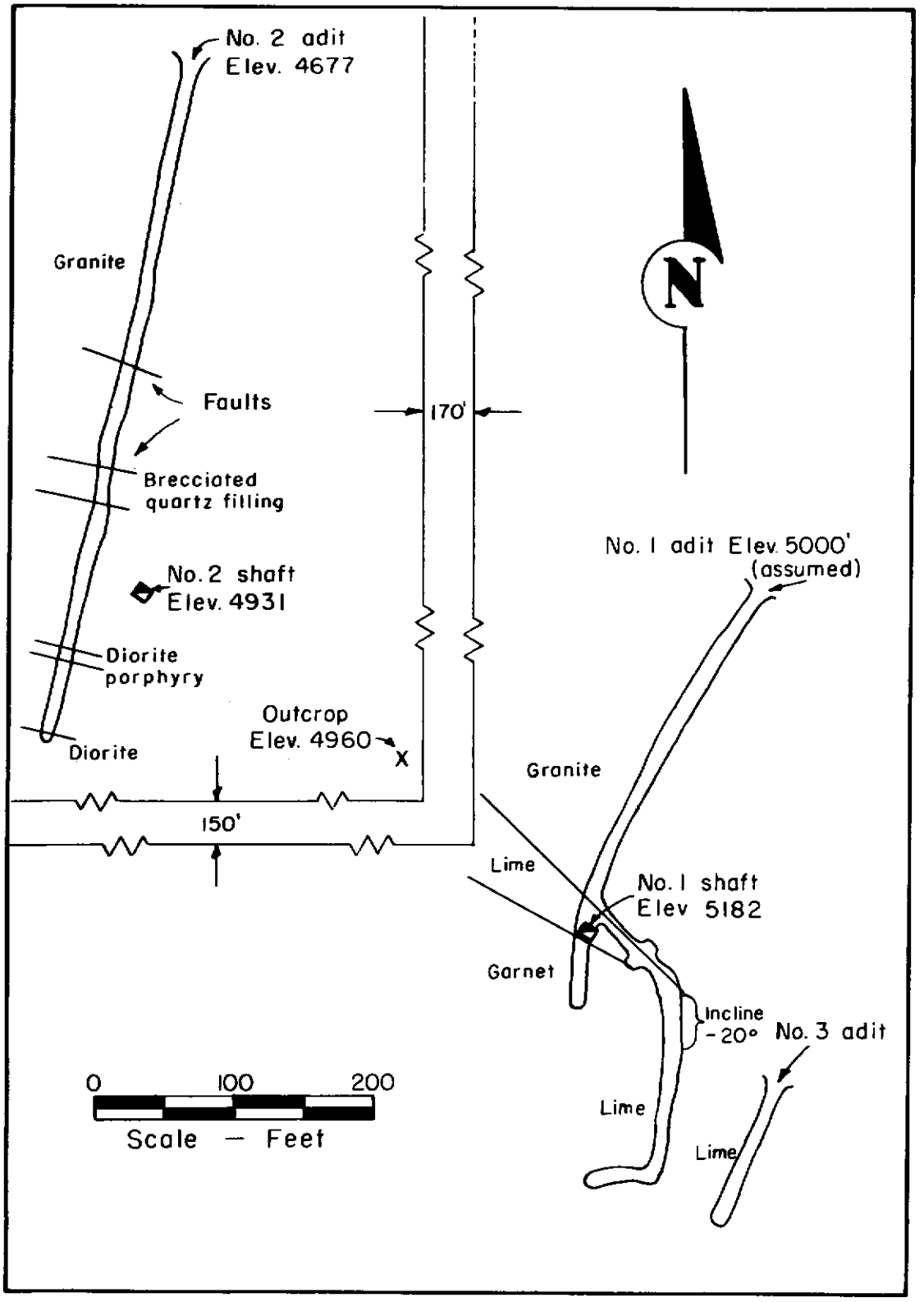

FIGURE 22. - Big Four Mine, Swisshelm Mountains.

The following samples were taken:

No.	Location	Material	Extent of sample, feet	WO_3, percent
570	No. 1 adit, 30 ft. S. of contact..	Garnet..	6.0	0.22
571	No. 1 adit, 40 ft. S. of contact..	..do....	5.8	.07
572	No. 1 adit, 50 ft. S. of contact	..do....	6.2	.01
573	No. 1 adit, 60 ft. S. of contact..	..do....	5.0	.17
574	No. 1 adit, 70 ft. S. of contact..	..do....	5.0	.29
575	Drift SW., 30 ft. from adit.....	..do....	3.0	.03
576	Drift SW., drift S., breast.....	..do....	4.0	.01
577	Drift SW., 60 ft. from adit.....	..do....	5.5	.01
578	Drift SW., 70 ft. from adit.....	..do....	5.5	.01
579	Drift SW., Drift No. 2 S. 10 ft. from SW. drift.....	..do....	6.5	.42
580	Drift No. 2 S., 15 ft. from SW. drift.....	..do....	5.5	.62
581	Drift No. 2 S., 20 ft. from SW. drift.....	..do....	3.0	.39
582	Drift No. 2 S., 30 ft. from SW. drift.....	..do....	4.0	.17
583	Drift No. 2 S., 40 ft. from SW. drift.....	..do....	4.5	.27
584	Drift No. 2 S., 50 ft. from SW. drift.....	..do....	4.0	.49
585	Valley View claim, side of location hole.....	..do....	3.0	.21
586	Valley View claim, south outcrop..	..do....	1.5	.01
587	Adit No. 1, 30 ft. S. of contact, check sample.....	..do....	6.0	.26
588	Adit No. 1, 60 ft. S. of contact, check sample.....	..do....	5.0	.9
589	No. 2 shaft, chips from around top of shaft.....	..do.....		.1

Figures 22 and 23 show the locations of these samples.

Mineral Reserves Mill

The Mineral Reserves Co., Ltd. has a tungsten concentrate processing plant situated a few hundred feet west of the railroad tracks on Ninth Avenue in Douglas, Ariz.

The plant was built originally by David P. McConnell for Anthony Martinolich, a San Francisco shipbuilder. It was built to upgrade Mexican tungsten concentrates for resale in the United States. The particle separation plant was completed in March 1956. Later the Mineral Reserves Co., Ltd. obtained a lease with purchase option. The plant is supervised by David P. McConnell and James W. Marino.

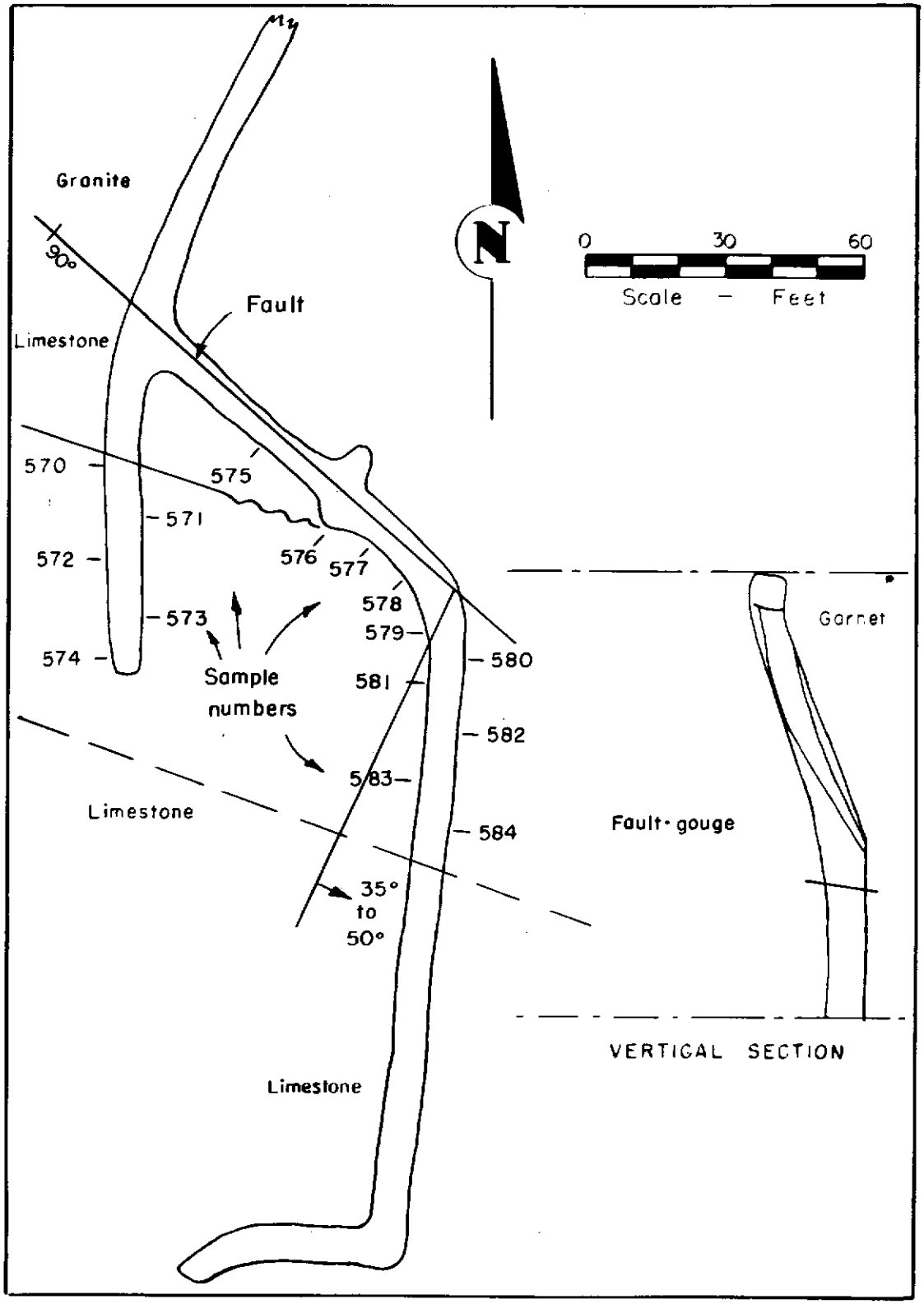

FIGURE 23. - No. 1 Adit, Big Four Mine, Swisshelm Mountains.

The daily capacity is 25 tons. The plant has good equipment to upgrade the Mexican concentrates by any one of a number of methods. There are tables for gravity concentration, flotation units, a magnetic separator, a static separator, a roaster, and acid-leaching equipment. When the writer visited the plant in June 1957 the plant was being remodeled and enlarged to add equipment for the production of synthetic scheelite.

Although the Mineral Reserves Co., Ltd. owns two tungsten properties in Mexico, most of the concentrates treated at the plant have been purchased from other Mexican producers. To date, about 85 tons of the concentrates with average grade of 65 percent WO_3 has been produced.

Pima County

Eastern Part of the Papago Indian Reservation

This area in which the tungsten mineralization occurs is within the Papago Indian Reservation in the foothills of the Quinlan and Baboquivari Mountains, some 50 miles west of Tucson, Ariz. (fig. 24). The area is unsurveyed, but the location of each of the properties is given in the detailed reports by projected section, township and range.

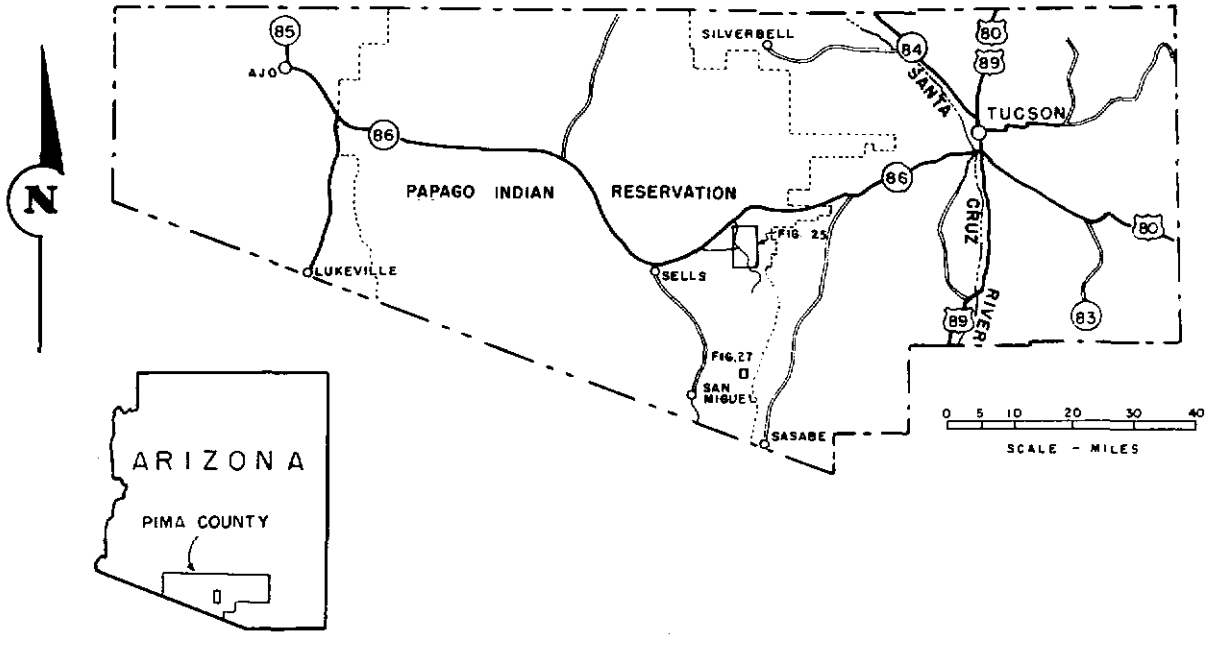

FIGURE 24. - Tungsten Deposits, Eastern Part of Papago Indian Reservation, Pima County, Ariz.

The following road log gives basic mileages to the various turnoffs that are mentioned in the report:

Miles	Turnoff
0.0..	Junction U.S. Highway 89 and State Highway 86 (Tucson-Ajo road) in South Tucson, traveling west on Highway 86 (toward Ajo).
47.0..	Junction of Foothill Truck Trail going to the south.
53.0..	Junction to mine access road, going to the east.
53.6..	Tungsten concentrating mill on north side of road.
61.5..	Sells Junction.

All mines or prospects described in this report are accessible from the 53.0-mile junction by traveling east 6.2 miles from the highway to the junction of the Foothill Truck Trail near San Juan village. Mileages are given from this point, as the various access roads originate along the trail, either north or south of the San Juan junction. This junction is 6 miles from Highway 86 via the trail road. This section of the road is in poor condition.

Discontinuous tungsten mineralization is present in a belt about 1 mile wide and at least 6 miles long in an area south of State Highway 86 (Tucson-Ajo road) and east of the old Foothill Truck Trail. The topography of this area is shown on the Baboquivari Peak quadrangle sheet, from which the position of each of the deposits was established. The mineralization that has been prospected is within an altitude range of from 3,050 to 3,750 feet (fig. 25).

A second area (Giant claims), located some 17 miles farther south, also contains scheelite mineralization. This occurrence is treated as a separate chapter in this report.

All claims discussed in this report were located when there were no reservation restrictions and the usual procedure of locating claims prevailed. None of the claims has been patented. By an Act of Congress the Papago Reservation was closed to regular mineral entry on May 22, 1955.

The deposits occur in shears or fractures, and the mineralization in general is in widely spaced, narrow bands. Multiple zones that could be mined from a centrally situated working are found at only two places; of these, the Big Banana was actively engaged in mining when these claims were visited, and the Yellow Star was idle and virtually undeveloped. Like most of the scheelite deposits known elsewhere, the lenses of ore are discontinuous in lateral extent as well as in depth.

Intensive prospecting doubtless would discover many more similar deposits, but because of the prohibitive restrictions placed on mineral entries in the Papago Indian Reservation since mid-1955, it is unlikely that unlocated ground will be prospected. The potential reserves of scheelite in the entire area

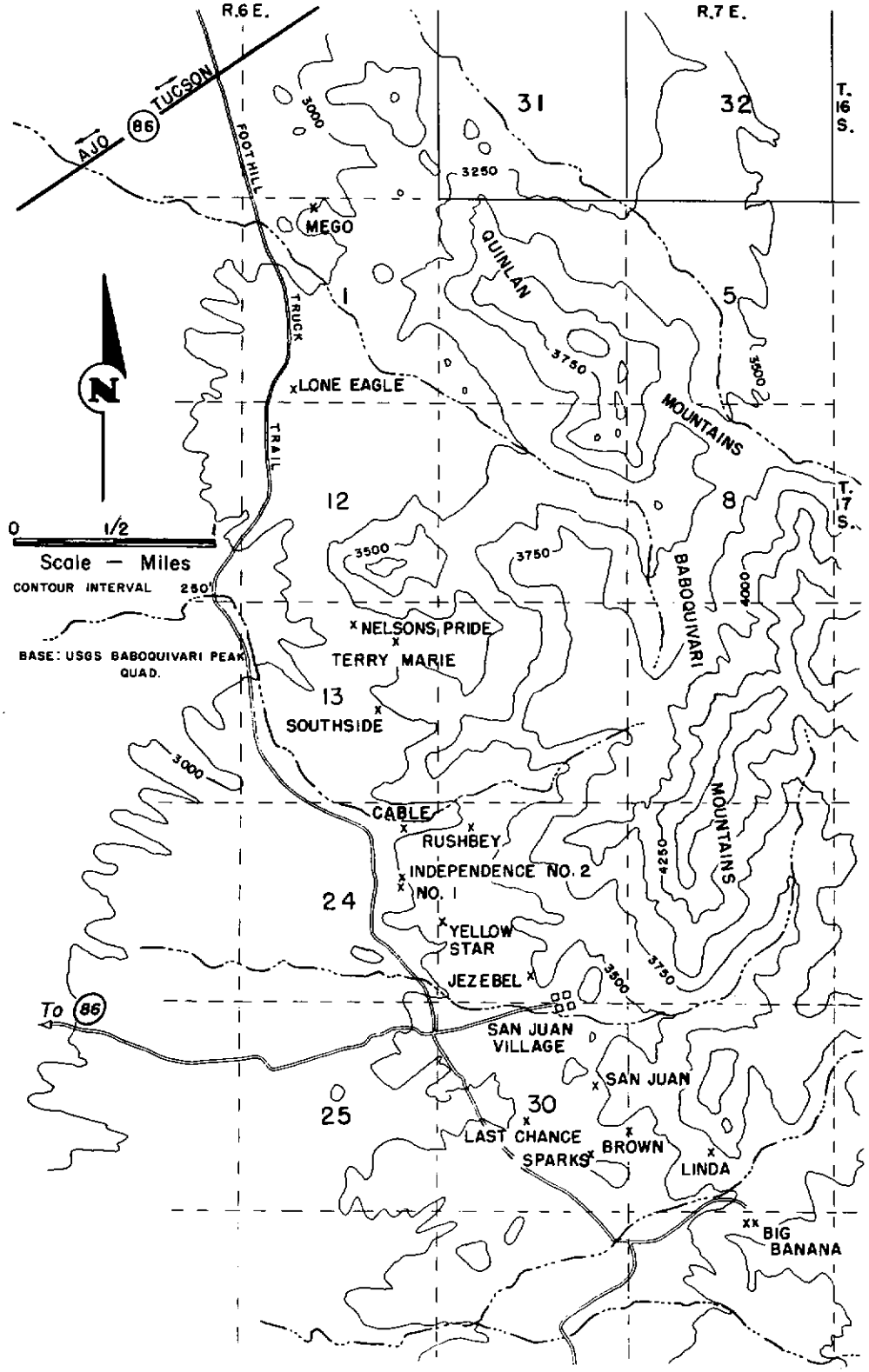

FIGURE 25. - Location Map of Tungsten Deposits, Northern Baboquivari Mountains Area.

undoubtedly are large, but much of the scheelite is in small, scattered deposits that cannot be mined at low cost.

Of the 18 properties examined, only 4 have made a production of $20,000 or more; 2 of these still were on a production basis in February 1957. Production has been curtailed in this area for lack of nearby milling facilities. A small mill of 1-ton-per-hour capacity was constructed on the Tucson-Ajo highway late in 1955. The Big Banana ore was milled regularly on a custom basis. Occasionally San Juan ore was milled, but the mill capacity was so low that both mines were accumulating stockpiles of ore. The mill is approximately 9 miles from the mines.

The old mill, which had been operated by the Cinderra Mining & Engineering Co., was taken over by the C. G. Glasscock-Tidelands Oil Co. some time after the field examination was made in February 1957. According to M. J. McKnight, superintendent, a larger mill with an improved flowsheet was constructed and put in operation in May 1957. Operations of the mine and mill were suspended in August 1957.

In this area, a belt of sedimentary rocks intruded by dikes and irregular patches of rhyolite has been highly metamorphosed. The dominant structural feature is a wide northwesterly striking fault system, the elements of which normally dip steeply to the west. The secondary faulting and intense shearing between the major faults probably are the result of tensional adjustment. All the known ore bodies are within these zones of structural disturbance, and seem to be localized along the tension shears in the metamorphosed sediments.

The sedimentary series are thought to have been composed of sandstone members of varying composition, interbedded to a minor extent with limestone layers. The fractures formed by the tensional shearing may cut the bedding or may appear as bedding-plane slips.

The sediments have been metamorphosed to such an extent that some members of the original sandstone series visually appear to be igneous, owing to texture and the presence of dark minerals, such as hornblende and biotite. However, microscopic examination of more than 20 rock specimens has shown that only 2 represented rhyolite. The remainder were classified as quartzite. Locally some of these beds are schistose in character.

Rhyolite was noted only at the southern end of the area near the Big Banana mine, but it is possible that smaller occurrences were not recognized in the area to the north. Narrow dikes of aplite, later than the metamorphism, have been intruded into the rocks throughout the area.

Epidote and various types of garnet are common constituents of the rocks. Small amounts of fluorspar were noted at two of the deposits. Copper oxide staining is prevalent in virtually all of the deposits.

Probably because of the greater ease of entry, the mineralizing solutions favored porous zones, and scheelite occurrences usually are localized along such bands rather than with the massive rock. Hydrothermal alteration has

further affected these bands, so that the scheelite usually is in lenticular bodies in a fairly soft, granular, often pulverulent matrix. Thin coatings or smears of scheelite occasionally extend into the fracture planes of adjacent massive rocks.

The scheelite occurs as discrete particles, seldom larger than a match head and usually much smaller, and often as mere specks. Most of the scheelite is molybdenum bearing and fluoresces a yellow color under the ultraviolet lamp.

It is reported that scheelite mineralization is present in similar metamorphic rocks higher in the mountains, 2 or 3 miles northeast of the Big Banana mine. No claims have been located there because of difficult accessibility.

Northern Area

Big Banana Mine (C. G. Glasscock-Tidelands Oil Co.)

The Big Banana property, consisting of four contiguous, partly overlapping claims, is situated in approximate sec. 32, T. 17 S., R. 7 E., unsurveyed, at an altitude of 3,700 feet. The mine is accessible by a 0.7-mile road branching east from the Foothill Truck Trail 1.6 miles south of the San Juan junction.

Wm. H. Coplen purchased the Maud E claim and located the three Big Banana claims early in 1954 and produced approximately $25,000 worth of tungsten concentrates.

In June 1955, the C. G. Glasscock-Tidelands Oil Co. entered into a purchase contract with Coplen, developed the mine, and through 1956 had produced an estimated $50,000 worth of concentrates.

The Banana ore zone lies within metamorphosed quartzitic rock, adjacent to and east of an irregular, intrusive mass of somewhat metamorphosed rhyolite. The general trend of the mineralized zone is S. 15° E. It is 1,000 feet or more in length. The rocks are intensely shattered. Within the mineralized zone, the ore shoots appear to be arranged in an en echelon pattern, and the individual shoots strike N. 10° to 20° W. and dip eastward.

No transit survey has been made of the entire Big Banana workings, but for the purpose of this report figure 26 has been compiled from the company's fragmentary Brunton survey maps.

Lower Cut Adit. - From the face of an opencut that had produced ore, the Lower Cut adit was driven southward for 100 feet, passing into almost barren rock at about 60 feet. At 40 feet from the portal a wide 50° inclined winze was sunk on the ore shoot. At the bottom the angle flattened to a nearly horizontal position. McKnight stated that the ore from a 6- to 8-foot zone averaged 0.5 percent down this incline. A 40-foot drift to the southeast produced ore for about half its length. Ore was being mined from a drift in

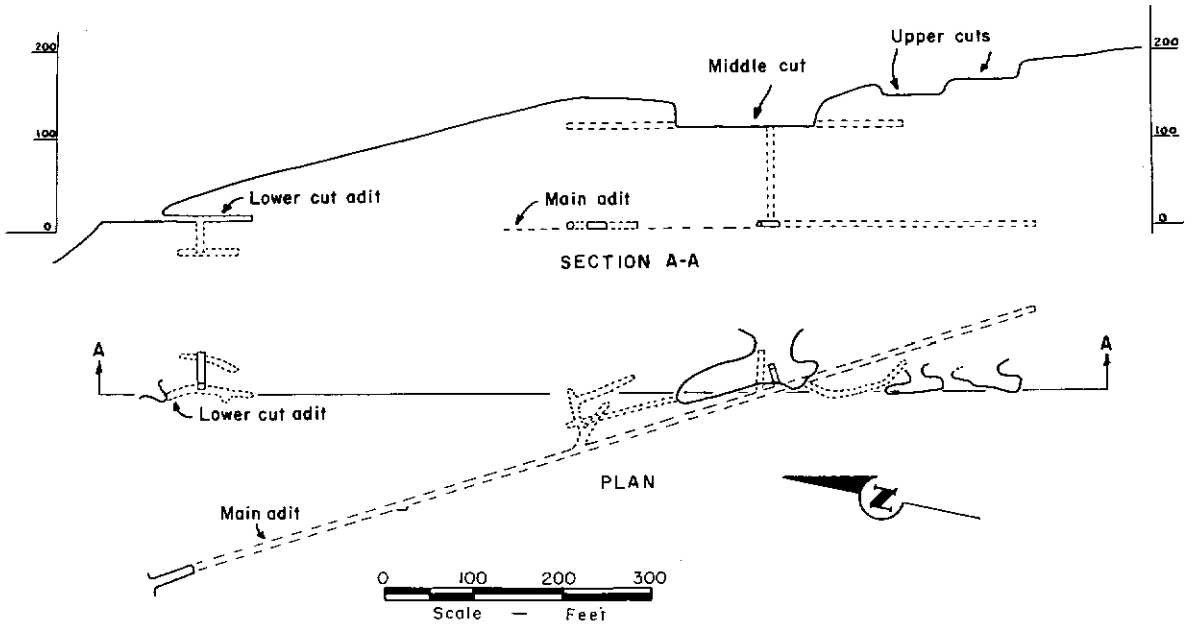

FIGURE 26. - Plan and Section, Big Banana Mine.

the opposite direction, which on January 10, 1957, had been advanced 20 feet. At this level some pyrite was present in the ore zone. When the ore was milled, most if not all of the pyrite remained in the concentrate.

Ore from the winze was hoisted, trammed to an ore dump, and placed in trucks by an end loader.

A character sample from the bottom of the winze (15045-A) was microscopically determined to be a quartzite, as was one (15045-B) taken on the surface 50 feet east of the adit portal.

Middle Cut. - Approximately 700 feet to the southeast and 100 feet higher, an opencut has produced considerable ore. At floor level the cut measured 160 feet long by about 35 feet wide, and the high side measured 30 feet. Considerable sorting was required to upgrade the product; all large, hard fragments were rejected. Probably certain parts of the excavated material that did not lamp scheelite were also rejected.

Drifts were being driven along the zone of mineralization from each end of the cut when the deposit was visited. Early in December 1956, when the north drift was 20 feet deep and the south end was in preparation for drifting, a combined muck sample consisting of 50 pounds from each place assayed the following percentages: 0.06 WO_3, 0.006 MoO_3, and 0.03 Cu. Evidently mineralization as lean as this would have been discarded. As of January 10, 1957, each of the drifts had been driven 125 feet. The material from the north drift was sent to the mill, but the face of the south drift was below milling

grade. The ore was mechanically mucked into mine cars and trammed to a 50-foot-long inclined chute, from the bottom of which trucks were loaded for the 9-mile haul to the mill.

A sample (15043-A) taken on a rock outcrop just east of the middle cut was identified as quartzite. A second sample (15043-B) taken about 50 feet west of the cut was identified as metamorhposed rhyolite porphyry.

Upper Cuts. - A cut about 200 feet farther southeast and 50 feet higher had a maximum depth of 20 feet and a floor dimension of 60 feet by 10 feet and another 30 feet higher was about 70 feet long and was cut into the hill for 20 feet. Both these cuts were producing ore for the mill in January 1957. Trucks were filled by an end loader.

A combined 50-pound muck grab from each end of the first-mentioned pit assayed 0.25 percent WO_3, 0.021 percent MoO_3, and 0.03 percent Cu. A 35-pound muck sample taken across the length of the face of the upper working assayed the following percentages: 0.25 WO_3, 0.018 MoO_3, and 0.02 Cu.

The hillside had been stripped by bulldozing along the zone for approximately 200 feet south of the upper cut to the top of the saddle, some 30 feet higher. This area lamped some scheelite. South of the saddle, the mineralization appeared to be cut off by rhyolite for about 1,000 feet. Although scheelite-bearing metamorphic rocks were reported in this southern area, there was no access road and no exploration had been done.

Main Adit. - From a point 200 feet southwest of the lower cut adit and 10 feet lower, an adit was driven S. 30° E. for a distance of 1,000 feet. It was poorly located and intersected only occasional traces of mineralization on shear planes. A rock sample (15044), taken 900 feet from the portal, was identified as slightly metamorphosed rhyolite porphyry.

Evidence of mineralization was noted 450 feet from the adit and followed westward. A small amount of low-grade ore was taken from part of the 170 feet of total drifting. This ore was stockpiled on the surface for possible future milling. A 50-pound sample taken around the edges of the pile assayed the following percentages: 0.13 WO_3, 0.011 MoO_3, and 0.02 Cu.

McKnight stated that long-hole drilling late in January 1957 had indicated an 8-foot ore zone at least 250 feet long near the portal and 45 feet to the east.

Linda Claim

The Linda claim is situated in approximate sec. 29, T. 17 S., R. 7 E., unsurveyed, and is said to adjoin the Banana property on the north and the Sparks property on the west. It was located by Charles Traister in 1954 and is accessible from the Sparks camp by a half-mile bulldozer trail up the north side of the gulch.

If the Banana structure extends across the gulch, it is not evident from surface outcrops. The only exploration noted in February 1957 was a shallow bulldozer cut on the hillside, and no sample was taken.

Sparks Mine

The Sparks property consists of 27 contiguous partly overlapping claims in approximate secs. 29, 30, and 31, T. 17 S., R. 7 E., unsurveyed. The claims were located by George W. Sparks in 1954-55. The campsite was just east of the Foothill Truck Trail at a point 1.2 miles south of the San Juan junction. The principal deposit, Juanita No. 9, was mined by lessees who are said to have produced 100 tons of ±0.5 percent scheelite ore.

Early in 1957 the property was lease-optioned by Earl Sands and associates, who were preparing to mine this deposit a short distance north of the campsite.

The scheelite mineralization occurs in a fracture zone that strikes S. S. 20° W. in a hornfels formation, which before metamorphism probably was an impure quartzite. The principal workings consisted of a 30-foot adit extending from a hillside cut. About half the length of the adit had been stoped to the surface. The zone that was mined was 4 to 5 feet wide and dipped 70° SE. In the floor of the cut at the portal, a 20-foot trench 10 feet deep had been excavated along the dip of the mineralization.

The fracture zone had been prospected by an opencut about 25 feet below the adit, and by a 10-foot shaft approximately 100 feet higher near the top of a hill. A sample chipped across the 7-foot width of this shaft assayed 0.11 percent WO_3. Truck trails lead to numerous other claims of the group, but no other workings were found except bulldozer cuts at various places. The area covered by these claims is east and south of the Juanita No. 9.

Brown Prospect

In early 1954 Vance J. Brown located four claims (Big Juanita group) that are situated in approximate secs. 29 and 30, T. 17 S., R. 7 E., unsurveyed. The property is northeast of the Sparks mine and is accessible by a 1/2-mile pilot road eastward from the Sparks camp.

At the time of the examination, early in January 1957, the principal work had been confined to the No. 1 claims where a northwesterly trending zone in quartzitic formation contained epidote, zoisite, garnet, and stringers of secondary calcite. A number of narrow aplite dikes cut irregularly through the formation.

A bulldozer cut had exposed a face about 50 feet long to a maximum height of 15 feet. On the hillside above this four shallow pits had been excavated in a distance of about 150 feet. Brown stated that from this work he produced 3.5 tons of ore that gave 50 pounds of 62-percent scheelite concentrates. There had been no production from the other three claims of the group, so they were not examined.

Last Chance Claim

The Last Chance claim in approximate sec. 30, T. 17 S., R. 7 E., unsurveyed, is accessible by a 0.2-mile pilot road turning south from the San Juan mine road 0.4 mile from the Foothill Truck Trail. The claim originally was located by Earl Hicklin, Jr., in September 1954, and was later sold to D. G. Wheeler, who produced about 20 tons of ore conatining ±0.5 percent WO_3. Wm. H. Coplen owned the claim in January 1957.

The claim covers a small knoll composed of highly fractured quartzitic material in which the predominent shearing strikes east-west and dips 55° N. On the north side of the knoll, prospecting had been confined to a 3-foot metamorphosed scheelite-bearing band that appears originally to have been limestone interbedded within sandstone layers. A 15-foot shaft, now partly backfilled, was sunk on this band, which strikes southeast. At the surface the dip is nearly vertical, but a few feet below the surface the bed flattens and takes an easterly dip. Approximately 20 feet north of the shaft, bulldozer stripping had exposed material, now metamorphosed to a fine-grained siliceous rock containing ferromagnesian minerals that originally may have represented an intrusive igneous body. It may have been only a sandstone layer rich in iron minerals, however.

On the other side of the knoll about 100 feet south of the shaft a very shallow pit exposed a similar mineralized occurrence.

A chip sample across the 8-foot width of the shaft and another sample across the 4-foot pit were combined and assayed 0.26 percent WO_3.

The property was examined in February 1957.

San Juan Mine

The San Juan property consists of four contiguous claims situated in approximate sec. 30, T. 17 S., R. 7 E., unsurveyed. It is accessible by a 0.6-mile road branching east from the Foothill Truck Trail 0.3 mile south of the San Juan junction. The claims originally were located by Wm. H. Coplen in 1951, and sold to Chas. M. Taylor and A. L. Gorman the following year. The latter parties excavated a number of pits and cuts, and sank a 42-foot inclined shaft with stub drifts at the bottom. A small amount of tungsten was produced by this work.

In 1954 Taylor and Gorman sold the property back to Coplen, who then made a production of approximately $21,000.

In April 1956, a lease with option to purchase was executed on three of the claims with A. K. Wilson, Jr., who was operating the property early in 1957 for the Mountain States Uranium Co. The production of this company, plus the estimated value of the tungsten in the ore stockpile, was on the order of $7,500.

The deposit lies within a faulted zone in quartzitic rock that has been metamorphosed to hornfels. The zone is sheared and shattered and contains considerable amounts of argillaceous alteration products. Most of the scheelite mineralization is confined to a discontinuous band ranging in thickness from 6 inches to 3 or 4 feet within the fault zone. The general course is slightly east of north, but development has shown that the band is sinuous both in strike and dip. The latter ranges from 30° to 60° E.

The deposit was opened by a sidehill cut from which a short adit was driven northward. Shallow underhand stoping was done along the cut, and two 50-foot inclined shafts, 100 feet apart, were sunk on the vein and connected by a bottom level. Very little stoping was done on this level. At the time of the examination in January 1957 production was confined to the north (main) shaft, where drifts were being extended north and south on the 32-foot level. The 45-foot drift to the north had been stoped nearly to the surface. The 25-foot south drift was being extended.

The mineralized zone had been stripped by bulldozer work for approximately 500 feet to the south. Wagon drilling indicated an increase in mineralization about 300 feet south of the main shaft, and preparations were being made to sink a shaft at this place.

A stockpile of ±0.5 percent ore had been accumulated and was being milled on a custom basis as facilities at the Cinderra mill were available.

A sample chipped across 20 feet of fractured footwall material 50 feet north of the main shaft assayed 0.18 percent WO_3.

In 1953, samples were cut across the width of the vein from available openings for a vein length of 300 feet. The weighted assay value of 7 samples was 0.34 percent WO_3. These were taken over vein widths ranging from 0.9 to 14 feet and averaged 4.5 feet.

It is reported that the Mountain States Uranium Co. relinquished its option in mid-1957.

Jezebel Mine

The Jezebel mine is accessible by a 0.5-mile road that turns east from the Foothill Truck Trail about 200 yards north of the San Juan junction and is situated in approximate sec. 19, T. 17 S., R. 7 E., unsurveyed. The Jezebel No. 1 claim was located by Earl Francis in January 1954, and later sold to James E. Thornton of Tucson. Several lessees are said to have produced a total of approximately 600 tons of ore from which the concentrates are estimated to have been worth $25,000.

The principal workings consist of a stope 50 feet long and half that wide, bordered on the north by a stub adit and on the west and south by deep bulldozer cuts. It is likely that ore was taken from an area of at least 60 by 80 feet.

The mineralized zone within the stope averages about 4 feet thick, dipping 10° to 15° SE. The greatest concentration of scheelite was in the bottom 12 to 18 inches of the zone, where alteration has been greatest and the siliceous material is vuggy and granular. Eight samples chipped across the ore zone at various places in the stope were combined and gave an assay value of 0.67 percent WO_3. The ore zone has been dragged down on the south side by a fault striking S. 80° E. and dipping 55° S. The ore was followed downward under the hanging wall of the fault for at least 15 to 20 feet below the floor of a bulldozer cut, but caving has virtually filled this part of the workings.

The rock immediately north of the fault is highly altered and contains abundant clay with slickensides in various directions indicating much movement. The country rock outside of the faulted area is quartzitic and somewhat schistose in character (15101).

About 175 feet to the north a small lens of mineralization was opened from a stub adit by a small underhand stope, now caved. It is reported that the narrow ore zone took a decided pitch to the south. A chip sample across 4 feet of the face of the adit assayed 0.12 percent WO_3.

The property was idle when visited in December 1956.

According to Thornton, the material that has filled the workings next to the hanging wall is blasted debris covering ore that would run over 10 percent WO_3. Beneath this debris a shaft was sunk 15 to 20 feet below the level of the floor made by the bulldozer, and Thornton states that the entire shaft was in ore. A miner is reported to have dug a prospect hole 6 or 7 feet deep beneath the floor of the bulldozer cut. Ore in this hole was estimated by the miner to run 5 to 7 percent WO_3.

Yellow Star Mine

The Yellow Star workings are accessible by a 0.4-mile access road that branches east from the Foothill Truck Trail 0.5 mile north of the San Juan junction. The property, in approximate sec. 19, R. 7 E., and sec. 24, R. 6 E., T. 17 S., unsurveyed, consists of two claims. The original locations were made in late 1952: Yellow Dragon No. 1 by Earl Francis, and No. 2 by Francis and Wm. H. Coplen. Later Coplen bought Francis' interest, produced about $2,000 worth of scheelite concentrates, and then sold the property to W. F. R. Griffith. Griffith relocated the claims as New Dragon Nos. 1 and 2, made a considerable production, and in March 1955 lease-optioned the property to the Standard Tungsten Corp.

The principal workings consist of a 90-foot north-bearing adit connecting with a 60-foot inclined shaft. The latter was started on a mineralized stringer dipping southwest. At about 20 feet below the shaft collar the dip of the stringer flattened, but the shaft was continued at minus 40° for 40 feet until it cut into the south end of a flat-lying cavity, 2 to 3 feet high by 10 to 12 feet wide, the walls of which contained some scheelite mineraliztion. The adit then was driven from the south side of the ridge to connect

with the bottom of the shaft. The adit encountered and followed the flat-lying mineralized contact along which the cavity was found. Mineralization was confined mainly to a friable, somewhat granular bed up to 2 feet wide, and was mined about 10 feet on each side of the adit. Rock samples (15111 and 15112) taken of the formation above and below this ore bed were identified as feldspathic quartzite. No exploration was conducted in the cavity north of the bottom of the shaft.

On the opposite side of the ridge, some 250 feet to the north, ore was produced from an opencut about 100 feet wide, where nearly vertical southeast-trending shears contained numerous narrow stringers of mineralization. A sample chipped across 50 feet of this zone assayed 0.19 percent WO_3. The rock (15107) was identified as metamorphosed feldspathic quartzite. An inclined adit was driven southwesterly for 35 feet along a mineralized fault near the center of the opencut. The east wall of the fault had the appearance of metamorphosed igneous rock, but was identified as quartzite (15109). A mineralized bed cut in the floor was followed by a branch drift for 40 feet to the southeast. This drift broke into a small cavity. A sample chipped vertically for 4 feet across the mineralized bed assayed 0.69 percent WO_3, and the host rock (15117) was quartzite. This bed also was mined from a small, now inaccessible, stope opened from the face of the cut. The stope likewise broke into a cavity.

A pit, 250 feet southwest of the north adit, is 6 by 14 by 16 feet deep, and another smaller pit is 25 feet farther to the west. These pits have been excavated on a zone of closely spaced southeast-trending shears. Chip samples across 14 feet in the larger pit and 8 feet in the smaller pit assayed 0.35 and 0.21 percent, respectively, and the rock was microscopically identified as quartzite.

Extensive bulldozer stripping has been done about 400 feet north of the north adit, where a bed 4 to 6 feet thick reportedly contained mineralization. No sample was taken here, as the bulldozer work had obscured the formation.

It is estimated by W. H. Coplen that the work of various operators has produced approximately $20,000 worth of scheelite concentrates from about 700 tons of ore.

The property was idle when visited in December 1956.

Independence Group

The Independence group, consisting of two contiguous claims, is situated in approximate sec. 24, T. 17 S., R. 6 E., unsurveyed. The property is on the east side and adjacent to the Foothill Truck Trail at a point 1.1 miles north of San Juan junction.

Each claim is said to have produced about 5 tons of ore.

Independence No. 1. - The Independence No. 1 claim immediately south of the end of the road originally was located by Walter N. and Eugene D. Calvert, and Vance J. and Wm. S. Brown on November 4, 1953. In the location monument

there also is a location notice dated November 12, 1954, stating that the New Dragon No. 4 claim is relocated "on forfeit and abandoned grounds" by W. F. R. Griffth.

The considerable amount of bulldozer stripping has obliterated the outcrops and filled an original cut and discovery shaft; consequently, no samples were taken.

Independence No. 2. - This claim was located by Walter N. and Eugene D. Calvert, and Vance J. and Wm. S. Brown on November 7, 1953, and later was purchased by Webster L. Fickett of Tucson and an associate. At the north side of the road a partly caved 12-foot shaft with a stub drift at the bottom has been sunk in sheared formation, the fractures of which strike N. 10° W. and di dip 70 E. The rock is somewhat altered and friable and contains coatings of copper oxides. A sample was chipped along the 12 feet of length of the west side of the workings. This assayed 0.056 percent WO_3.

A second shaft some 500 feet to the northwest in a similar shear zone was sampled across the formation, assaying 0.021 percent WO_3. An opencut 50 feet farther northwest conatined appreciable quantities of chrysocolla, some fluorite, limonite, and malachite, and a few specks of scheelite. The owners report that a sample from this opencut assayed 0.12 ounce of gold, 8.4 ounces of silver, and 13.05 percent copper. This mineralization was confined to a narrow fracture striking northwest and dipping northeast. A small area at the end of the road was stripped with a bulldozer.

Rushbey Prospect

The Rushbey property, apparently consisting of three claims, was located in January 1954 by Dewitt T. Rushbey and E. L. Hicklin. The location monument and workings of the Birthday claim were found, and the monument contained an affidavit for 1955 assessment work on this and two other claims, the latter of which were not found. The claims are in approximate sec. 19, T. 16 S., R. 7 E., unsurveyed, at the end of a 0.7-mile pilot road that branches east from the Foothill Truck Trail 1.25 miles north of San Juan junction.

Some ore has been produced from a working consisting of a triangular opencut 25 feet long and of like width. From the face of the cut, an opening 12 feet wide extends 10 feet into the hillside. This work was done on a scheelite-bearing band of hydrothermally altered material 12 to 18 inches wide. The band, striking N. 20° W. and dipping 30° W., is underlain by massive metamorphosed quartzite (15048) and overlain by a sheared and shattered quartzitic member. The principal shears strike N. 30° E. and dip 70° SE.

The work was done with handsteel; a production of several tons of hand-sorted screened material was made from which 200 pounds of 65 percent WO_3 reportedly was recovered. Occasional thin bands of tungsten-bearing material were noted on minor planes near the main zone.

The material from sample cuts across the main band assayed 0.78 percent WO_3. Because of overburden, the ore zone could not be traced beyond the limits of the cut.

Cable and Gajewski Claim

The claim located by Wayne M. Cable and Barney Gajewski in March 1955 was not named on the location notice. It is in the north part of approximate sec. 24, T. 17 S., R. 6 E., unsurveyed. The access road for this and the Rushbey prospect branches eastward from the Foothill Truck Trail 1.25 miles north of San Juan junction. The location monument and cut are immediately south of this road at a point 0.3 mile from the trail.

A 25-foot opencut had been excavated across a closely fractured shear zone in metamorphic rock. The fractures strike N. 75° E. and dip 75° SE. A sample chipped along the side of the cut for its full length assayed 0.003 percent WO_3. There probably was no production from this work.

Southside Prospect

The Southside claim is about one-quarter mile south of the Terry Marie No. 1 in the approximate center of sec. 13, T. 17 S., R. 6 E., unsurveyed. Access is by a 0.7-mile dirt road that branches east from the Trail 2.4 miles north of San Juan junction.

The claim was located in April 1955 by Frank and Pauline Clark. Shortly thereafter the Cinderra Mining & Engineering Co., Inc. entered into a purchase agreement and mined from an opencut a few tons of ore that produced 150 pounds of scheelite concentrate. Later this company relinquished the option.

The cut is approximately 50 feet long and 15 feet wide and has a maximum depth of 12 feet. the face exposes closely spaced fractures that strike N. 65° E. and dip 55° SE. The immediate area has been bulldozed so that the formation is obscured, but the general regional formation is a feldspathic quartzite (15039) and appears to strike N. 80° W. with dips of 70° N.

A sample cut across the 15-foot face assayed 0.057 percent WO_3. Minor copper oxide staining was noted throughout the shear zone.

Calvert Prospects

The Calvert prospects are situated on two groups of claims in an area just east of the Foothill Truck Trail in approximate sec. 13, T. 17 S., R. 6 E., unsurveyed. Both groups (Nelson's Pride Nos. 1-4 and Terry Marie Nos. 1-3) are accessible by a pilot road branching east from the trail 2.8 miles north of San Juan junction, or from Highway 86, which is 3.2 miles to the north.

The properties were idle when visited in December 1956.

Nelson's Pride Nos. 1-4. - The camp building for this group of claims is 0.7 mile east of the trail, near which are the location monuments and pits of claims 1 and 2. The claims were located by Walter N. Calvert in November 1953. A posted nonliability notice dated October 1, 1956, indicates that the property now is in the possession of the Southwest Mining Industries of Tucson.

On claim No. 2, samples were taken from an 8- by 12- by 8-foot pit adjacent to the road and from a shallow shaft 100 feet to the north. The combined samples assayed 0.01 percent WO_3. Both workings were in sheared and fractured feldspathic quartzite (15033 and 15035). The shearing in the larger pit had a strike of S. 70° E. and a dip of 80° N. One hole was diamond-drilled to a depth of 100 feet in the vicinity of the opencut, but no information was available on the result.

The two adjacent shallow pits on claim No. 1 were in a similar formation (15035) that had a strike of S. 30° E. with a dip of 80° SW. A chip sample across the shearing of these two pits assayed 0.019 percent WO_3.

It is reported that in late 1955 a lessee mined 7 tons of material from these claims that produced 150 pounds of $\pm$50 percent WO_3 concentrate.

Terry Marie Nos. 1-3. - The pilot road extends 0.3 mile farther east to the Terry Marie claims, which were located by Eugene D. Calvert in April 1954. This property likewise has been optioned by the Southwest Mining Industries.

In this area the formation is a somewhat schistose feldspathic quartzite (15037) and has a general strike of N. 20° E. and a dip of 35° W. This formation has been fractured in a N. 70° W. direction with some of the shears containing thin aplite dikes. An opencut has been made for a width of 25 feet on claim No. 1 in an area where the shearing is intense and the fractures are closely spaced. A sample (15050) across the length of the face assayed 0.037 percent WO_3 and likewise was microscopically identified as a feldspathic quartzite.

Lone Eagle Prospect

The Lone Eagle claim, situated in approximate sec. 1, T. 17 S., R. 6 E., unsurveyed, is accessible by a 0.2-mile pilot road that branches east from the Foothill Truck Trail 3.8 miles north of the San Juan junction. This turnoff is 2.1 miles south of the Tucson-Ajo highway.

The claim originally was located by Earl Francis, and later sold to Fred Rhoades and Earl Hickok. Under a working agreement Jack Ballam and Brinton Brown produced 20 tons of ore. At a later date Rhoades became sole owner.

At this locality, the original sedimentary series apparently contained a thin band of limestone within sandstone beds. The beds now are tilted, metamorphosed, and faulted along a bedding plane striking N. 10° E. and dipping 60° E. A 10- by 10-foot pit, 8 feet deep, on this fault shows 2 to 3 feet of

graunular gougy material between the quartzitic hanging wall and the metamorphosed limestone (wollastonite, epidote, etc.). The hanging wall appears to be virtually barren of mineralization. The gouge member assayed 0.43 percent WO_3, and a 4.5-foot chip sample across the remainder of the pit wall, including the 2-foot "limestone" member, assayed 0.37 percent.

Shallow pits have traced the fault zone for about 100 feet along its strike. The property was idle when visited in January 1957.

Mego Nos. 1 and 2

The Mego No. 2 claim is situated in approximate sec. 1, T. 17 S., R. 6 E., unsurveyed. It was located by Cecil Beckett and Glenn Gibson in January 1955. The claim is accessible by a dim 0.3-mile trail that branches east from the Foothill Truck Trail 5.4 miles north of the San Juan junction, or about 0.75 mile south of the Tucson-Ajo highway.

It had been reported that lamping indicated extremely sparse scheelite mineralization in this area, and that the locators had failed to find any mineralization of interest. Consequently, only a casual inspection was made. The several very shallow pits noted on each claim apparently had been excavated in an effort to find a mineralized zone.

Apparently this locality is the northern limit of the tungsten-bearing zone described in the foregoing report.

Southern Area

The southern area that was investigated for tungsten is situated in the southeast corner of the Papago Indian Reservation, on the western foothills of the Baboquivari Mountains at an altitude of 3,200 to 3,400 feet. This region is accessible by traveling 20.2 miles south from Sells on the San Miguel road and then taking a dim truck trail eastward for 6.3 miles to the Government well of Chui Vaya. This locality is shown on the Presumido Peak, Ariz., Quadrangle sheet.

Coplen states that there are scheelite showings at various places in this area, but except for the Giant property, no claim locations have been made.

Giant Claims

The Giant group, consisting of nine claims, eight of which are contiguous, is situated in approximate secs. 24 and 25, R. 6 E., and secs. 19 and 30, R. 7 E., T. 20 S., unsurveyed. From the Chui Vaya well, truck trails lead to the various workings. The claim map, figure 27, has been sketched from the best available information.

The claims were located in early 1951 by Wm. H. Coplen and later sold to Shannon Mines, Inc., J. L. Mercer, agent. The property was purchased under a lease-option agreement by the Cinderra Mining & Engineering Co., Inc. in

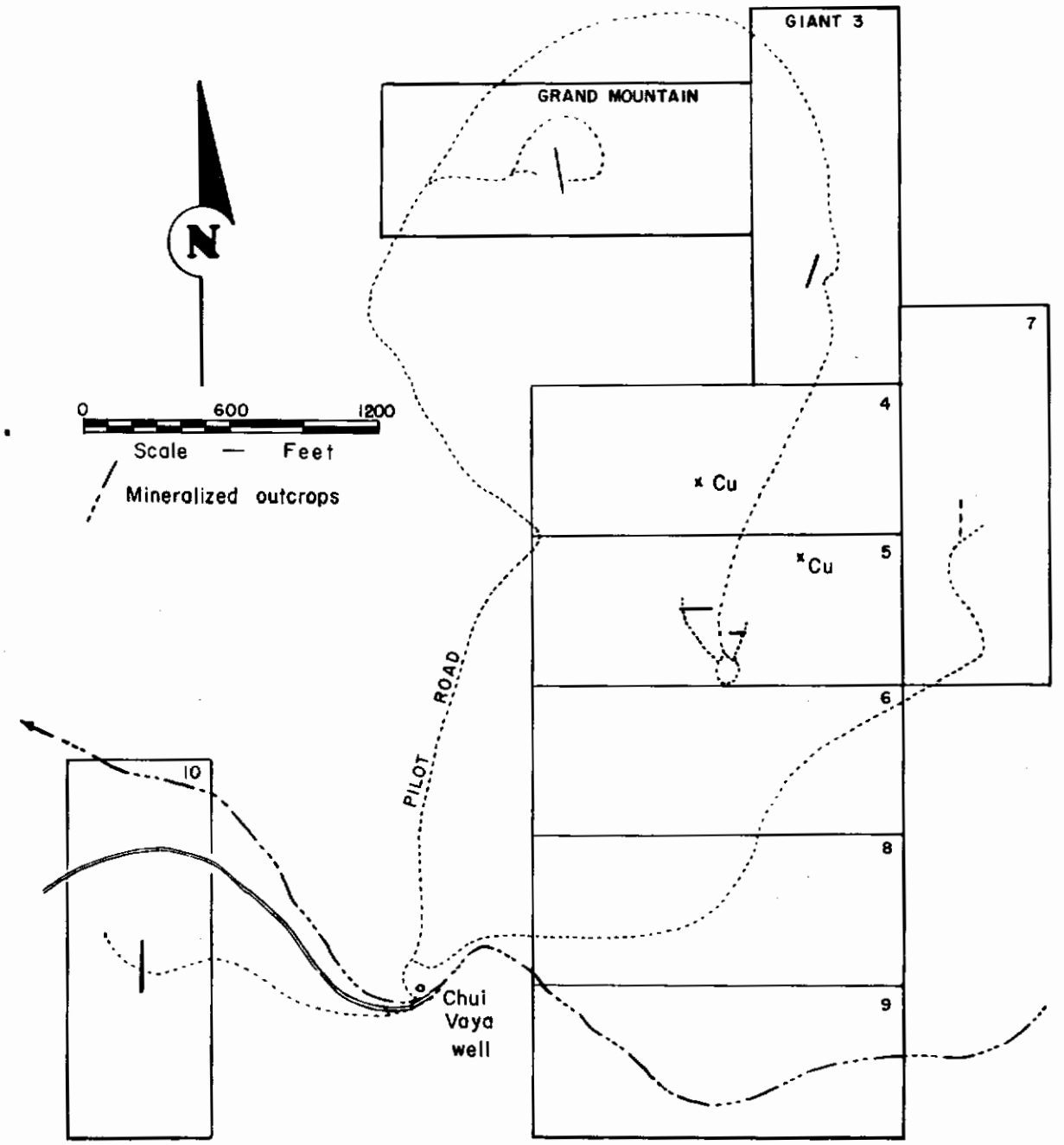

FIGURE 27. - Claim Map, Giant Tungsten Group, Pima County, Ariz.

March 1956. This company extended bulldozer roads to several of the claims an and sank a number of pits on the various outcrops from which 50 tons of ore was mined for a mill test. The concentrates were said to have run only 40 percent WO_3 owing to the presence of calcium-aluminum silicates that failed to respond to magnetic separation.

The metamorphic rocks of the area are quartzitic, and appear to have been metamorphosed from a sequence of sandstone beds of variable composition. In general the bedding has a northerly strike with dips ranging from east to west, but on one claim in the central part of the group the beds strike east. No intrusive rock other than narrow aplite dikes was recognized.

The scheelite mineralization noted at various places on the property occurs in discontinuous lenses that are restricted to a rather porous zoisite-bearing 4- to 6-foot quartzitic bed. Selected specimens of this bed, taken from several exposures, assayed 0.30 percent WO_3 and 0.056 percent MoO_3.

Rock samples taken on the best exposure, that of the Grand Mountain claim, are described in detail in the appendix. Samples of the porous scheelite-bearing bed are numbered 15049 and 15115A. The adjacent footwall is an epidotized quartzite (15115B), and a somewhat schistose formation, classified as a hornfels (15115C), is present on the footwall side a few tens of feet from the mineralized bed.

Repetition of the same stratigraphic sequence of beds at most of the mineralized exposures examined suggests faulting with considerable horizontal displacement of the various segments.

Sparse copper mineralization, consisting of chrysocolla and malachite, occurs at two localities on the claims.

Grand Mountain. - On the Grand Mountain claim, the mineralized bed strikes N. 10° W. and dips 55° W. The outcrop is prominent on the top of a hill and for a short distance down the south side. The Cinderra company erected an ore bin and excavated a 40-foot cut on this side. A chip sample across the 6-foot width of the cut, combined with a similar sample from the location shaft on the top of the hill, assayed 0.11 percent WO_3. The mineralized bed grades abruptly on each side into fine-grained barren quartzite.

This deposit was investigated in January 1952 by a Bureau engineer who stated that the bed could be traced southward for approximately 200 feet down the hill, beyond which it was concealed by talus. Assays of nine samples taken in a distance of 140 feet from the top of the hill averaged 0.19 percent WO_3 and 0.04 percent MoO_3 over an average width of 4.5 feet.

Unfortunately, bulldozer work by Cinderra down the hill from the ore bin obliterated the outcrop and covered the bed with debris so that it could not be traced even by ultraviolet light during the present examination.

The outcrop cannot be traced down the north side of the hill. Two old trenches on that side failed to disclose the mineralized zone.

Giant No. 3. - On this claim a sequence of beds similar to the Grand Mountain exposure is exposed on the summit of a ridge. The bedding strikes N. 27° E. and dips 85° E. The original location pit, sunk on the mineralized bed, was said to have contained disseminations of scheelite, but this opening had been bulldozed over. About 30 feet to the north, an 8- by 12- by 12-foot

shaft showed barren under the ultraviolet lamp except for the smooth east wall. It is thought that this side is the footwall of the mineralized zone, which was not penetrated by this later work. Because of the bulldozer work around this area no sample could be taken that would represent the width of the mineralized bed. The schistose hornfels member was present to the east of these workings.

Giant No. 5. - Near the center of No. 5 claim a small pit on each side of a south-trending ridge exposes scheelite mineralization in nearly vertical bedding that strikes east-west. Above the cut on the west side the outcrop can be traced by occasional scheelite-bearing boulders for about 50 feet to the east.

A sample taken across 8 feet of bedding in the east cut assayed 0.19 percent WO_3, but the mineralization could not be traced on the surface. As the east cut is 250 feet S. 30° E. from the west cut, and the bedding on each strikes east-west, these occurrences either are on separate zones, or are faulted segments of the same zone. The latter explanation seems more likely, as the schistose hornfels member occurs near and on the north side of each occurrence.

Giant No. 7. - An area 50 feet wide by 200 feet long had been bulldozer-stripped northward up the hillside. An outcrop is said to have indicated a zone striking north, but the bulldozing had obliterated the showings. Ultraviolet lamping showed only occasional remnants, and no reliable sample could be taken.

Giant No. 10. - Two cuts had been made on a zone in quartzite that appeared to be similar to the one on the Grand Mountain claim. The bedding had a northerly strike and dipped steeply west. As selected pieces of broken rock from one of the cuts appeared to contain scheelite, this area was lamped at night. Although occasional pieces could be seen to contain scheelite, the presence of a continuous mineralized zone could not be established. As was the case on other claims, the bulldozer stripping along the strike had removed the projections and covered the low-lying parts of the outcrop. The schistose hornfels was present on the east side of the workings.

Later information from M. F. McKnight disclosed that the Cinderra Mining & Engineering Co. relinquished its option on the Giant property in March 1957.

Milling

J. L. Mercer completed the construction of a small concentrating plant about October 1955. The mill was situated on the north side of the Tucson-Ajo road, near the Government well about 8 miles east of Sells. Prior to construction of this mill it was necessary to truck ore considerable distances to other concentration plants. Ore has been concentrated at the mill of the Picacho Mines Co., 12 miles north of Sells; at the Fernstrom mill at Arivaca, a haul of some 90 miles; and at the Lieberman mill at Tucson.

Early in 1956, the Mercer (Shannon Mines, Inc.) mill was purchased by the Cinderra Mining & Engineering Co., Inc. Ore was concentrated on a custom basis; the charge was $9.00 per ton if delivery was made to the mill or $10.00 per ton if Cinderra trucked the ore from the mines in the vicinity. At the time of the examination in December 1956, the only operations furnishing ore to the mill were the Big Banana and the San Juan mines. As the mill could handle only 24 tons per three shifts, stockpiles of ore were accumulating at each mine.

It is said the concentrates produced averaged 55 percent WO_3 and that the mill recovery was on the order of 75 percent. However, no systematic assaying was done on the heads or tailings. It is likely that the mill heads from the Banana mine averaged about 0.3 to 0.4 percent WO_3.

McKnight stated that the C. G. Glasscock-Tidelands Oil Co. completed construction of a new mill in May 1957, and he furnished information concerning the new flowsheet that is shown on figure 28.

Mineral Hill-Twin Buttes Area

Mines in this area were worked as early as 1875 for copper ores. The date scheelite first was detected is not known, but active prospecting for the mineral started about 1941.

The area of scheelite mineralization is in the eastern foothills of the Sierrita Mountains about 20 miles south-southwest of Tucson. A good road traverses the area. The mines with known deposits of scheelite ore are located very close to the road, as may be seen on figure 29.

There are loading facilities on the Southern Pacific Railroad at Sahuarita about 10 miles northeast of Twin Buttes.

Production from this area amounts to less than 500 tons of scheelite ore, and indicated reserves of scheelite ore, as such, are less than 1,000 tons. However, a few hundred thousand tons of mill tailings from copper ores in the area contains about 0.10 percent WO_3.

In general the Sierrita Mountains are composed of a granitic core with metamorphosed sedimentary rocks on the west slope and much less altered sediments on the east. Coarse-grained intrusive igneous rocks, ranging from granite and quartz monzonite to granodiorite, underlie much of the eastern piedmont. Porphyry dikes of acidic to basic composition cut the sedimentary rocks and are believed to be related to the granitic intrusion. Irregular areas of andesite are younger than some of the Cretaceous beds and have been mineralized. Sedimentary rocks in the area range from Cambrian to Upper Cretaceous.

The regional structure has been complicated by folding, overturning, low-angle thrust faulting, and steeply dipping faults.

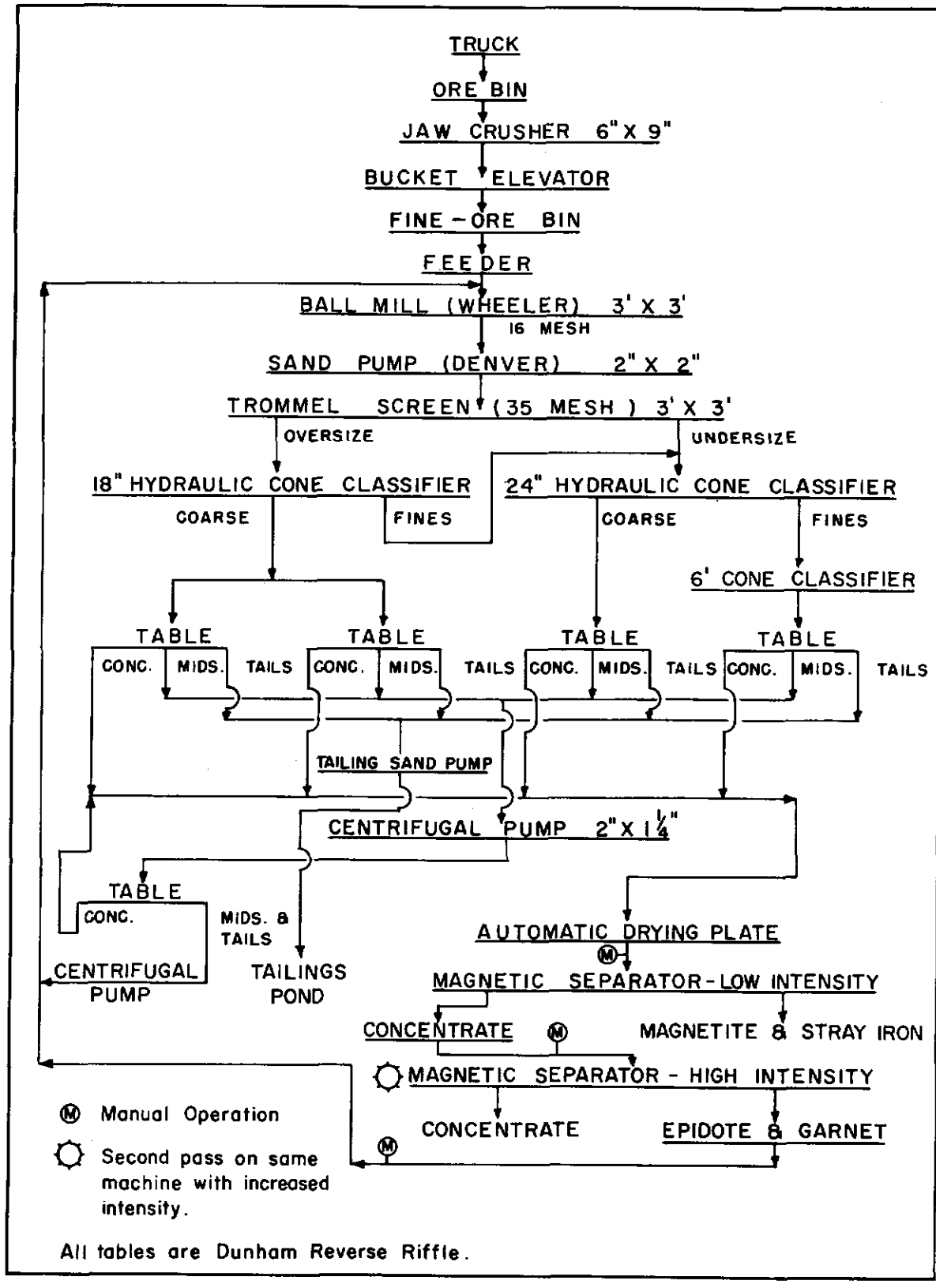

FIGURE 28. - Mill Flowsheet, C. G. Glasscock-Tidelands Oil Co., Pima County, Ariz.

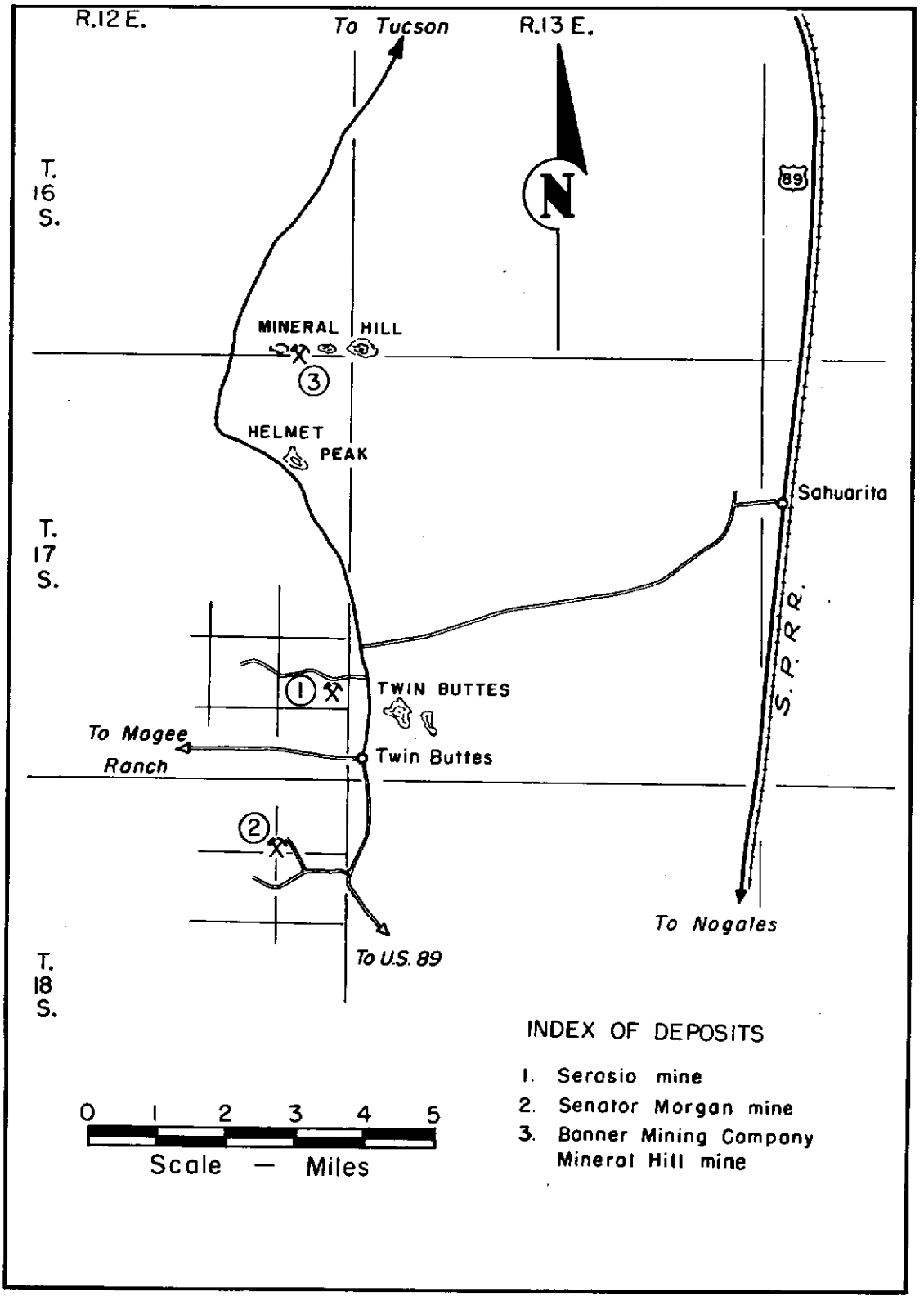

FIGURE 29. - Location Map of Tungsten Deposits in Mineral Hill-Twin Buttes Area, Pima County, Ariz.

Ore deposits in this area include contact, replacement, and vein types. Scheelite is found in the contact and vein types.

Senator Morgan Mine

Seven patented claims in secs. 1, 2, 11, and 12, T. 18 S., R. 12 E. form the Senator Morgan property. The area is in the eastern foothills of the Sierrita Mountains at an altitude of about 3,500 feet. There is a good road to the property from Tucson. Follow the San Xavier Mission road for 23.5 miles southerly from the junction of the Ajo road and the Mission road to a good dirt road that branches westerly, thence go 0.4 mile to a truck trail that branches northwesterly, and thence go 0.8 mile to the old Morgan shaft.

Claims in this area first were located in 1875 and 1876 and have been worked intermittently since then for copper ores. In 1906, the Twin Buttes Mining & Smelting Co. of Milwaukee, Wisc., was formed to work the claims. This operation was confined mainly to the Senator Morgan, and when work was terminated in 1913, 15,688,237 pounds of copper had been produced. The ore is reported to have carried about 2 ounces of silver per ton. Apparently the Morgan group of claims lay idle until 1941 when C. M. Taylor and A. L. Gorman leased the property from Twin Buttes Mining & Smelting Co. to explore scheelite occurrences.

The Senator Morgan mine was at one time the end of a railroad, built in 1905, connecting with Tucson. The Tucson-Sahuarita portion of the railroad was sold to the Southern Pacific system, and the remaining part of the line was scrapped after 1926.

Banner Mining Co. obtained a lease and option on the Morgan group in 1951 (fig. 30).

There is record of only one shipment of scheelite ore having been made from the property. In 1942, E. P. Hilton obtained a sublease from C. M. Taylor. During 1942 and 1943, Hilton shipped about 120 tons of ore that assayed approximately 1.25 percent WO_3 to the Tucson Ore Milling Co. Combined gravity and flotation concentration methods effected a recovery of about 50 percent of the scheelite. Hilton reported that most of the scheelite was too fine to recover.

Scheelite was discovered at the Senator Morgan by C. M. Taylor in February 1941. The following general geological features of the Morgan mine are abstracted from a report by Ransome.[24]

The Senator Morgan mine lies along the northeast base of a low ridge composed chiefly of epidotized quartzite. The beds strike with the ridge, N. 50° W., and dip about 45° SW. The rock shows varying degrees of epidotization from films of epidote on joints to a rock in which epidote and quartz in nearly equal proportions form a closely interlocking aggregate. Exposures

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24/ Ransome, F. L., Ore Deposits of the Sierrita Mountains, Pima County, Ariz.: Geol. Survey Bull. 725, 1922, Part I, pp. 426-427.

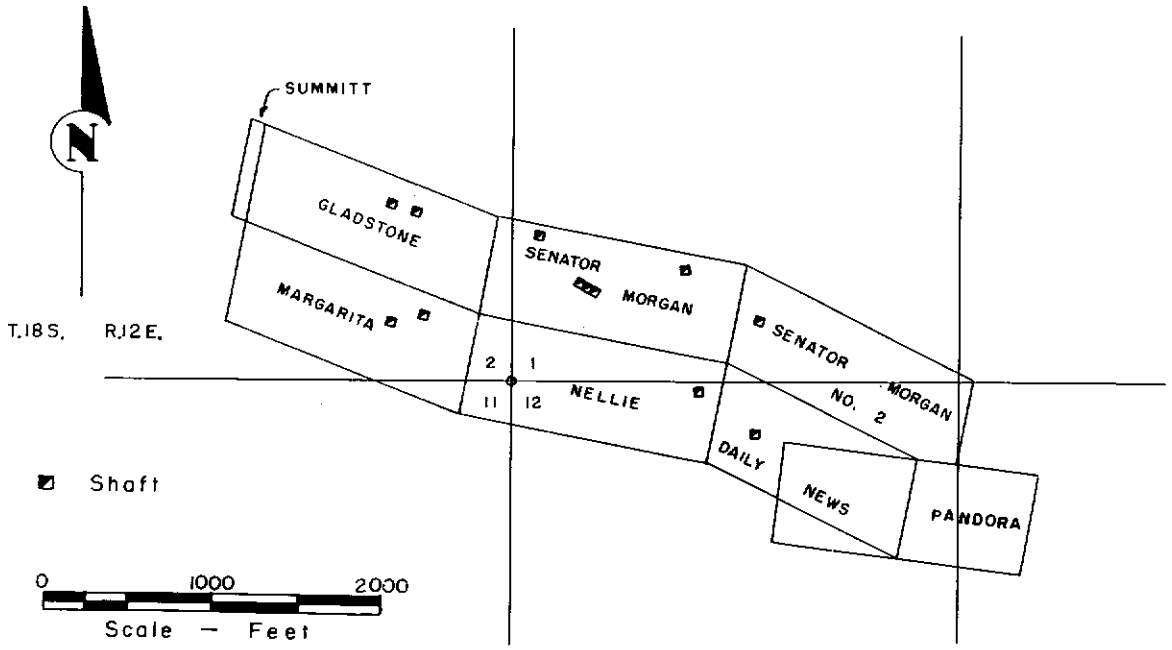


FIGURE 30. - Claim Map, Morgan Group.

in prospect pits indicate that the formation is generally thin bedded and contains some shale. Presumably the epidote quartz rock was at one time a calcareous sandstone. Northeast of the quartzite is a belt of calcareous shale, and northeast of this is a belt of gray limestone, probably of Carboniferous age. This rock is conspicuously altered and conatins masses of garnet rock with bunches of epidote. The deposit has the characteristics typical of a contact-metamorphic deposit, and its formation was clearly a consequence of the intrusion of granite into the limestone.

Taylor found disseminated scheelite and powellite in the garnetiferous contact zones of this area, but very little prospecting was done on these occurrences. Taylor and his associates explored the disseminated scheelite deposits in quartz veins near the old Morgan shaft.

The following information and figures 31 through 36 are taken from Bureau files.

Scheelite occurs in all quartz exposures examined, although, excepting a portion of the lower vein in blocks I and II, there is no likelihood that it can be classed as ore. Where there is enough scheelite to form a pattern in the veins, it is seen to occur in streaks or individual grains.

A minor amount of powellite occurs with the scheelite, and on the 165-foot level two very small parallel quartz veins show this mineralization almost exclusively. When compared with the fluorescence of high-grade scheelite, all lampings on the property seem to have a slight yellowish cast, which may denote a small molybdenum content.

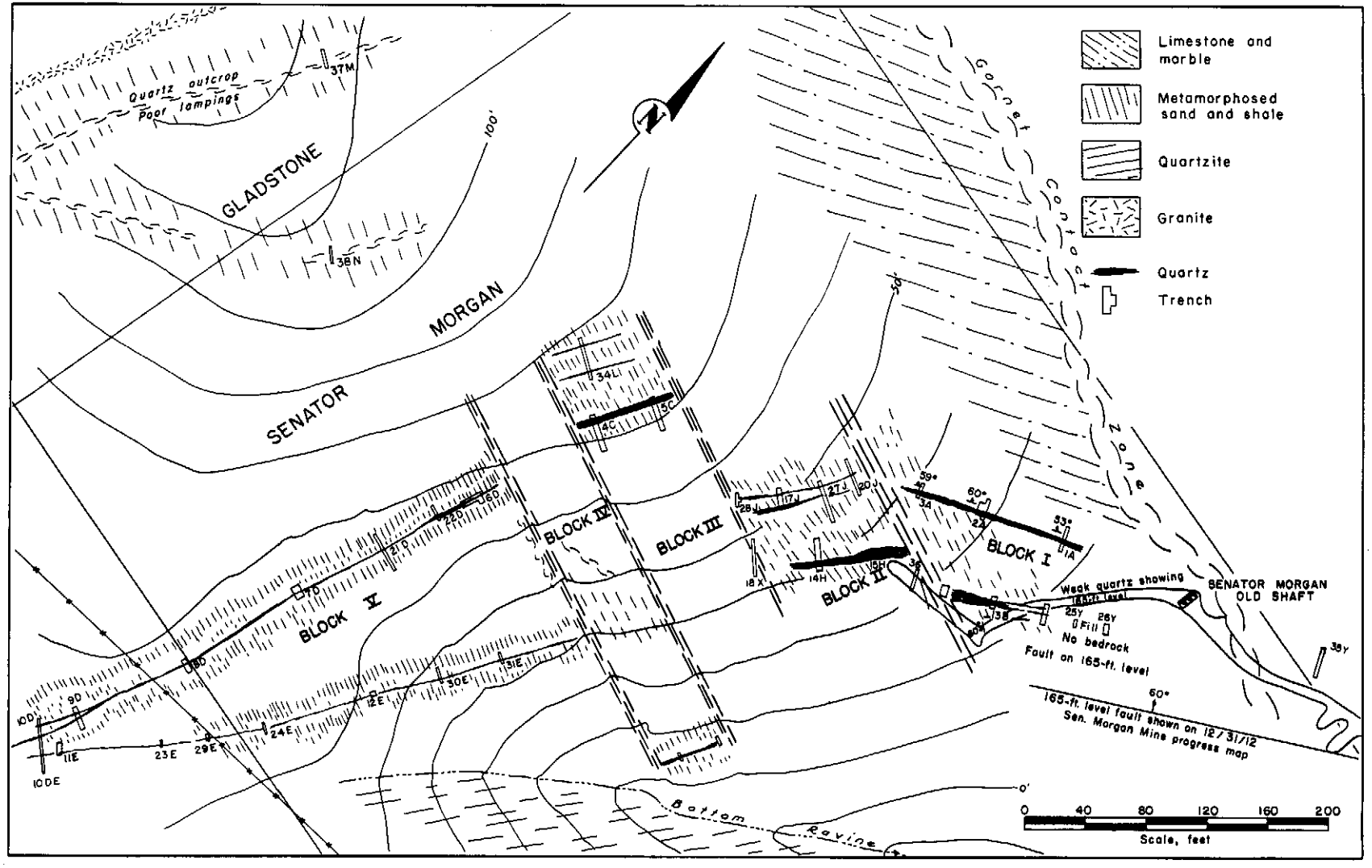


FIGURE 31. - Quartz Area, Senator Morgan Mine (Composite).

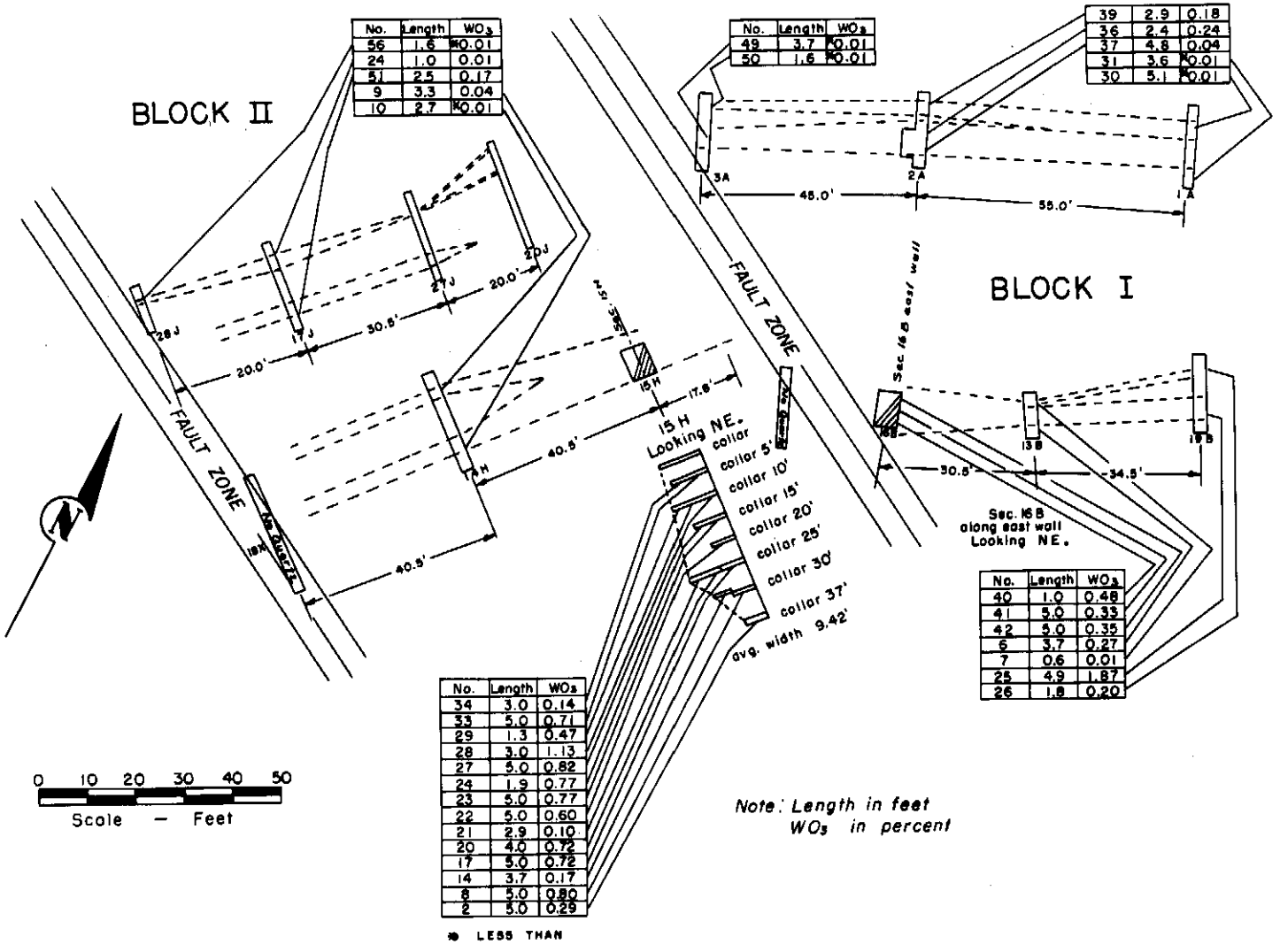


FIGURE 32. - Blocks I and II, Quartz Area, Senator Morgan Mine.

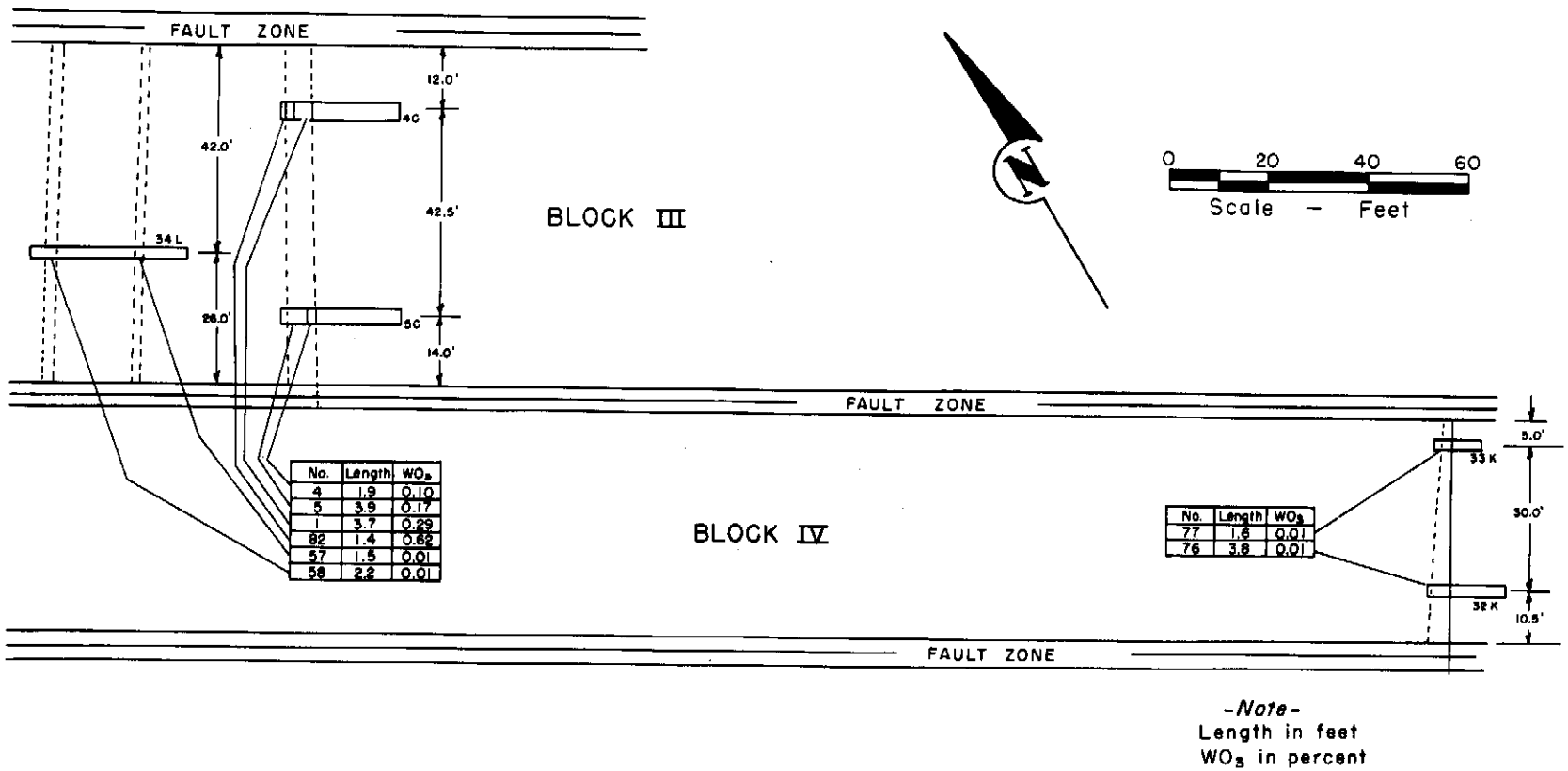


FIGURE 33. - Blocks III and IV, Quartz Area, Senator Morgan Mine.

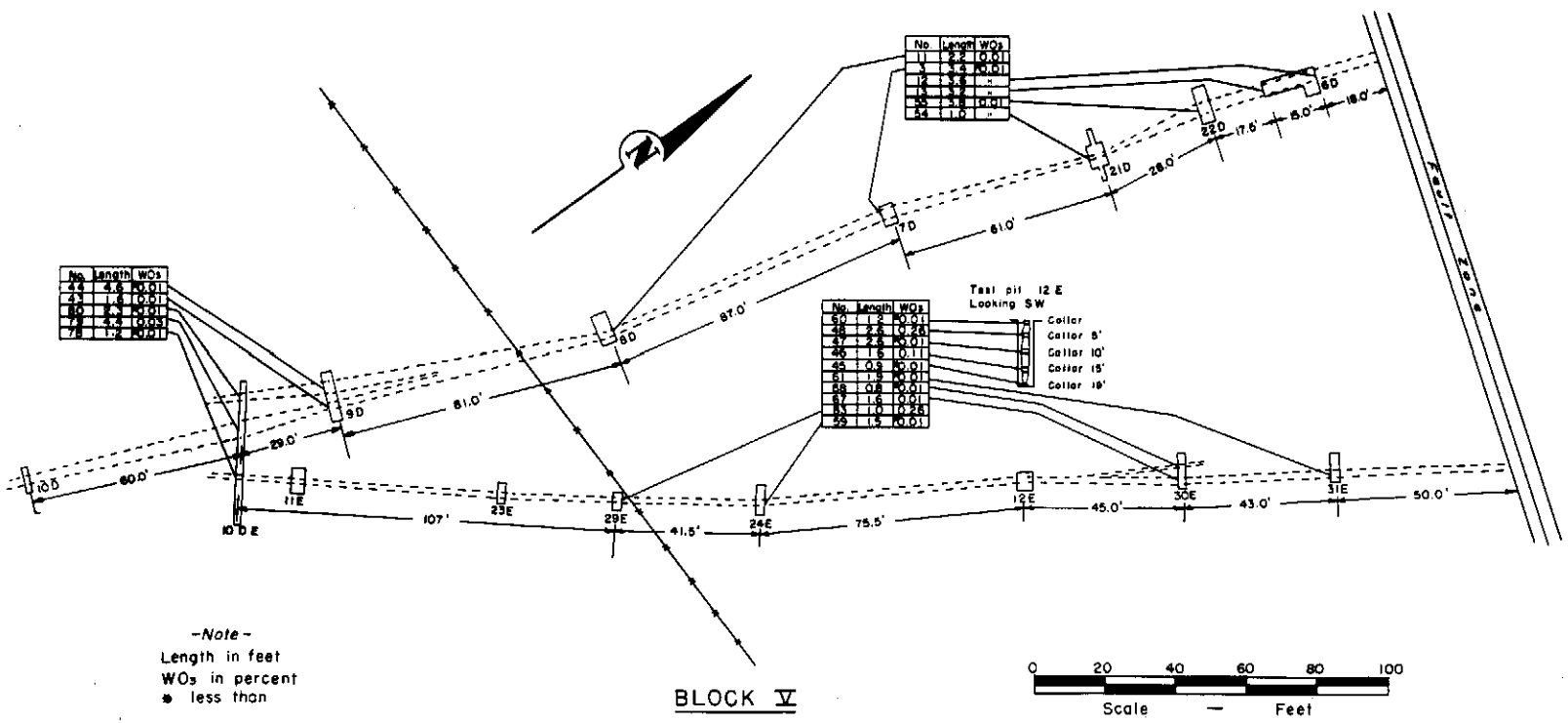
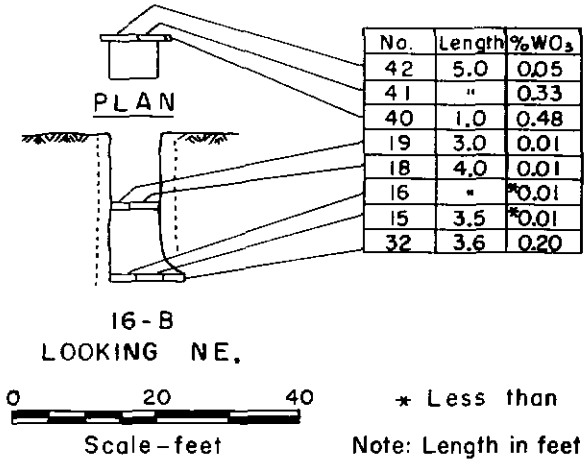


FIGURE 34. - Block V, Quartz Area, Senator Morgan Mine.



No.	Length	%WO_3
42	5.0	0.05
41	"	0.33
40	1.0	0.48
19	3.0	0.01
18	4.0	0.01
16	"	*0.01
15	3.5	*0.01
32	3.6	0.20

FIGURE 35. - Test Pit, No. 16-B, Senator Morgan Mine.

In one trench only, 4C, mineralization of the walls was noted. In this instance scheelite in good quantity had penetrated the hanging wall for a distance of 1 foot.

In block V there is evidence of shearing parallel to and affecting the veins themselves, particularly toward the center of the block. With the exception of the upper part of the vein exposed in test pit 12E, all of the shattered quartz lamps very weakly.

The combined length of the two-vein system in blocks I, II, III, and V is about 600 feet. Block IV has been excluded because the quartz vein occurring at its eastern end cannot be tied in with those in the other blocks.

Some doubt must be admitted as to whether the vein lengths in the various blocks were once united in an uninterrupted series, rather than being short lenses essentially in place. The field evidence in favor of a once-continuous system appears much the stronger. In test pit 16B, the fault zone is clarly exposed. Fault gouge appears in trenches northeast and southwest of test pit 16B and indicates the strike of the fault. The fault then is seen to pass beyond the end of the outcrop of the lower vein in block I, and also to tie in with the southern end of the upper vein outcrop in block I.

The fault shown between blocks II and III is based on three points. They are: (1) The abrupt ending of quartz outcrops on segment C; (2) fault gouge a and shattered quartz in trench 28J; and (3) shearing parallel to the strike of this inferred fault zone in trench 18X.

The line of separation between blocks III and IV is defined by the abrupt termination of segment C to the south, a like termination of segment K, and a small drainage line coincident with the fault. The upper vein in block III does not actually crop out, but quartz fragments from it are strewn thickly over the area between the fault lines, whereas very few are seen on the adjacent blocks.

Along the line separating block IV from block V, the upper vein in block V, there of good width, ends. A barren quartz vein parallels, and is immediately adjacent to, this line. The lower vein does not crop out north of trench 31E and has not been traced over this interval. A fault scarp is visible in the small ravine marking this line of weakness, and may be projected to the southern end of the segment K.

There is no conclusive evidence of the extension in depth of the veins sampled at or near the surface. On the 165-foot level quartz appears, but it cannot be projected to outcrops.

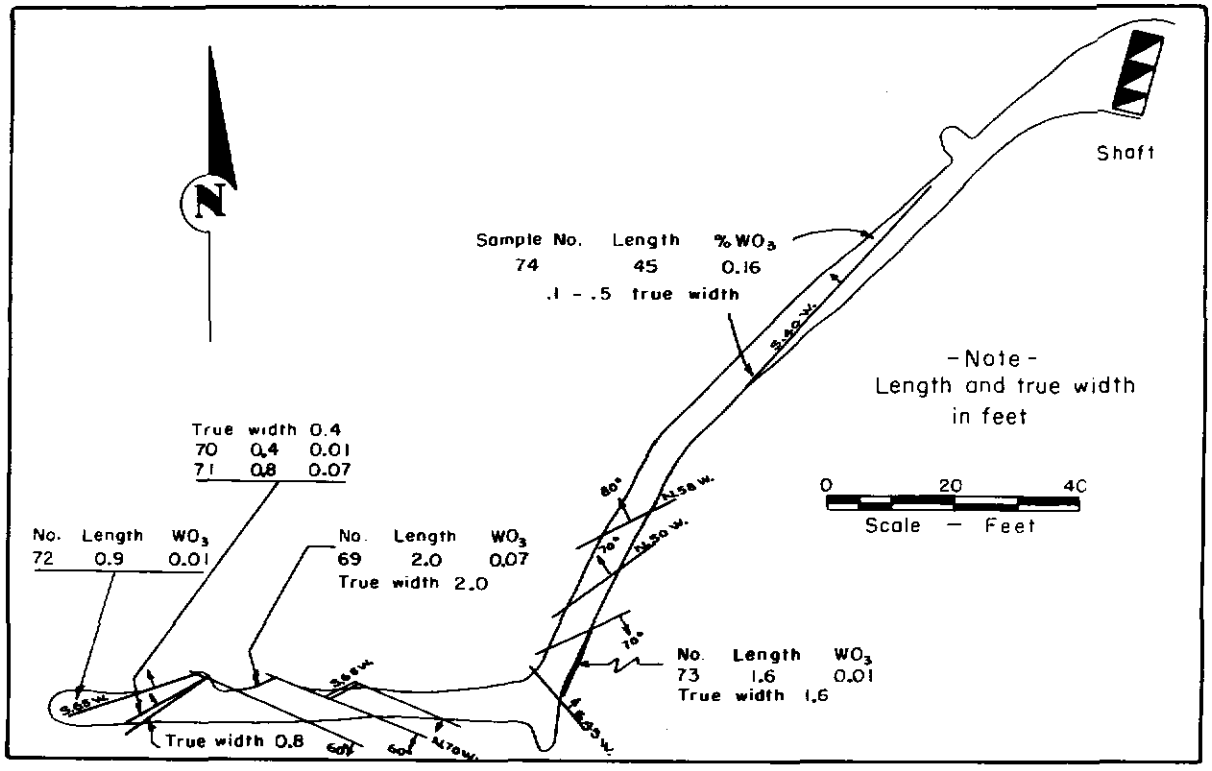


FIGURE 36. - Senator Morgan Mine, Morgan (Old) Shaft, 165-Foot Level.

The presence of scheelite-bearing quartz in a divided vein in the last 20 feet of the southwest drift driven on the 165-foot level proves that at least down to this horizon tungsten mineralization exists. Because of its proximity to the more promising lower vein in blocks I and II, the latter may be expected to contain small scheelite shoots to the 165-foot level.

Minor amounts of quartz are present in the garnet zone bounding the investigated area on the north. No place tested with the ultraviolet lamp showed more than a few specks of scheelite.

The vein system has been investigated with a reasonable degree of thoroughness on the surface. A total vein length of about 1,200 feet shows one shoot of marginal ore at this horizon.

The ore is amenable to concentration. An ore sample assaying 0.805 percent WO_3, ground from 5.1 percent plus-65-mesh to 32.1 percent minus-200-mesh, produced concentrates by flotation treatment that assayed 62.08 percent WO_3 with a recovery of 92.5 percent.

No work has been done on the scheelite occurrences since Taylor and associates released the property sometime during the late 1940's.

Serasio Mine

Six patented and 21 unpatented lode claims comprise the Serasio group in secs. 25 and 36, T. 17 S., R. 12 E., and secs. 30 and 31, T. 17 S., R. 13 E. The altitude in this area is approximately 3,500 feet. There is a black-top road to the mine from Tucson. Follow the San Xavier Mission road 20.2 miles southerly from the junction of the Ajo and Mission roads to a good dirt road. Follow this dirt road westerly for 0.3 mile to the central part of the claims.

In 1911, a man named Pemberton shipped from this group of claims about 10 carloads of copper ore, carrying from 3.5 to 5.0 percent copper with a few ounces of silver. Michael Serasio, the present owner, relocated a number of the claims in 1912. Since that time 7 or 8 carloads of copper ore has been shipped from the property. The ore contained from 3.5 to 7 percent copper and a few ounces of silver. There has been one shipment of tungsten ore from the property by a lessee, but no record of the shipment is available. It is thought by Serasio that about 20 tons, carrying an estimated 4 percent WO_3, was shipped from the Chapultepec shaft.

Figure 37 is drawn from maps possessed by Serasio, showing the locations of samples cut by Serasio and associates. Assay results are shown on the drawing. The senior writer cut one rock-type sample (14839) from the workings on Catherine No. 4 claim. There were no ladders in the shafts; hence no samples for tungsten assay were cut.

Copper carbonates, sporadic scheelite, and a small amount of silver occur in a contact-metamorphic deposit. The ore occurs near a contact of granite and limestone in a garnetized zone. The scheelite is intermingled with calcite and garnet throughout the deposit. Pockets of ore occur in the Chapultepec and Serasio shafts.

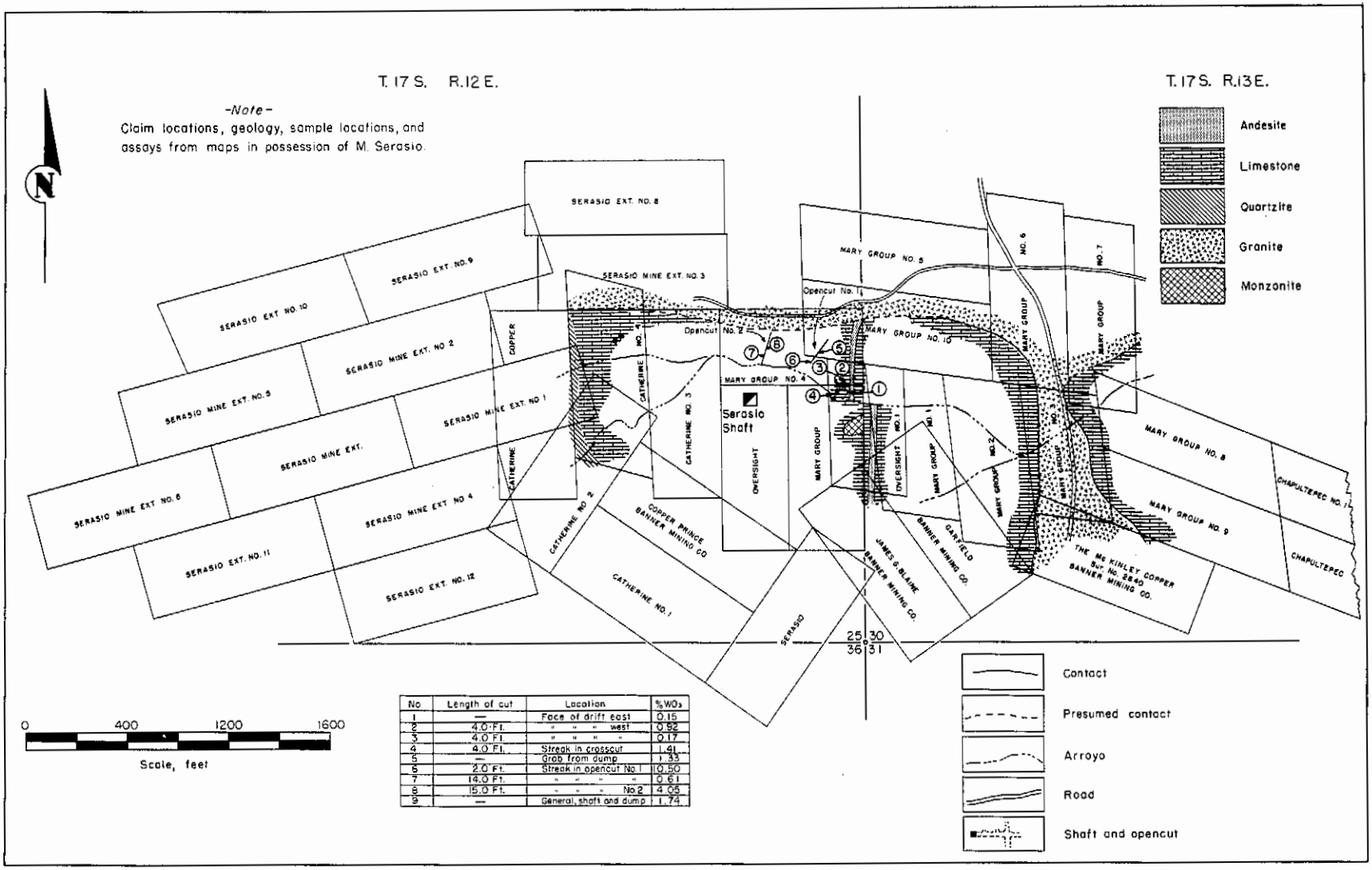
The scheelite may be floated easily from the garnet. Such a flotation concentrate from a metallurgical test by the Arizona Bureau of Mines in 1941 assayed 40 percent WO_3. The principal impurity was calcite, and the concentrate was subsequently leached with hydrochloric acid, leaving the concentrate as a residue containing 65.6 percent WO_3.

Mineral Hill Mine

The Mineral Hill group of 38 patented claims is in sec. 2, T. 17 S., R. 12 E., and sec. 35, T. 16 S., R. 12 E., Pima mining district, Pima County, Ariz. This mine is reached by driving 16 miles south from the junction of the Mission and Ajo roads in Tucson and thence 0.1 mile easterly to the office of Banner Mining Co., owner. The claims lie on the northeast piedmont of the Sierrita Mountains at an altitude of about 3,500 feet. The main shaft and structures are at the south foot of Mineral Hill.

The following history, production, and geology were abstracted from a recent report.[25]

25/ Storms, W. R., and Bowman, A. B., Mining Methods and Practices at the Mineral Hill Copper Mine, Banner Mining Co., Pima County, Ariz.: Bureau of Mines Inf. Circ. 7786, 1957, pp. 1-6.



No	Length of cut	Location	%WO3
1	—	Face of drift east	0.15
2	4.0 Ft.	" " " west	0.92
3	4.0 Ft.	" " " "	0.17
4	4.0 Ft.	Streak in crosscut	1.41
5	—	Grab from dump	1.33
6	2.0 Ft.	Streak in opencut No. 1	10.50
7	14.0 Ft.	" " " "	0.61
8	15.0 Ft.	" " " No. 2	4.05
9	—	General, shaft and dump	1.74

FIGURE 37. - Part of Serasio Group, Twin Buttes District, Pima County, Ariz.

Claims on Mineral Hill were located first about 1882, and were worked intermittently for high-grade copper ore until 1921. There were no mining operations on the property from 1921 to 1951, when the Banner Mining Co. with Government exploration assistance pumped out the mine, rehabilitated most of the old underground workings, and thoroughly sampled them. With enough ore indicated, a 400-ton flotation plant was placed in operation in June 1954.

Production records are incomplete. However, it is reported that approximately 100,000 tons of ore was mined from the property during the years 1882 to 1917 at grades ranging from 3.8 to 20.0 percent copper. The ore carried a small amount of silver.

Sedimentary rocks, ranging from Cambrian to Cretaceous in age and consisting principally of limestones, shales, and quartzites, crop out in the vicinity of the Mineral Hill mine. Further eastward these rocks are covered by surface material, which is some 150 feet deep at the eastern property line. The sediments have been intruded by granite, which underlies much of the area, and are cut by several porphyry dikes.

A large east-west preore thrust fault, the Mineral Hill fault, transverses the claims for almost 5,500 feet. At places this fault strikes almost north-west, but its general trend is east-west; it dips about 35° southward. Ore mineralization occurs along this large fault, usually at intersections with cross faults or at or near intrusive contacts with limestone or quartzite.

Copper-ore deposits at the Mineral Hill mine are of the contact-metamorphic type; the deposits usually occur sporadically along shear zones in the limestone and also are disseminated through the contact silicates. Chalcopyrite is the principal ore mineral, although small amounts of chalcocite and bornite also occur. Some magnetite and pyrite and small amounts of sphalerite, molybdenite, and scheelite are found. The gangue consists of limestone, quartz, pyrite, hematite, calcite, and contact silicates.

Considerable work has been done on the recovery of scheelite as a byproduct. According to A. B. Bowman, the original mill circuit was set up to float the pyrite out of the copper tailing. The copper tailing then went to ten 5-turn rougher spiral separators followed by two 5-turn cleaner spiral separators. The concentrate from the cleaner spirals went to a No. 6 Wilfley table.

On an average head of from 0.06 to 0.10 percent WO_3 this method effected a recovery of from 10.0 to 12.0 percent, and the final concentrate ran from 3.0 to 3.5 percent WO_3.

In an attempt to increase recovery and upgrade the concentrate, a large amount of test work was done. Flotation and combinations of flotation and

gravity concentration were tried. Recoveries of 75 percent and better were obtained, but the concentrate grade fell to from 1.0 to 1.5 percent WO_3. By treating the concentrate with acid it was found that the grade could be raised to about 15.0 percent WO_3. Due to high acid consumption, this treatment was considered not economically feasible.

The approaching end of the Government's tungsten purchasing program combined with the doubtful economics of the recovery of tungsten from the copper tailing caused the project to be shelved.

Four samples (14840, 14841, 14842, and 14843) were taken from the tailings pond by the senior author. These samples were cut with a 4-inch auger to a depth of 10 feet. Three of the samples assayed 0.08, and the other 0.07, percent WO_3. The samples, aggregating about 350 pounds, were turned over to the Minerals Utilization Branch of the Bureau of Mines Southwest Experiment Station for beneficiation tests.

Wet tabling and flotation tests were made on a composite of four auger samples of dry impounded flotation tailing from the Mineral Hill deposit to determine the grade and recovery of tungsten concentrate that could be obtained. The sample weighed about 350 pounds and had an assay of 0.08 percent WO_3, 18.5 percent Fe, and 0.15 percent Cu. The sample contained scheelite associated with limestone, quartz, magnetite, and pyrite. About 70 percent of the scheelite was finer than 325-mesh. Flotation tests also were made on three samples of wet tailing obtained from the copper concentrator over an interval of several months at about the time the property was examined by the field engineer. These samples assayed 0.06 percent WO_3 and had the same mineral composition and association as the impounded tailing. Most of the scheelite in these samples also was in the slime fraction; about 73 percent was finer than 325-mesh.

The impounded tailing sample was pulped and tabled, but because of the extreme fineness of the scheelite only a small quantity was recovered. The table concentrate assayed 0.87 percent WO_3 and accounted for a tungsten recovery of 11 percent. An additional 7 percent of the scheelite reported in the table middling, which assayed 0.4 percent WO_3. In view of the poor results obtained in the test on the impounded tailing, tabling of the wet tailing samples was not attempted.

A number of selective flotation tests were made on the impounded and wet tailings to determine the best procedure for recovering the scheelite. Optimum results were obtained by floating the pyrite with xanthate collector, followed by flotation of the scheelite with fatty acid. Preliminary to the flotation step, mild attrition scrubbing and washing of the tailing to a pH of about 8 was obligatory to remove soluble calcium hydroxide that had been added in the milling step to retard the pyrite during copper flotation. The washing treatment improved the pyrite flotation, gave better selectivity in the

scheelite float, and reduced reagent requirements. Summarized results of several tests on the four samples are given in the following table:

Summarized results of selective flotation tests on impounded and wet tailings

Sample	Scheelite rougher concentrate		Rougher tailing	
	Assay, percent WO_3	Distribution, percent WO_3	Assay, percent WO_3	Distribution, percent WO_3
Impounded tailing..	3.79	45.4	0.054	54.4
Impounded tailing..	1.46	55.6	.044	44.2
Wet tailing No. 1..	1.04	77.2	.016	20.8
Wet tailing No. 2..	4.64	76.0	.014	22.9
Wet tailing No. 3..	2.28	85.5	.009	14.1

Reagent requirements for the different tests varied only slightly. In a typical test, the pyrite was floated at a pH of 8.5 with 0.6 pound of Na_2S per ton of dry tailing as an activator; the collector and frother requirements per ton of tailing were 0.16 pound of potassium amyl xanthate, 0.16 pound of mercaptobenzothiazole, and 0.04 pound of pine oil. After removal of the pyrite, the flotation pulp was conditioned with 5.0 pounds of soda ash, 3.0 pounds of sodium silicate, and 0.2 pound per ton of quebracho. The scheelite was floated from a dispersed pulp at a pH of 10 using 1.5 pounds of oleic acid per ton of tailing.

The pyrite froths produced in the different tests assayed about 0.005 percent WO_3 and accounted for tungsten losses of 0.2 to 2.0 percent. The grade of scheelite concentrate produced was low because of the presence of calcite, activated quartz, and residual pyrite which persisted in floating with the scheelite. The use of gangue depressants such as lignin sulfonates, organic and inorganic chelating compounds, sodium cyanide, and other inorganic reagents failed to yield higher grade products.

Flotation of the pyrite from the impounded tailing was more difficult than from the fresh wet tailings, and the recovery of scheelite was somewhat lower. The incomplete flotation of the pyrite is attributed to partial oxidation in the tailing pond. Contamination of the scheelite surfaces by decomposition products of the organic reagents and lime used for copper flotation probably vitiated the tungsten recovery. In the wet flotation tailings, the scheelite surfaces were still relatively clean, and the mineral floated more readily.

The recovery of high-grade tungsten concentrates by one- and two-stage cleaning of the rougher froths was not successful. Concentrates assaying about 12 percent WO_3 were produced, but the tungsten recoveries were 25 to 35 percent because the small quantity of scheelite froth produced in treating the low-grade tailings was difficult to clean. In a continuous flotation operation where more froth would be available, scheelite concentrates assaying 15 to 20 percent WO_3 might be produced, but it is doubtful that concentrates

of much better grade could be recovered. A combination method of flotation and some means of hydrometallurgical treatment probably will be required to obtain good recovery of a marketable-grade scheelite product from either the wet or the impounded tailings.

Arivaca District

Arivaca, Ariz., is 59 miles southwest of Tucson. The nearest railroad shipping point is Amado on the Tucson-Nogales branch of the Southern Pacific Railway, some 24 road miles to the northeast.

There are several places in the district where there is enough water for small concentrating plants of up to 25 or 30 tons capacity. Fernstrom & Co. had a 25-ton gravity mill 2 miles east of Las Guijas. J. E. Casey operated a 25-ton capacity gravity mill in the Arivaca Wash about 5 miles west from Arivaca.

This resume includes the Las Guijas tungsten deposits about 6 air miles north-northwest of Arivaca, the tungsten occurrences in the San Luis Mountains some 6 air miles to the southwest, and the Lesjimfre prospect at the southeast corner of the Baboquivari Mountain range, approximately 18 air miles west of Arivaca (fig. 38).

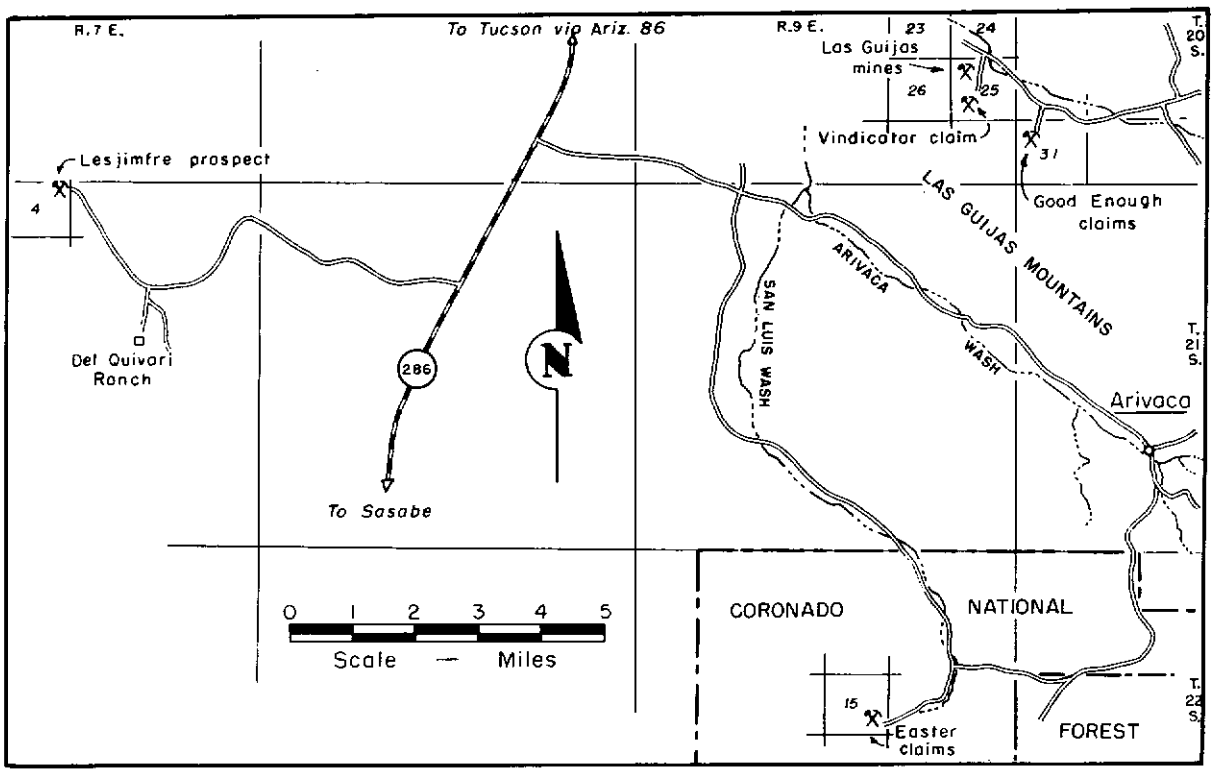


FIGURE 38. - Location of Tungsten Properties in the Arivaca Area, Pima County, Ariz.

The Las Guijas Mountains contain the most noted deposits, where tungsten was found about 1900. Production records are not complete, but it is thought that about 20,000 units of WO_3 have come from this area. Only a few tons of tungsten ore have been taken from the San Luis Mountains and the Lesjimfre prospect.

The Las Guijas deposits occur as wolframite series in quartz veins. There are at least six veins, two of which attain major size, in an area about 1.5 miles long by 3,000 feet wide. The veins cut granitic rocks.

The San Luis tungsten occurs as scheelite in narrow discontinuous quartz veins in granite. Very little work has been done on them.

The tungsten occurrence at the Lesjimfre prospect, from present evidence, is probably best described as scheelite in a local contact metamorphic deposit. Here narrow pegmatite dikes cut a calcareous schist formation. There are other intrusive dikes nearby, probably rhyolite. This is a recent discovery, and little work has been done.

Indicated reserves in the Arivaca district are estimated to be about 5,000 tons at 0.5 percent WO_3 and about 25,000 tons at 0.2 percent WO_3. There is estimated to be 100,000 tons of dump material at 0.05 percent recoverable WO_3. There is a good chance that further exploration work will uncover additional ore.

Good Enough Claims

The Good Enough claims, No. 1 and No. 2, are in the NW1/4 sec. 31, T. 20 S., R. 10 E. at an altitude of about 3,800 feet. They lie on the northeast slope of the Las Guijas Mountains about 59 miles southwest of Tucson. The property is reached by driving 37 miles south from Tucson on U.S. Highway 89 to the Kinsley ranch and thence westerly for 14.5 miles on a good gravel road to a junction marked Mary G mine. Follow the right branch 6.0 miles to an unimproved road that branches southerly or to the left. Follow this road 0.5 mile to its end at the lower adit on the Good Enough No. 1 claim.

It is reported that these claims originally were located in 1892 for silver ore. The claims, formerly a part of the Soto group, bave been abandoned and relocated several times. Carl Schwartz located the claims in 1929 as part of the Esperanza group. In 1930 the claims were acquired by Frank Zappia and associates, from whom G. A. Aliprandini and J. A. Zappia purchased the property about 1950.

It has been estimated that about 1,000 units of WO_3 was produced from this property prior to 1943. Since then, small-scale operations have been carried on. In 1956, Don Lieberman Enterprises, Inc. leased the mine and is reported to have produced about $5,000 worth or ore. Zappia said a pocket of wolframite ore 4 feet wide was encountered. After Lieberman, a man named Lemas took a short-term lease on the property and produced a few thousand pounds of concentrate. The ore was concentrated at Fernstrom's mill, in Las Guijas Wash about 0.6 mile from the lower adit of the Good Enough No. 1 claim.

Considerable exploration and development work has been done on the property, as shown by the mine map (fig. 39).

The wolframite series with minor amounts of scheelite occur in quartz lenses in an irregular fracture zone through a granitic formation. On the Good Enough No. 1 claim the outcrop is exposed for some 800 feet. The zone strikes N. 75° W. and dips approximately 60° NE. The irregular, discontinuous quartz bodies within the fissure range from 10 to 50 feet in length and from a few inches to about 5 feet in width. They pinch and swell abruptly along both the strike and the dip. Cross-faulting and postmineral lamprophyre dikes appear to have been responsible in some cases for the abrupt termination of quartz segments.

The fracture zone has been explored continuously for about 500 feet. Most of the quartz encountered showed little or no tungsten mineralization. Sporadic bunches and small pockets of wolframite have occurred along the outcrop for a strike length of about 80 feet. In the middle adit, about 75 feet below the surface, the oreshoot was only about 40 feet long.

The nonpersistence of tungsten ore bodies for any great distance below the surface appears to be generally true throughout the Las Guijas district.

Vindicator Group

The Vindicator group of three unpatented claims, formerly of the Stewart-Fernstrom (Carboloy) group, is in sec. 25, T. 20 S., R. 9 E., situated on the north slope of the Las Guijas Mountains about 60 miles southwest of Tucson. The altitude at the mine is about 3,800 feet. The discovery monument on the Vindicator claim is about 300 feet south of the General Electric No. 2 workings. The mine is readily accessible by road. From Kinsley's ranch, 37 miles south of Tucson on U.S. Highway 89, follow a good gravel road westerly for 14.5 miles to a junction marked Mary G mine. Follow the right branch 7.7 miles to a road trending south. Follow this road across the Tungsten Mining Corp. property for 1.1 miles to the Vindicator workings.

The old Stewart group of 12 unpatented claims, located by L. L. Stewart in 1916, was worked by lessees prior to 1925 and later by the Cleveland Tungsten Co. L. G. Fernstrom bought seven of the claims in November 1940. The claims were named Union Nos. 1 to 4 and Las Guijas Nos. 1 to 3. Very little work was done on the claims by Fernstrom until 1950, when F. H. and R. Mining Co. leased the property. This company worked until September 1952, when the lease was canceled. Fernstrom worked the property from September 1952 to December 30, 1952. The Vindicator claims were relocated July 1, 1954, by Fred R. Carlson. In February 1956, Carlson deeded the claims to I. M. Whitney. Clarence Jarnigan leased the claims from Whitney during September 1956. According to L. G. Fernstrom, the Vindicator claim was leased to C. C. Calvin in October 1957.

There are no records of early production from the property. It is thought that no more than 200 units of WO_3 was produced prior to 1950. Jarnigan produced 1,300 pounds of concentrates that assayed 68 percent WO_3 from an

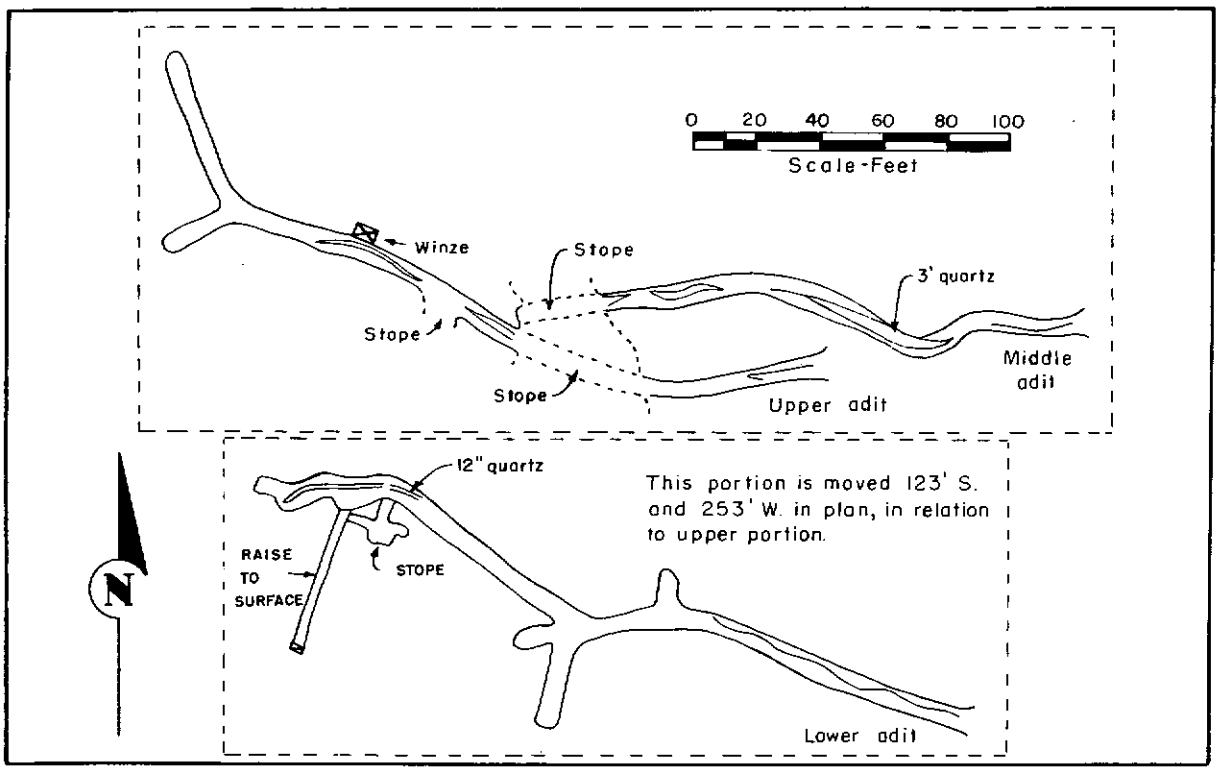


FIGURE 39. - Plan of Mine Workings, Good Enough No. 1 Tungsten Claim, Pima County, Ariz.

estimated 17 tons of ore. According to Fernstrom, about 500 units of WO_3 was produced from November 1956 to April 1957.

Surface exposures on the Vindicator claim consist of zones of small quartz stringers, trending N. 65° to 75° W. and dipping steeply northeast. The wolframite series, together with small amounts of pyrite and chalcopyrite, occur sporadically in the quartz. The geology is very similar to that at the Good Enough property about 1 mile to the east-southeast. Quartz lenses occur in a fracture zone through a granitic mass. The ore pockets pinch and swell on both the strike and the dip. The ore removed by Jarnigan averaged about 18 inches in width. According to Fernstrom, the ore occur in widths ranging from 12 inches to 8 feet and assays from 0.50 percent WO_3 to as high as 25 percent WO_3.

The underground workings were locked and inaccessible at the time of the writer's visit to the property. A description of the workings by L. G. Fernstrom must suffice. A lower adit containing three stopes is 400 feet long. An upper adit is 150 feet in length. One of the stopes connects the two adits. Fernstrom states that most of the 500 units of WO_3 produced from November 1956 to April 1957 came from the upper adit.

Las Guijas Mine[26/]

The Las Guijas tungsten property, owned by Tungsten Mining Corp., consists of 38 patented claims and a 40-acre mill site in secs. 23, 24, 25, and 26, T. 20 S., R. 9 E. about 60 miles southwest of Tucson. The route from Tucson to the mine follows U.S. Highway 89 southerly 37 miles to the Kinsley ranch and thence runs westerly on a good gravel road for 14.5 miles to a junction marked Mary G mine. Follow the right branch 7.9 miles to the Las Guijas camp. The mining areas are south and east of the camp.

The presence of tungsten ore at Las Guijas was known before 1900, but no appreciable production was reported until the First World War. H. Whitcomb and associates bought 16 claims and worked the deposits extensively during this war. No record is available, but several thousand tons of ore was taken from the workings. After the war there was little activity until 1930, when Tungsten Alloys Corp. acquired part of the property. This company built a gravity mill of 30 tons daily capacity. After running the mill for over a year, the company ceased operations. In 1933, the Ore Metal & Engineering Co. leased and reopened the mine and built a new mill. In 1935, the Southwestern Ore Corp. acquired a bond and lease on the property. In 1936, ownership passed to the General Electric Co. Tungsten Mining Corp. acquired the property on August 30, 1945. Production for the active periods of operation from 1930 to 1936 amounted to about 11,000 units of WO_3. Most of the ore mined during this time came from General Electric zone 2.

E. and L. G. Fernstrom held the property under a working agreement from 1942 to 1952. They produced about 1,000 units of WO_3, most of it from 1950 to 1952.

In 1954, F. H. Parker leased the property to work the old dumps. Parker estimated 100,000 tons of material in the dumps, containing about 1 pound of recoverable WO_3 per ton. His production is not known.

There are extensive underground workings and numerous surface trenches and shallow pits (fig. 40). A notice of patent lists 29 shafts, 2 crosscuts, 4 drifts, and 1 winze. The major workings consist of 2 shafts, one 270 feet deep and the other 70 feet deep; 5,015 feet of drifts and adits; 650 feet of crosscuts; and 535 feet of raises and winzes. Ore stopes ranged in width from 3 to 5 feet.

The wolframite series with small amounts of scheelite occur sporadically in quartz veins ranging in width from tiny stringers to 20 feet. The milky-white quartz occurs in granitic rocks consisting chiefly of quartz and feldspar. There are dikes of dark-colored, fine-grained lamprophyre and light-colored aplite in the granite. The quartz veins and lamprophyre dikes appear to be associated with one another, whereas the light-colored dikes are seldom

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26/ Information for this report came from the following sources:
Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, pp. 37-39. Bureau of Mines examinations made in 1941, 1942, and 1954.

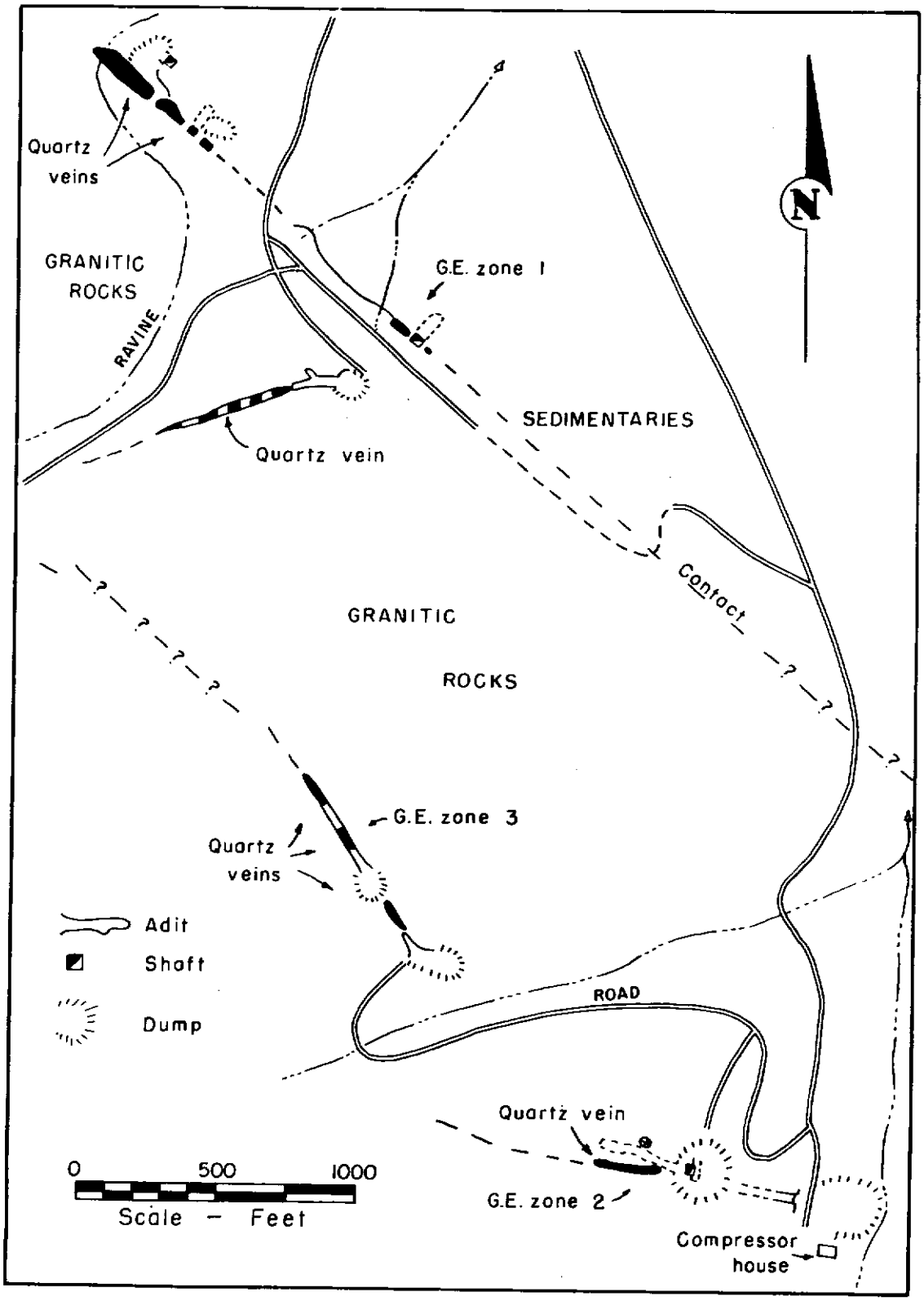

FIGURE 40. - Tungsten Mining Corp. Tungsten Property, Las Guijas District, Pima County, Ariz.

found near the quartz. The veins generally strike from N. 65° to 80° W. and dip 45° to 85° NE. One of the major veins on the property as shown on figure 40 strikes N. 60° E. and dips 70° NW.

Huebnerite is the principal ore mineral. Its distribution in the veins is extremely spotty, and pockets of rich ore and larger bodies of low-grade ore alternate with barren quartz in an erratic manner. Pyrite and chalcopyrite occur with the wolframite minerals; very minor amounts of fluorite and sphalerite usually are present.

Black Gold Group

The Black Gold group of three unpatented claims was not visited by the writer but was reported by Wilson.27/

The claims are situated about 2 miles north of Las Guijas. E. and L. G. Fernstrom were the owners in 1940. Development consists of a 40-foot shaft and a 70-foot adit on a branching northeast vein that yielded some 500 units from 1936 to 1940.

According to a Bureau field report in 1954 the mine was closed in 1940 and no further work had been done up to 1954 because the vein had become too narrow to work.

Easter Prospect

There are five unpatented lode claims in the Easter group, situated in the SW1/4 sec. 14 and the SE1/4 sec. 15, T. 22 S., R. 9 E. at an altitude of about 4,000 feet. The claims lie in the San Luis Mountains within the Coronado National Forest. To reach the property by road follow U.S. Highway 89 from Tucson 37 miles to the Kinsley ranch and thence 22 miles southwesterly on a good gravel road to Arivaca. Go south from Arivaca into Las Jarillas Canyon. At 5.5 miles from Arivaca and about 300 feet southwest of the Las Jarillas ranch windmill, turn west onto a good truck trail. Follow this trail 2.2 miles into San Luis Wash, then turn south and follow a trail to its end, 1.7 miles up the wash to the foot of a steep hill and about 200 feet east of the Easter scheelite discovery.

These claims first were located in 1929 or 1930 by the Brouse brothers on meager gold showings. Wm. J. Brouse owns the property today.

There has been a very small tungsten production from the property. About 1951 or 1952, Stockwell and Cummings picked up about 2,700 pounds of high-grade float from the surface. J. E. Casey mined and milled ore from the property from which about 400 pounds of concentrates were sold. These concentrates assayed about 77 percent WO_3. Don Lieberman Enterprises, Inc. leased the property in 1956 and made a bulldozer road into the working area. The

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27/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 39.

company planned to explore the scheelite occurrences, but the Government stopped purchasing tungsten ores, so work on the property was halted.

Only a few shallow pits and trenches have been dug on the scheelite deposit.

Sparse particles of straw-colored scheelite, ranging in size from small grains to masses weighing over 10 pounds, occur sporadically in a series of narrow, discontinuous quartz veins within a light-gray medium-grained granitic formation containing considerable muscovite. The quartz fissures strike generally N. 85° W. and dip steeply north. They range in width from a fraction of an inch to as much as 2 feet. There are several veins, but apparently some are barren because not all have been worked. Intermittent outcrops can be traced over a distance of several hundred feet. The scheelite occurs in bunches and small pockets in milky-white quartz, stained in some places with hematite and limonite.

A bed of dark-colored shale appears downstream in San Luis Wash about 0.5 mile northeast of the end of the truck trail.

Arivaca Placers

E. D. Wilson describes[28/] placers in the Las Guijas area.

Wolframite placers on the northeast slopes of the Las Guijas Mountains and on a tributary of Arroyo Seco about 2 miles north of Las Guijas camp were notably productive during the First World War. Since that time they have been worked intermittently, especially after heavy rains. Placer claims in this general region were held in 1940 by C. E. Udall and by M. J. Mitchell.

Scheelite and wolframite placers occur in the upper part of San Luis Wash about 5.5 air miles southwest of Arivaca. This area is a short distance northeast of and below the Easter group of claims. L G. Fernstrom held placer claims in this area for a number of years. In 1956, Clarence Jarnigan located two claims and tested the placer. He reported that some of the placer ran as much as 3 percent WO_3 and that he was able to make a dry-washer concentrate that assayed 20 percent WO_3.

Lesjimfre Prospect

The Lesjimfre property, comprised of one unpatented lode claim, is in the NE1/4 sec. 4, T. 21 S., R. 7 E. at the southeastern edge of the Baboquivari Mountains. The altitude in the vicinity of the claims is about 4,100 feet. The claims may be reached from Tucson by either of two roads. One may go west on State Highway 86 for 20.4 miles from the intersection of the Mission and Ajo roads to the junction of State Highway 286 and thence southerly for 37.1 miles on State Highway 286 to the Quivari ranch road. Follow the Quivari ranch road where it turns south and a truck trail turns west. Follow the winding truck trail northwesterly for 2.3 miles to the prospect. An alternate route

28/ Work cited in footnote 27, p. 104.

is to take U.S. Highway 89 south from Tucson for 37 miles to the Kinsley ranch and thence 22 miles southwesterly to Arivaca. From Arivaca go northwesterly on the Sasabe road for 12.2 miles to its junction with State Highway 286 to the Quivari ranch road.

Nothing is known of the early history of this prospect. One shallow shaft had been sunk before the property was located by its present owners.

In 1953, F. R. Carlson, L. G. Fernstrom, and J. R. Cummins located the Lesjimfre claims. Fernstrom bulldozer-stripped an area 30 by 80 feet to a depth averaging about 4 feet. From ore produced during this stripping operation, mill tests were made that produced 200 units of WO_3 that assayed from 55 to 60 percent WO_3. Four shallow pits from 4 to 6 feet deep were dug to better expose the ore zone in the bottom of the stripped area. According to Fernstrom, the ore taken out averaged about 0.28 percent WO_3. Two holes, 40 and 70 feet deep, were diamond-drilled a few feet west of the excavation. Fernstrom states that the material from the holes averaged 0.38 percent WO_3 in an ore zone 50 feet thick.

A number of very narrow pegmatite dikes have cut metamorphic rocks of schistic structure. In the white, altered feldspar of the dikes, fluorite can be seen. In zones ranging from a few inches to several feet on either side of the dikes sporadic scheelite mineralization is found. There are zones of epidote as much as 12 inches wide immediately adjacent to the narrow dikes. The pegmatite dikes are only a few inches wide.

The dikes strike E-W. and dip irregularly about 60° N. The beds of calcareous schist appear to strike northwesterly. A great amount of shearing action has taken place within the beds.

Scheelite mineralization is distributed throughout the stripped area; the host rock is mainly quartzite. Zones from 1 to 6 feet wide carry sporadic scheelite, and barren zones from 2 to 4 feet wide alternate with the ore. The area is covered with alluvium, but float can be observed for a few hundred feet on either side of the stripped area. Some of this float may have come from the stripped area when blasts were set off.

This occurrence resembles the scheelite deposits on the west side of the Baboquivari and Quinlan Mountains in the Papago Indian Reservation.

One sample for assay was cut during investigation of the property. Sample 14835, cut across 3.7 feet of quartzite in the northeast pit, assayed 0.23 percent WO_3. Samples (14836-14838) were cut for rock classification.

Circle Claims

A deposit not visited during the course of this investigation, but reported by Wilson,[29] is the Circle group. Inquiries in the area indicated

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29/ Work cited in footnote 27 (p. 104), pp. 39-40.

that very little, if any, production was made in the claims in recent years. Wilson's description follows:

> The Circle group of three unpatented claims is in the southeastern portion of the Baboquivari Mountains, some 60 miles by road from Tucson and 7 miles, via Ronstadt's gate, west of the Sasabe highway.
>
> These claims were located in 1939 by G. T. Harford and C. E. Bent. When visited early in 1940, they had been developed by a few shallow cuts.
>
> Here, the steep sides of Schaffer Canyon consist largely of a faulted complex of siliceous sedimentary beds and volcanic rocks, intruded by dikes of acidic and intermediate composition.
>
> One of the open cuts exposes a vein 6 to 18 inches wide and dipping 10 to 20 degrees westward. It consists of dull-white quartz with scattered bunches of wolframite, very sparse scheelite, and some pyrite.

Empire Mountains

Hilton Property

In May 1941, E. P. Hilton located two claims covering scheelite occurrences on his ranch in the Empire Mountains. The claims were on homestead land. Scheelite mineralization crops out in secs. 4, 8, and 9, T. 18 S., R. 17 E. at an average altitude of about 5,000 feet. To reach the area, go 23 miles southeasterly from Tucson on U.S. Highway 80 to Mountain View and thence 10 miles southward on Arizona State Highway 83 to a good, single-lane road leaving the highway through an iron gate. Follow the winding road westerly for 4.4 miles to the Hilton ranch. The mineralized zone is only a few hundred feet southeast of the buildings and trends southwest and northeast for a considerable distance (fig. 41).

Wilson[30/] described the geology in 1941:

> Here Paleozoic beds have been intruded by a stock, which, according to F. W. Galbraith, of the University of Arizona, ranges in composition from monzonite to granodiorite. This area is part of the Empire district, which from 1880 to 1930 preduced more than $1,000,000 worth of lead, copper, silver and gold.
>
> The principal scheelite deposits so far discovered in this area occur as disseminations in marble and in garnetiferous or siliceous beds. A belt of these altered sedimentary beds, 10 to 15 feet wide and intruded by granodiorite on both sides extends northeastward for about 3/4 mile from near the Hilton ranch house. When visited in

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30/ Work cited in footnote 27 (p. 104) p. 36.

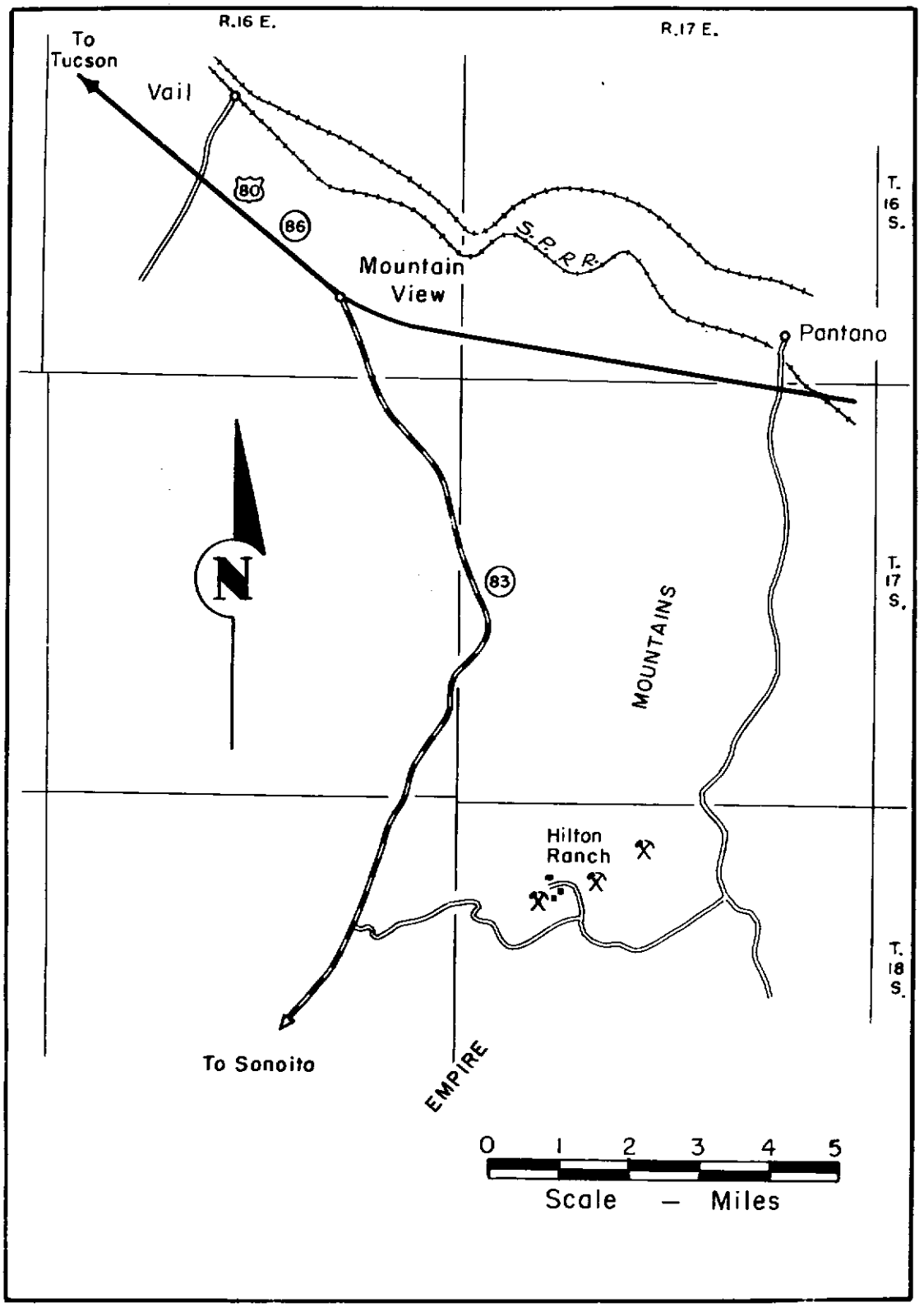

FIGURE 41. - Location Map Showing Approximate Trend of Scheelite Zone, Empire Mountains, Pima County, Ariz.

June, 1941, it had been found to contain disseminated scheelite bodies at several places along its outcrop but not enough prospecting had been done to determine much regarding their size, extent, or grade. Similar deposits occur a few hundred feet farther northeast where the granodiorite intrudes Carboniferous limestone at the base of a long ridge.

Conditions are unchanged today. In 1941, Hilton shipped 3 tons of ore that assayed about 0.75 percent WO_3 from a pocket east of the ranch house and about 20 tons of ore that carried approximately 0.50 percent WO_3 from a shallow shaft about 0.75 mile northeast of the house. No other work has been done since this ore was shipped.

The tungsten mineral fluoresces a light blue to yellow, the latter indicating high molybdenum content. Copper carbonates and small amounts of lead and silver occur with the scheelite. Large amounts of epidote and garnet are present.

Santa Rita Mountains

Helvetia Camp

Low-grade scheelite mineralization occurs in the garnetized zones of the limestone-granite contacts in the Helvetia district. The old Helvetia camp is in sec. 23, T. 18 S., R. 15 E. on the western slope at the northern end of the Santa Rita Mountains. The area may be reached by traveling south from Tucson for 18 miles to Sahuarita on U.S. Highway 89 and thence 14.1 miles southeasterly on a winding, graded road to Helvetia (fig. 42).

There has been a production, worth several million dollars, of copper, silver, gold, zinc, and molybdenum ores from the Helvetia district. There has been a very small, unknown production of scheelite ore.

In 1940, O. C. Mitchell discovered stringers of scheelite adjacent to molybdenite bodies in the Leader mine. Early in 1941, C. M. Taylor found disseminated scheelite and powellite in the garnetiferous contact zone near the Black Horse shaft. At this time these mines were the property of the Helvetia Copper Co. whose 42 patented claims in the district were leased to C. M. Taylor in 1941.[31/]

Today these mines are controlled by Lewisohn Copper Corp.

The Leader mine, one of the earliest to be worked in the Helvetia distric district, is 1.2 road miles easterly from the camp. The workings here consist of an adit, drifts, crosscuts, a shaft, and several winzes. The main adit was driven northerly on an irregular contact fissure which dips 30° to 60° easterly. Ore occurs in irregularly shaped lenses along the fissure between a granite hanging wall and a limestone footwall. Ore was extreacted principally for copper and molybdenum values. Gangue minerals are mainly magnetite,

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31/ Work cited in footnote 27 (p. 104), pp. 35-36.

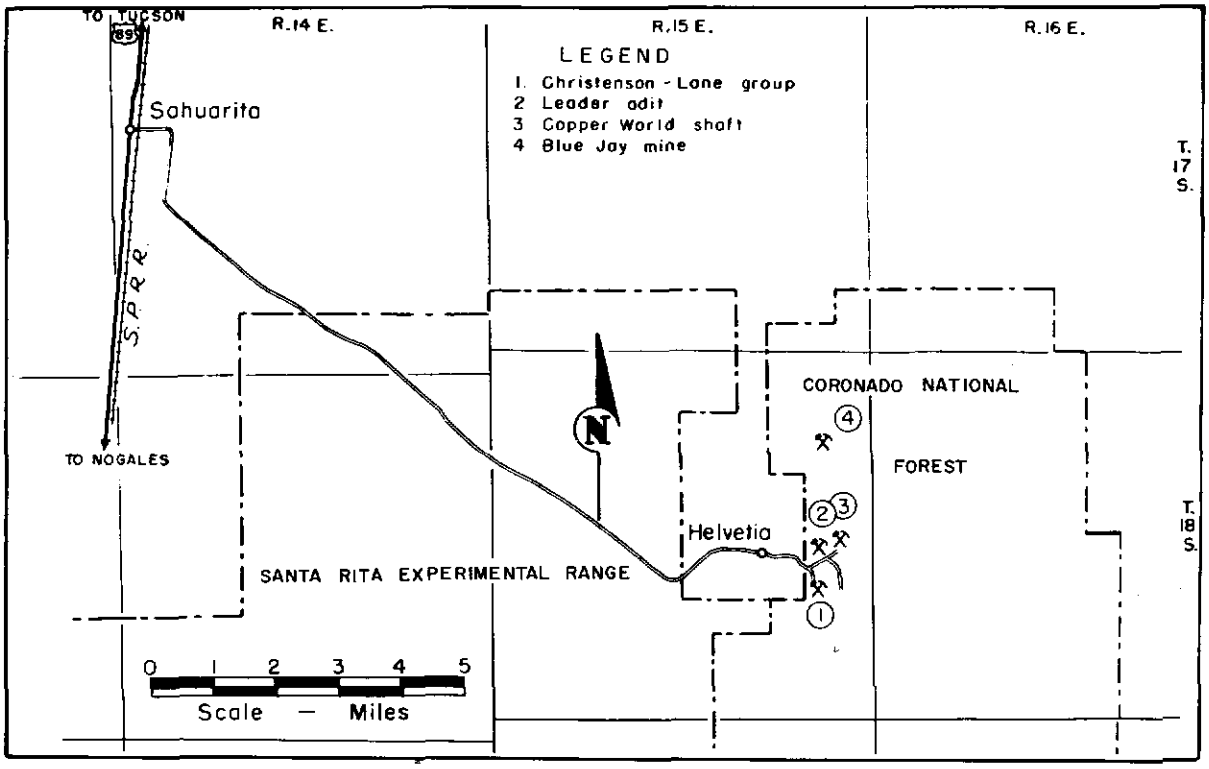

FIGURE 42. - Location Map of Scheelite Occurrences in Helvetia District, Pima County, Ariz.

garnet, epidote, diopside, and silicated limestone. About 150 feet from the portal of the adit is a crossfault on which a winze was sunk. Schrader[32] noted the presence of molybdenite in this winze, but did not mention powellite in the less altered limestone along and near the east-west cross fracture on the adit level. Some scheelite occurs with the powellite.

The Copper World shaft is about 800 feet northeast of the Leader adit, and the Black Horse shaft is about 800 feet north of the Copper World. The two shafts are connected by underground workings. The exact location of the scheelite near the Black Horse shaft, mentioned by Wilson, is not known.

According to Johnson[33] there is scheelite ore in the vicinity of the Blue Jay mine, located about 1.5 air miles north of the Leader mine.

32/ Schrader, F. C., Mineral Deposits of the Santa Rita and Patagonia Mountains, Ariz.: Geol. Survey Bull. 582, 1915, pp. 106-108.

33/ Johnson, Vard H., The Geology of the Helvetia Mining District, Arizona: Univ. of Arizona, Ph. D. Thesis, 1941, p. 99.

Scheelite also occurs in traces disseminated throughout the mineralized zone at the Rosemont lease,[34] a group of patented claims situated on the eastern slope of the Santa Rita Mountains a few miles east of Helvetia.

Christenson-Lane Group

The Christenson-Lane group of three unpatented claims is in approximate sec. 24, T. 18 S., R. 15 E., unsurveyed, in the northern part of the Santa Rita Mountains at an altitude of about 4,700 feet. The claims are within the Helvetia mining district. The property may be reached from Tucson by driving 18 miles south of U.S. Highway 89 to the village of Sahuarita, thence 14.1 miles southeasterly on a graded road to the Helvetia mining camp, and thence 1.7 miles southerly on a bulldozer road to the approximate center of the group.

O. O. Leonard discovered scheelite here in 1950. He built a road to the property, dug a pit 20 feet deep, and sank an inclined shaft 20 feet.

There has been no production from the property.

Scheelite occurs in narrow quartz veins in granite which contains some inclusions of schist, a few weak shear zones and fractures, and probable diabase dikes. The veins strike north to northeast and dip flatly to the east. There are two tungsten-bearing veins that average about 2 inches in width. One of the veins can be traced along its outcrop for about 200 feet, and the other vein is traceable for about 50 feet. The scheelite occurs sporadically through the quartz, as do copper stains and bunches of galena with little pyrite.

Samples of sorted ore are reported to assay in excess of 3 percent WO_3.

C & H Prospect

There are three unpatented lode claims in the C & H group, situated in sec. 21, T. 17 S., R. 16 E. at the northern tip of the Santa Rita Mountains at an altitude of about 4,000 feet. The claims are on State land. They may be reached by traveling southeast 22 miles from Tucson on U.S. Highway 80 to a dirt road that turns south through an iron gate. Follow this road 4.3 miles to a road fork. Take the right or west fork and go 0.6 mile to another road fork. Take the left or south fork and go 1.8 miles in a winding, southeasterly direction to the main workings on the property. The last one-half mile of road is primitive but is accessible by automobile (fig. 43).

Two shafts, one 60 feet deep and the other about 100 feet deep, were sunk on meager copper showings. Most of the old workings are inaccessible. G. L. Herring discovered scheelite at the old diggings in 1954, and in December 1954, he, H. E. Collins, and R. F. Humpal located three claims. During 1955 they mined from the surface and sorted from a dump 3 tons of

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34/ Creasey, S. C., and Quick, G. L., Copper Deposits of Part of Helvetia Mining District, Pima County, Ariz.: Geol. Survey Bull. 1027-F, 1955, p. 313.

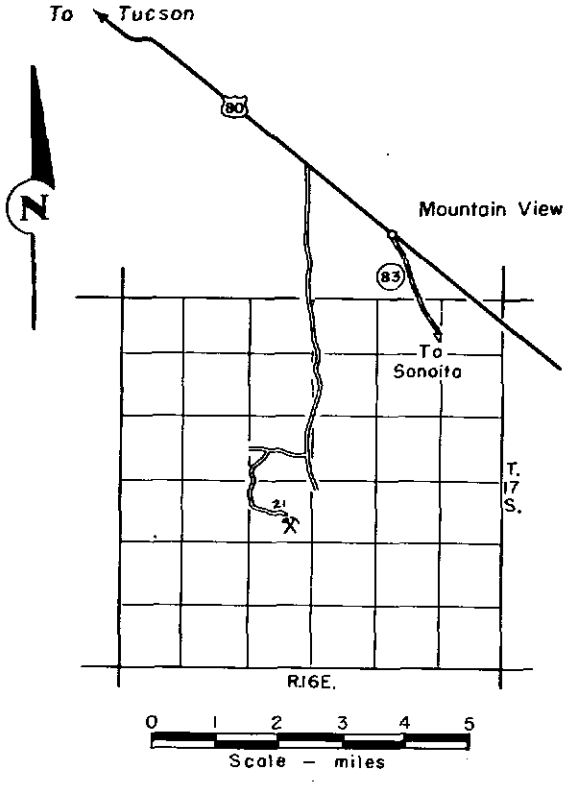

FIGURE 43. - Location Map of C & H Prospect.

scheelite ore which assayed 1.23 percent WO_3. This ore was shipped to the Fernstrom mill, where approximately 50 percent of the scheelite was recovered.

Sporadic, molybdenum-bearing scheelite, ranging in size from microscopic particles to 0.5-inch crystals, occurs in tactite consisting of garnet, epidote, calcite, and quartz. The tactite occurs in shear zones in limestone adjacent to two distinct types of granitic intrusions. One is of dioritic nature, and the other is a light-colored, fine-grained granite. The area is covered with alluvium, and not enough of the granitics can be seen to determine if they are of dike, laccolith, or stock origin. Wide zones of tactite seem to occur at the intersection of northeast- and southeast-trending shears adjacent to the granitics. Copper carbonates and small amounts of chalcopyrite and pyrite occur in narrow seams along the shears. There is a wide bed of marble present, but no mineralization appears to have penetrated it.

Three samples were cut. One was cut at the entrance to the main workings across 13.5 feet of tactite trending N. 38° E. with an apparent steep, southeasterly dip. It assayed 0.13 percent WO_3 and 0.10 percent copper. Another was cut 7.0 feet across the same tactite zone about 70 feet northeast of the first sample. It assayed 0.20 percent WO_3 and 0.26 percent copper. The third sample was taken from the dump of a small prospect hole at the top of a hill about 500 feet S. 40° E. from the main workings. It assayed 0.076 percent WO_3 and 0.26 percent copper. The hole was 3 feet wide in a tactite zone trending easterly.

Santa Catalina Mountains

Taylor X Claims

There are 32 unpatented lode claims owned by Standard Tungsten Corp., the bulk of which are in approximate sec. 13, T. 11 S., R. 15 E., unsurveyed, near the crest of Oracle Ridge in the Santa Catalina Mountains at an approximate altitude of 6,000 feet. The group is in Coronado National Forest, in the Old Hat mining district. Easiest access to the property is from the Oracle road. Go north 22 miles from Tucson on U.S. Highway 89 to Oracle Junction and thence easterly 11.6 miles on State Highway 77 to the old San Manuel road junction east of Oracle. Keep right, and follow a narrow, winding road (the old Mount Lemmon road) southeasterly 22.0 miles to the Control mine beside the

road. From there follow a bulldozer road 3.5 miles southwesterly to the Taylor scheelite workings (fig. 44).

Little is known of the history of the Taylor scheelite prospect. It probably first was worked about 1900 when prospectors were attracted to the Santa Catalina Mountains by discoveries of copper, lead, silver, and gold. Scheelite probably was not recognized here until about 1942, when C. M. Taylor acquired three claims. Sometime after 1942 a 110-foot adit was driven to connect with a 25-foot shaft from the surface, and two winzes were sunk about 20 feet below the adit. In 1948, a shipment of 800 pounds of hand-sorted ore containing 36.10 percent WO_3 was made. In 1953, the Standard Tungsten Corp. bought the 3 X claims from Taylor and either bought or located 29 additional claims. This company has shipped 4.5 tons of concentrates from ore extracted from the X claims, according to S. C. Hu, company president. Milling records show that the tungsten content of the ore averaged between 1 and 5 percent WO_3.

A prominent quartz vein, which strikes easterly and dips 45° to 75° southerly, occurs in a belt of schist and gneiss about 200 feet wide. Coarse-grained feldspar is a constituent of the quartz, and epidote and garnet occur in the schist near the vein. Scheelite occurs as large crystals and small masses disseminated in the quartz and also as veinlets or irregular bunches in brecciated zones. Ore has been found in small, high-grade pods, pockets, and shoots. The winzes were inaccessible at the time of the writer's visit to the property.

The geologic map of the Tucson quadrangle[35/] shows that the Taylor claims are situated near the contact between the Oracle granite of possible Precambrian age and the Leatherwood diorite of possible Late Cretaceous or Tertiary age.

Figure 45 is a geologic map of the area adjacent to the workings.

Control Mines

The Control property, a group of 50 patented and 25 unpatented claims, is in secs. 16, 17, 18, 20, and 21, T. 11 S., R. 16 E. on the northeast slope of the Santa Catalina Mountains within the Coronado National Forest. The mean altitude on the property is approximately 6,000 feet. Easiest access to the mines is from the Oracle road. Go north 22 miles from Tucson on U.S. Highway 89 to Oracle Junction, and thence easterly 11.6 miles on State Highway 77 to the old San Manuel road junction east of Oracle. Keep right, and follow the old Mt. Lemmon road southeasterly 22.0 miles to the Control mine buildings beside the road. An alternate route is by the New Mt. Lemmon paved highway from Tucson. The mine is 7 road miles northeast of the recreational area on Mt. Lemmon (fig. 46).

35/ Moore, B. N., Tolman, C. F., and Others, Geology of the Tucson Quadrangle, Arizona: Geol. Survey Open File Rept., Arizona Bureau of Mines, Pl. I, 1949.

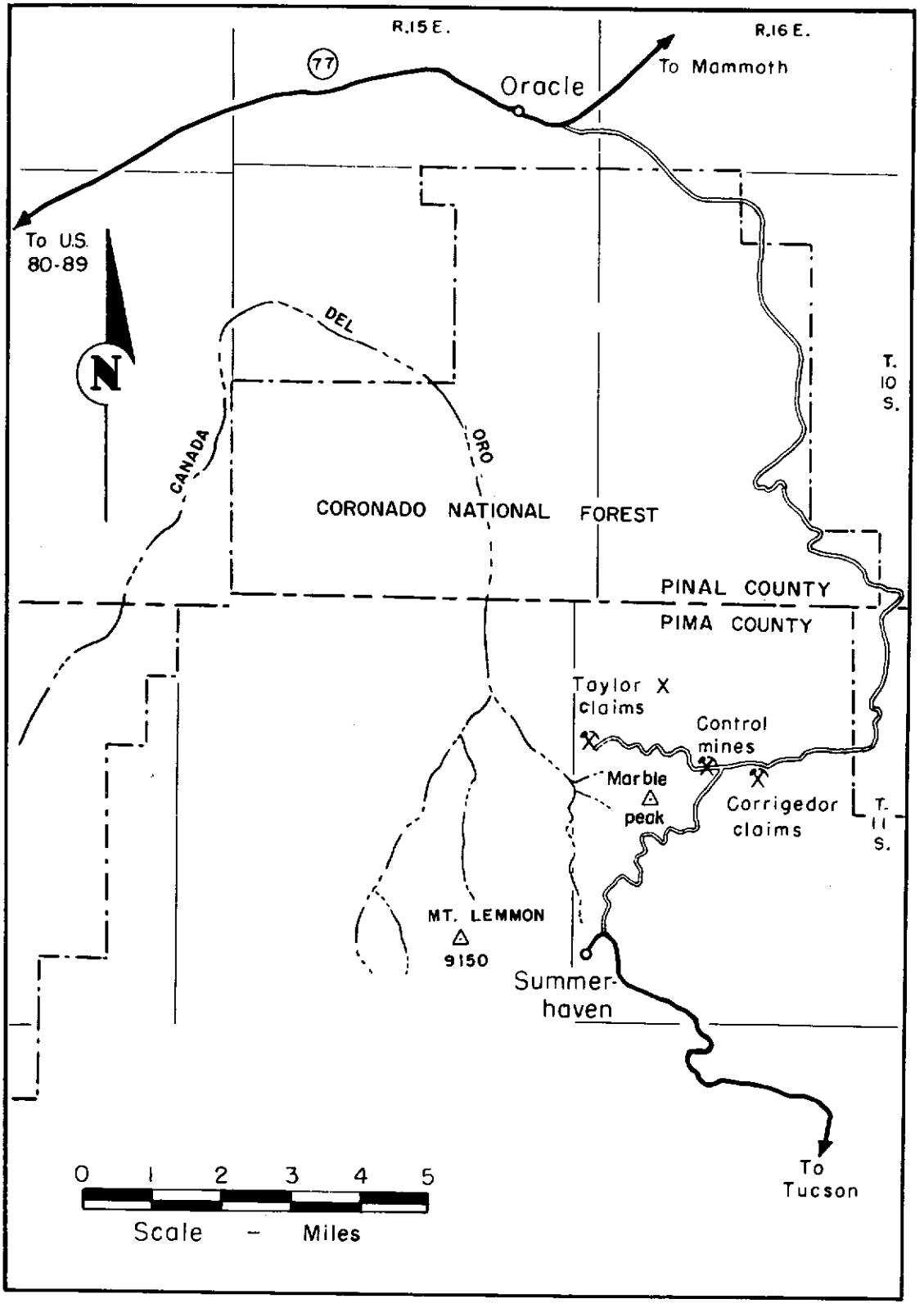

FIGURE 44. - Location Map of Scheelite Deposits in Santa Catalina Mountains, Pima County, Ariz.

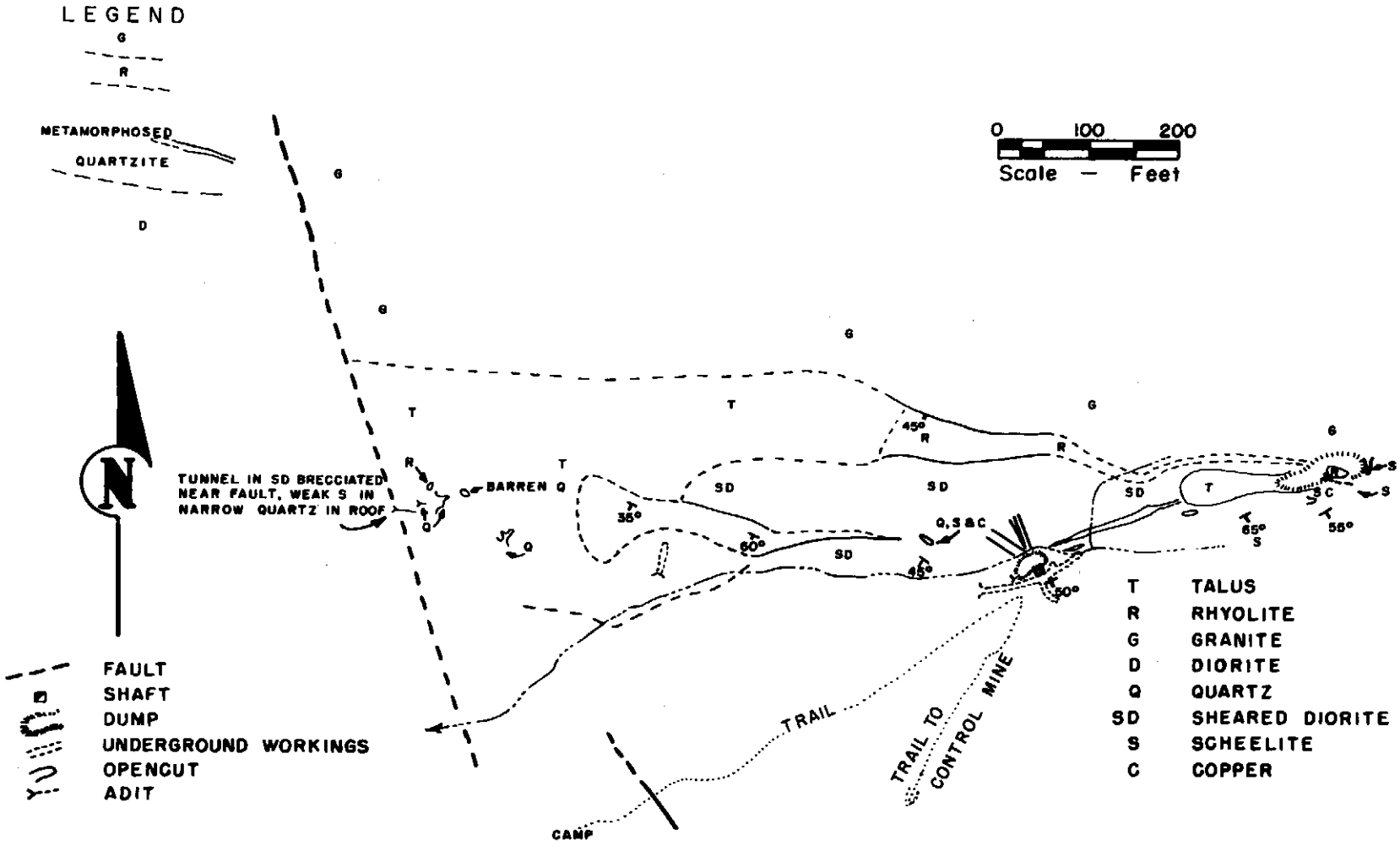

FIGURE 45. - Geologic Map of Taylor X Scheelite Deposit.

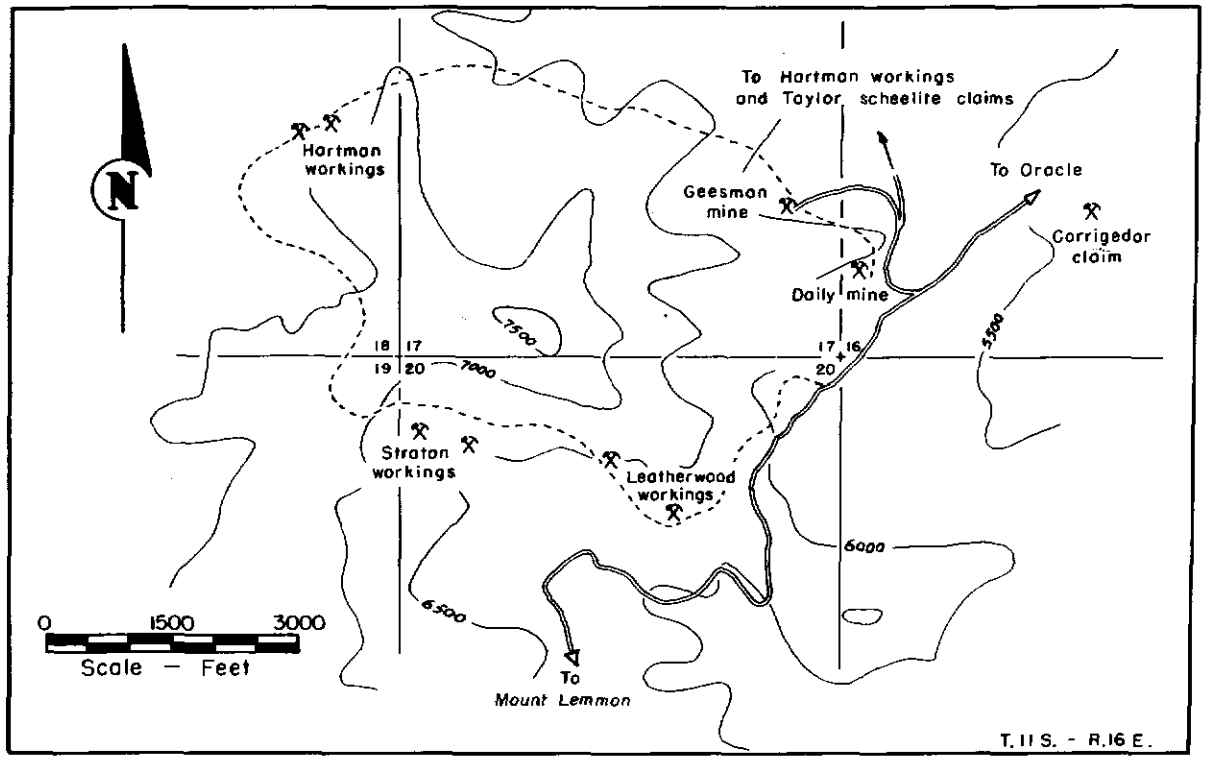

FIGURE 46. - Control Mines, Santa Catalina Mountains, Pima County, Ariz.

Prospectors found copper around Marble Peak, probably about 1900. Phelps Dodge Corp. began to explore the copper deposits in 1910 and did extensive development work during the next 3 years. The Geesman shaft was sunk and drifting was done on the 100-, 200-, and 250-foot levels. In 1937 the Catalina Consolidated Copper Co. leased the Geesman group and the adjoining Daily property. A 100-ton flotation plant was built, and 18,000 tons of ore, averaging 2.7 percent copper, was milled. In October 1939, Control Mines, Inc. bought the mill and leased the Daily property. In May 1940, the company acquired the Geesman property from Phelps Dodge Corp. From October 1939 to August 1942, production averaged between 1,500 and 2,000 tons of copper ore per month. In 1943, the property again changed hands, becoming the Control Mines Co. This company is said to have produced at approximately the same rate as the previous company until the middle of 1946, when the Government premium plan was discontinued and the operation was stopped. Later Arizona Copper Mines, Inc. acquired the property, and by 1951 had consolidated a number of contiguous groups of mining claims. This company retains ownership of them today.

Production of tungsten ore has been small. The greatest production has come from the Corrigedor claim, one of a group of six claims located by Newt Wells in 1942 or 1943. The Corrigedor lies about 3,000 feet east of the old Catalina Consolidated mill site. The group of claims was sold recently to

Arizona Copper Mines, Inc. Newt Wells sold 100 tons of ore containing 4 percent WO_3 from the Corrigedor.

One ton of scheelite ore containing 11 percent WO_3 was sold from the Geesman mine. The ore was taken from near the surface.

Ore deposits in this area occur in a contact metamorphic zone of almost continuous extent around Marble Peak. The trace of the contact is a great oval some 7,000 feet from east to west and 4,500 feet from north to south. Intrusive into a sedimentary series of limestones and quartzites is a mass of diorite. The intrusive has formed a tactite zone, which in general is composed of garnet, epidote, and quartz, and which has altered the limestone to marble.

Mineralization has been found at many points along the contact, and sizeable ore bodies have been developed and mined on the Geesman and Daily groups of claims. The ore minerals are chalcopyrite with subordinate amounts of bornite and chalcocite, and a minor amount of scheelite.

Scheelite has been found on the tactite-marble contact in the Daily mine in two small pockets, each estimated to contain less than 10 tons. Sporadic traces of scheelite are found throughout the Geesman mine, but the only places where scheelite ore could possibly be mined are along the tactite-marble contact in the P.D. adit and on the 100-foot level west of the hoisting shaft. In both of these localities the ultraviolet lamp indicates the presence of scheelite wherever the contact is exposed, but the mineralized zone is less than 2 feet wide in most places.36/

Scheelite on the Corrigedor claim occurs in quartzite that has been greatly altered. The stratum of quartzite crops out for about 500 feet along its easterly strike. The ultraviolet lamp shows scheelite for about 250 feet of this distance. Two shallow shafts have been sunk into the quartzite. The ore near the surface is as much as 3 feet wide, but narrows at depth. There is sparse scheelite at a depth of 30 feet.

In 1955, the American Exploration & Mining Co. mapped and sampled the Daily and Geesman properties. With the permission of Arizona Copper Mines, Inc., owners of the property, the following information was abstracted from a geological report by the American Exploration & Mining Co.

About scheelite mineralization in the Daily mine, the report states:

> The limestone immediately overlying the tactite contains a little scheelite. The mineralization is irregular and spotty and the zone is narrow, being about one foot wide.

36/ Peterson, Nels P., and Creasey, S. C., Some Copper Deposits of the Old Hat Mining District, Pima County, Ariz.: Geol. Survey Open File Rept., 1943.

Some scheelite occurs disseminated through the tactite but the grade is in general less than 0.2% WO_3. Locally, small pockets of scheelite occur in the narrow quartz epidote veins.

Enough scheelite showed in the Geesman mine so that a separate study was made there. A scheelite zone was found in the Geesman No. 1 level that was 200 feet long with an average width of 2.7 feet and an estimated grade of 1.4 percent WO_3. In the P.D. adit on the Geesman property a scheelite zone was found, also 200 feet long, with an average width of 2.0 feet and a content of 1 percent WO_3 with a mining width of 4 feet.

Sporadic traces of scheelite are found throughout the underground workings of the Geesman mine.

Two samples (14845 and 14846) were cut from the mill tailing dump. Both samples assayed 0.01 percent WO_3.

Big Bug Claims

The Big Bug group of four unpatented claims is situated on the eastern slope of Piety Hill at the southeastern extremity of the Santa Catalina Mountains in sec. 31, T. 12 S., R. 18 E. The altitude is approximately 4,000 feet. The claims lie on State land about 1 mile east of the Coronado National Forest boundary. To reach the claims, follow the Redington road northeasterly for 27.6 miles from the corner of Speedway and Wilmot Road in Tucson to a narrow bulldozer road turning northwest. Follow this road 0.1 mile to the location shaft on Big Bug No. 1 claim. About 10.6 miles of this road is paved and the remainder is a graded mountain road (fig. 47).

This property was located in 1944 by J. E. and H. A. Kinnison. Workings on the claims consist of a few shallow pits and opencuts. There has been no production.

Scheelite occurs near a garnetized area close to a contact between limestone and gneiss. The Tucson geologic quadrangle map[37/] shows that the limestone is the Cambrian Abrigo formation and that the gneiss is Catalina gneiss. There is a small exposure of Precambrian Oracle gneissic granite along the contact. The limestone has been marbleized to a great extent. The ore occurs sporadically in a discontinuous zone with a maximum width of 2 feet. The zone strikes northwest, dips steeply northeast, and can be traced along the strike for about 1,000 feet.

Associated with the scheelite are epidote, garnet, wollastonite, quartz, and a very small amount of copper carbonates.

Very little work has been done on the property. There is a shaft about 15 feet deep and few shallow prospect holes. An adit about 10 feet long has

37/ Moore, B. N., Tolman, C. F., and Others, Geology of the Tucson Quadrangle, Arizona: Geol. Survey Open File Rept., Arizona Bureau of Mines, 1949.

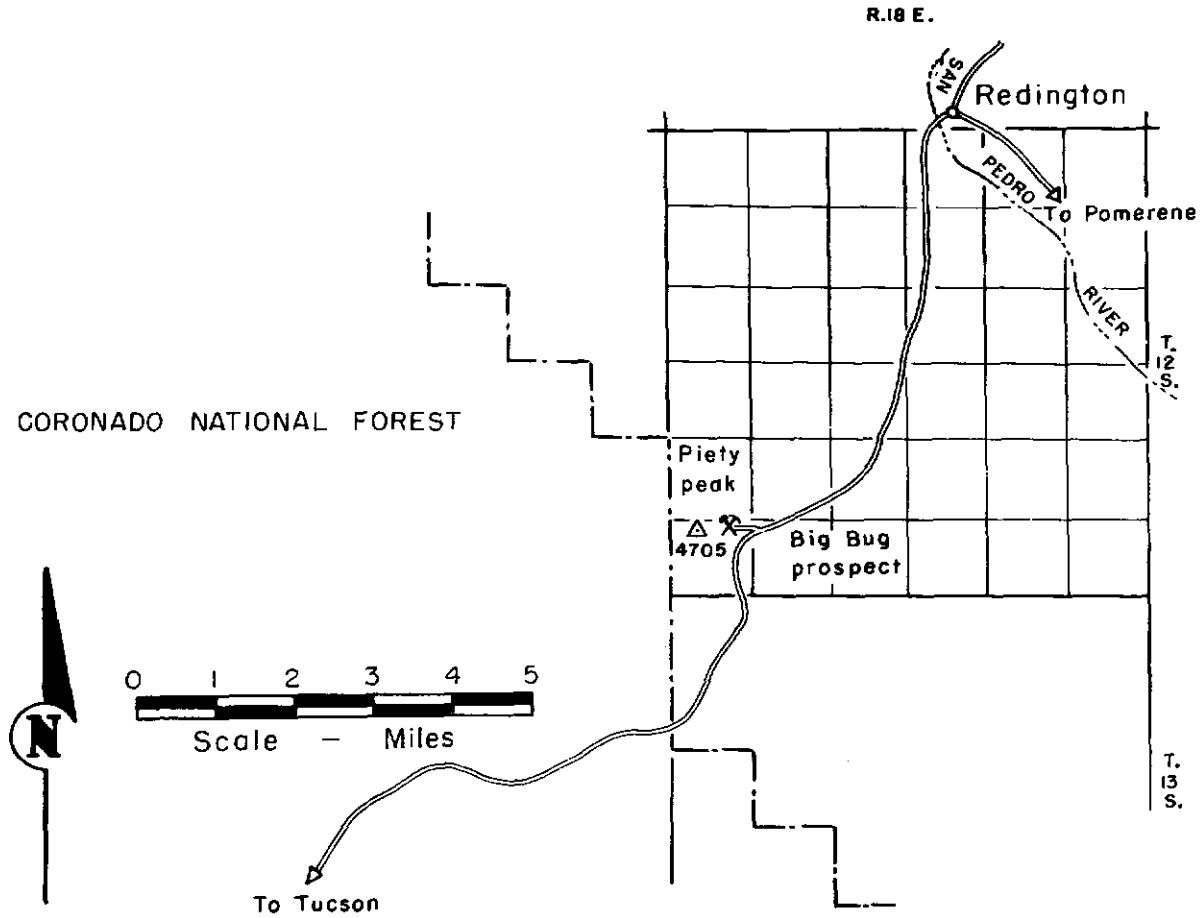

FIGURE 47. - Location Map of Big Bug Prospect, Santa Catalina Mountains, Pima County, Ariz.

been driven beside a local garnetized zone. Most of the area is covered with alluvium, and only float can be seen along the contact.

Santa Cruz County

Calabasas Tungsten

J. M. Hill[38/] first reported the occurrences of wolframite and scheelite in the Calabasas area.

The tungsten occurs in the NW1/4 sec. 18 and the SW1/4 sec. 7, T. 23 S., R. 14 E. It lies on the Baca Float No. 3 land grant and is owned by Baca Float, Inc. The old workings may be reached by traveling north from Nogales on U.S. Highway 89 for 4 miles to where the old Tucson-Nogales highway leaves the new road. Follow the old road 2.4 miles to the junction of Santa Cruz River road and the old Tucson-Nogales highway. Follow the river road easterly

38/ Hill, J. M., Note on the Occurrence of Tungsten Minerals near Calabasas, Ariz.: Geol. Survey Bull. 430, 1910, pp. 164-166.

0.7 mile to a dim trail on the top of a ridge. Follow this dim trail northerly 0.5 mile to a fence on the Baca Float boundary; then follow the dim trail on foot a distance of 0.25 mile to the old workings (fig. 48).

According to Hill, this deposit of tungsten ore has been known since 1906. He states that up to 1909 about 1,500 pounds of ore containing 50 percent WO_3 had been mined and shipped by a man named Reagan. Some production was made in 1913, according to Eldred Wilson.[39] The property was worked in 1937 and 1938 by William Loftus, who sold 66 pounds of concentrates during this time. It has been reported that H. B. Imus had the property in 1940, but apparently no ore has been produced since 1938.

The following geology is from the article by Hill:

> This area, between Nogales Wash and Santa Cruz River, is made up of coarse-grained light-gray granodiorite intruded by dikes of aplite and lamprophyre. Cutting these rocks are veins of bonded, comb-textured quartz with wolframite, minor scheelite, and sparse calcite. There are many veins, all striking N. 25° W. and essentially vertical, but apparently most of them are barren or of low grade.

Three of the quartz veins have been worked for tungsten content. The shallow shafts and pits have caved and are now inaccessible, but remnants of the ore can be found. Loftus deepened one of the shafts sunk by Reagan to about 60 feet. Although not caved, it is inaccessible.

Narrow bands of the reddish-brown wolframite are fairly continuous through the quartz veins. Where ore has been removed the veins average about 4 inches in width. No pockets are visible today. However, Hill stated that the largest pocket seen was about 3 by 4 feet in a 6-inch vein.

Scheelite occurs as tiny crystals associated with the wolframite.

Martha Washington Claim

The Martha Washington claim is one of a group of 160 claims owned by Coronado Mines, Inc., which lies between the Santa Cruz River and the crest of the Patagonia Mountains near the Washington Camp road. The Martha Washington claim is in the southwestern corner of the group. It is in the NE1/4 sec. 12, T. 24 S., R. 15 E. The claim may be reached by road from Nogales. Follow State Highway 82 for 5.2 miles to a road fork immediately east of the Santa Cruz River bridge. Take the right fork toward Washington Camp for a distance of 7.1 miles to a dim trail going southeast. The trail ends about 0.1 mile from the road at an old campsite. The workings are situated on top of a low peak a few hundred yards southwest of the old campsite (fig. 48).

39/ Wilson, E. D., Tungsten Deposits of Arizona: Arizona Bureau of Mines Bull. 148, 1941, p. 50.

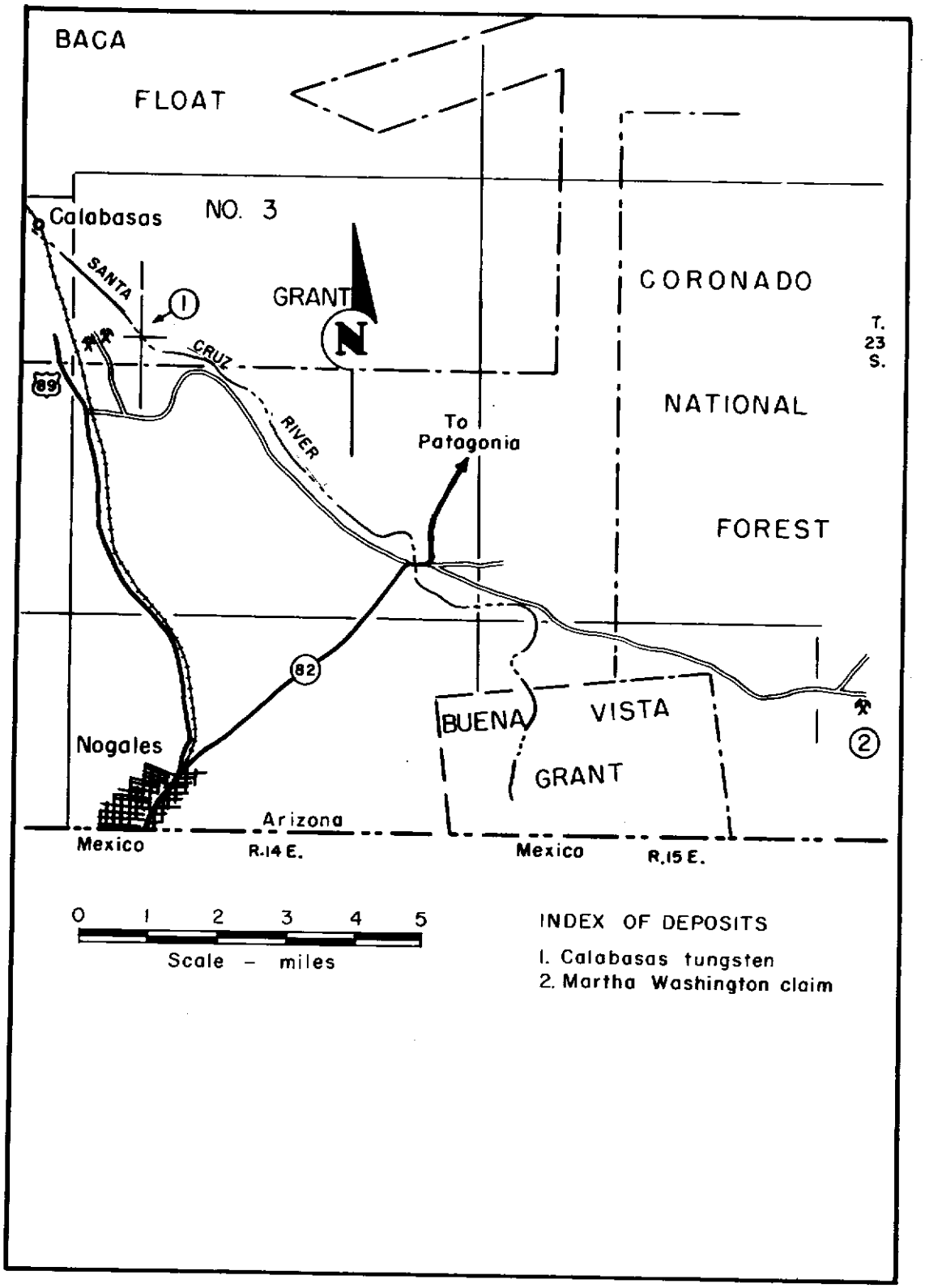

FIGURE 48. - Location Map of Tungsten Deposits, Santa Cruz County, Ariz.

The history of this small scheelite occurrence is vague. The claim was located before the First World War by a man known simply as Julio. Sometime in the late 1930's or early 1940's Hugo Miller of Nogales, Ariz., purchased the claim from Julio, and later sold it. The date that Coronado Mines, Inc. acquired the claim is not known. Julio mined a few units of scheelite, but, so far as is known, no production has been made since that time.

There are an adit about 30 feet long with a winze approximately 25 feet deep and a few shallow opencuts and pits.

Sporadic scheelite, molybdenite, and copper carbonates occur in pockets in quartz and fault gouge cutting a coarse-grained granite. The deposit strikes generally N. 30° W. and dips 34° NE. Scheelite formed near a shear along which there appears to have been some movement. The shear strikes N. 73° E. and dips 78° NW. Scheelite float from sporadic pockets may be lamped at night over a considerable distance. The pockets that may be seen are very small.

Red Mountain Claims

A tungsten deposit in Santa Cruz County, not visited by the writer but reported by Wilson,[40] is included in this report for historical value. Wilson's report follows:

> The Red Mountain claims, held by the Kino Copper Company, include the southeastern side of Guajolote Flat.
>
> Here, granitic rock is invaded by a stock or pipe of acid porphyry about 1,200 feet in diameter. The southern border of this mass shows northerly vertical fracturing and local intense sericitic alteration. A sericite zone about 5 feet wide contains irregular particles and masses, up to several inches in diameter, of a brownish tungsten mineral of unknown identity. The adjacent wall rock also carries some particles of a similar tungsten mineral. Oxidized molybdenum compounds are abundant in this mineralized area.

40/ Work cited in footnote 39 (p. 120), p. 50.

APPENDIX

Rock-Type Log

No.	Mine	Location	Description
14809.....	Silver Hill...	Sec. 13, T. 17 S., R. 30 E...	Dark-colored limestone with minor amounts of tremolite, quartz, and pyrite.
14810.....	....do.....	.....do.....	Epidosite with minor amounts of calcite, quartz, limonite, tremolite, and sporadic grains of scheelite ranging in size from 0.3 mm. to 0.02 mm.
14811.....	....do.....	.....do.....	Limestone with sporadic grains of pyrite, limonite, and antigorite.
14812.....	....do.....	.....do.....	Altered latite porphyry; minerals identified are orthoclase, oligoclase, pyrite, calcite, epidote, sphene, and iron oxides. No quartz.
14815.....	....do.....	.....do.....	Granite porphyry. Minerals identified are orthoclase, oligoclase, quartz and minor amounts of chlorite, sphene, hematite, hornblende, and zircon.
	Texas shaft...	.....do.....	
	Galeyville....	Sec. 18, T. 17 S., R. 31 E...	
	Leadville.....	Sec. 24, T. 17 S., R. 30 E...	
14816.....	Galeyville....	Sec. 18, T. 17 S., R. 31 E...	Wollastonite and minor amounts of zoisite and limonite.
14836.....	Lesjimfre.....	NE1/4 sec. 4, T. 21 S., R. 7 E.	Quartzite from hanging-wall side of mineralized zone. Contains chlorite, epidote, magnetite, hematite, feldspars, and limonite.
14837.....	....do.....	.....do.....	Quartzite from footwall side of mineralized zone. Contains a considerable amount of chlorite and sporadic grains of feldspars, biotite, and magnetite.

No.	Mine	Location	Description
14839.....	Serasio.....	Sec. 25, T. 17 S., R. 12 E...	Altered metamorphic rock composed predominantly of garnet with some calcite, epidote, quartz, iron oxides, chrysocolla, malachite, and sporadic grains of yellow to orange fluorescent scheelite. Spectroscopic tests on a panned concentrate showed lines for tungsten and molybdenum.
15033..... 15035..... 15037..... 15050.....	Calvert (summary).	Sec. 13, T. 17 S., R. 6 E....	Feldspathic quartzite. The original rocks were probably Arkosic sandstones containing calcite as the cementing material Different degrees of metamorphism are represented by the samples as revealed by the accessory minerals and texture parallelism. The amount of metasomatism or replacement from igneous sources is difficult to ascertain.
15033.....	Nelson's Pride No. 2.	.....do.....	From prospect pits. Mineral assemblage includes quartz, orthoclase, andradite, oligoclase, and small amounts of ilmenite, epidote, zircon, and manganese oxide stains. Both the epidote and manganese oxide stains occur on fracture planes as coatings and represent alteration derived from the feldspathic quartzite. The texture of the rock shows considerable granulation in the quartz and feldspar grains. Some flowage has occurred between the quartz and feldspar grains, with the garnet occurring in random clusters. The sample is very dense and compact, leaving very little space for tungsten mineralization.

15035.....	Nelson's Pride No. 1.	Sec. 13, T. 17 S., R. 6 E....	Similar in composition to that of sample 15033. Texture studies show more flowage and parallelism among the minerals. The andradite occurs in irregular bands.
15037.....	Terry Marie No. 1.	.....do.....	Composed of quartz and orthoclase with minor amounts of chlorite, hornblende, and ilmenite, and sporadic grains of epidote, zircon, and andradite. There is definite banding and parallelism of the mineral grains. Studies of thin sections show some large, elongated quartzite pebbles in a fine-grained matrix of quartz, orthoclase, hornblende, and chlorite. The flowage pattern of the matrix-type material around the quartzite pebbles is observed clearly under the microscope.
15050.....	.....do.....	.....do.....	Quartz, orthoclase, grossularite, and sporadic inclusions of epidote, zircon, and scheelite. The texture of the material shows only a minimum of flowage in the quartz and orthoclase; the grossularite is in random clusters. The scheelite is adjacent to some of the grossularite clusters.
15039.....	Southside.....	.....do.....	Feldspathic quartzite. Minerals identified were predominantly quartz, orthoclase, and minor amounts of oligoclase, epidote, andradite, zircon, ilmenite, and manganese oxide stains. Examination of a thin section under the microscope showed a granular texture and several areas where the quartz had been recrystallized. It appears that the original arkosic sandstone also contained some small pebbles of quartz.

No.	Mine	Location	Description
15043A.....	Bib Banana....	Sec. 32, T. 17 S., R. 7 E....	Quartzite from footwall side of the deposit. The quartz particles were cemented by a fine-grained intergrowth of sericite and quartz. The quartzite showed different shades of brown coloring which represented the original bedding planes of the sandstone.
15043B.....	....do.....	.....do.....	Hornfels from the hanging-wall side of the deposit. Composed predominantly of quartz and hornblende with some feldspars, chlorite, biotite, and iron oxides. Texture studies showed a dense, sugary-grained intergrowth of fine-grained quartz, hornblende, chlorite, and biotite in which remnant, coarse grains of oligoclase, quartz, and orthoclase occurred.
15044.....	....do.....	.....do.....	Slightly metamorphosed rhyolite porphyry taken 900 feet from the portal of the main adit. Identified minerals were orthoclase, oligoclase, quartz, hornblende, chlorite, hematite, magnetite, ilmenite, and epidote. Some calcite, clay, and hematite occurred on fracture planes as thin coatings. About one-half of the sample was composed of quartz and feldspar phenocrysts with sporadic black grains identified as hematite. Studies of the matrix portion showed that it was composed of a fine-grained intergrowth of feldspars, quartz, hornblende, and chlorite. A few small quartz veinlets crosscut both the phenocrysts and matrix. Texture studies revealed that the sample had been subjected to a slight amount of pressure. Many of the

15044.....	Big Banana....	Sec. 32, T. 17 S., R. 7 E....	phenocrysts were granulated and existed in separated, recemented fragments. Contacts between the phenocrysts and matrix were rounded and sutured, which clearly indicated the influence of metamorphic conditions.
15045A.....	....do.....	.....do.....	Quartzite, in which sporadic grains of hornblende, chlorite, and iron oxide occurred. A thin section also contained one small calcite veinlet.
15045B.....	....do.....	.....do.....	Arkosic quartzite. Texture showed flowage and parallelism among the quartz and feldspars.
15048.....	Rushbey.....	Sec. 19, T. 17 S., R. 7 E....	Quartzite, in which minor amounts of hornblende, orthoclase, zircon, chlorite, and iron oxides occurred. Texture studies showed parallelism and some recrystallization of the quartz grains. The hornblende particles were altered to chlorite in some areas.
15049.....	Giant.....	Secs. 19 & 20, T. 20 S., R. 7 E.	Porous quartzite, in which considerable manganese-bearing zoisite and molybdenum-bearing scheelite occurred. The quartz grains have been granulated and recrystallized in most of the thin sections observed under the microscope. It is believed that the original feldspars in the quartzite have been altered to zoisite by contact-metamorphic conditions.

No.	Mine	Location	Description
15115A.....	Giant.....	Secs. 24 & 25, T. 20 S., R. 6 E.	Two samples from vein material classified as quartzite in which zoisite, calcite, and sporadic grains of molybdenum-bearing scheelite occurred. The texture was about the same as that in sample 15049.
15115B.....	....do.....	.....do.....	Quartzite from the footwall. Contains appreciable amount of epidote. Small veinlets of quartz observed throughout the sample. Adjacent to the quartz veinlets were sporadic, acicular crystals of altered actinolite. A thin section showed a uniform intergrowth pattern between the quartz and epidote. A large portion of the quartz had been recrystallized.
15115C.....	....do.....	.....do.....	A black, micaceous sample from the footwall, composed of about equal amounts of quartz and chlorite together with some ilmenite, magnetite, and zircon. The chlorite appeared to have been formed as a result of the alteration of biotite. The texture and mineral composition of this rock indicates that the original material was a sandstone which contained larger amounts of clay and iron oxides. The sample was classified as hornfels.
15101.....	Jezebel.....	Sec. 19, T. 17 S., R. 7 E....	Quartzite, in which some fragments were high in epidote and others contained appreciable chlorite. Minor mineral constituents were andesine, biotite, ilmenite, zircon, and iron oxide stains. A large portion of the chlorite appeared to have been formed as a result

15101.....	Jezebel.....	Sec. 19, T. 17 S., R. 7 E....	of alteration of biotite. Texture and mineral composition revealed that the original rock was a sandstone containing some andesine and calcareous clay. The source of contact metamorphic conditions appears to have been near these rock samples. The large amount of granulation and recrystallization observed in the quartz, plus the formation of epidote, proves this observation.
15106..... 15107..... 15109..... 15111..... 15112..... 15117.....	Yellow Star...	Sec. 19, T. 17 S., R. 6 E....	All six samples are feldspathic quartzite in various phases. The samples contained grossularite and sporadic grains of epidote, zircon, and scheelite, and were cut by milky-white veins of almost pure orthoclase which ranged in size from three-quarters of an inch in diameter to hairline veinlets. Small veinlets of quartz were also observed. Both the orthoclase and the quartz in these veins and veinlets were introduced into quartzite and represent an igneous source. A heavy mineral concentrate prepared from sample 15106, which showed a typical occurrence of the garnet, was examined spectroscopically. Results of tests showed strong spectral lines for calcium, aluminum, and silicon, together with weak lines for manganese, iron, and titanium.

Assay Log

Assay No.	Mine	Location	Length of cut, feet	WO_3, percent
14804.....	Silver Hill.....	Sec. 13, T. 17 S., R. 30 E.....	36	0.04
14805.....	....do.....	.....do.....	17	.02
14806.....	....do.....	.....do.....	7.5	.04
14807.....	....do.....	.....do.....	88	.02
14808.....	....do.....	.....do.....	43	.03
14813.....	Galeyville.....	Sec. 18, T. 17 S., R. 31 E.....	22	.17
14814.....	....do.....	.....do.....	27	.01
14817.....	King-Ainsworth.....	Sec. 5, T. 17 S., R. 31 E.....	Grab sample.....	1.70
14818.....	Chiricahua.....	Sec. 14, T. 17 S., R. 30 E.....	4	.06
14819.....	Silver Strike.....	Sec. 28, T. 14 S., R. 28 E.....	6	.04
14820.....	....do.....	.....do.....	5	.14
14821.....	....do.....	.....do.....	0.3	2.05
14822.....	Silver Bell.....	Sec. 29, T. 14 S., R. 28 E.....	3.5	.09
14823.....	Hill Top.....	Sec. 5, T. 17 S., R. 30 E.....	6.3	.23
14824.....	Silver Hill.....	Sec. 13, T. 17 S., R. 30 E.....	3	.04
14825.....	....do.....	.....do.....	3.5	.14
14826.....	....do.....	.....do.....	2.3	.18
14827.....	....do.....	.....do.....	3.5	.89
14828.....	Columbia.....	.....do.....	12	.13
14829.....	....do.....	.....do.....	Grab sample.....	.18
14830.....	Ram.....	Sec. 21, T. 14 S., R. 28 E.....	3.5	.79
14832.....	Republic mill.....	Sec. 25, T. 15 S., R. 22 E.....	10- by 14-in. diam.	.064
14833.....	....do.....	.....do.....	.....do.....	.142
14834.....	....do.....	.....do.....	.....do.....	.067
14835.....	Lesjimfre.....	NE1/4 Sec. 4, T. 21 S., R. 7 E.....	3.7	.227
14840.....	Mineral Hill mill.....	Sec. 35, T. 16 S., R. 12 E.....	10- by 4-in. diam..	.082
14841.....	....do.....	.....do.....	.....do.....	.081
14842.....	....do.....	.....do.....	.....do.....	.080
14843.....	....do.....	.....do.....	.....do.....	.066
14844.....	San Xavier mill.....	Sec. 13, T. 17 S., R. 13 E.....	6- by 4-in. diam...	.001
14845.....	Control mill.....	Sec. 17. T. 11 S., R. 16 E.....	10	.011
14846.....	....do.....	.....do.....	10- by 4-in. diam..	.014
14847.....	C & H.....	Sec. 21, T. 17 S., R. 16 E.....	Grab.....	.076

14848.....	C & H.....	Sec. 21, T. 17 S., R. 16 E.....	13.5	.13
14849.....	....do.....	.....do.....	7.0	.20
15027.....	Big Banana.....	Sec. 32, T. 17 S., R. 7 E.....	Grab.....	.06
15028.....	....do.....	.....do.....	.....do.....	.25
15029.....	....do.....	.....do.....	.....do.....	.25
15030.....	....do.....	.....do.....	.....do.....	.06
15031.....	....do.....	.....do.....	.....do.....	.13
15032.....	Calvert.....	Sec. 13, T. 17 S., R. 6 E.....	-	.01
15034.....	....do.....	.....do.....	-	.019
15036.....	....do.....	.....do.....	25	.037
15038.....	Southside.....	.....do.....	15	.06
15040.....	Cable and Gajewski.....	Sec. 24, T. 17 S., R. 6 E.....	25	.003
15041.....	Rushbey.....	Sec. 19, T. 17 S., R. 7 E.....	-	.78
15042.....	Independence No. 2.....	Sec. 24, T. 17 S., R. 6 E.....	12	.056
15046.....	....do.....	.....do.....	6	.021
15047.....	Giant.....	Sec. 19, T. 30 S., R. 7 E.....	-	.30
15102.....	Jezebel.....	Sec. 19, T. 17 S., R. 7 E.....	-	.67
15103.....	....do.....	.....do.....	-	.12
15104.....	Yellow Star.....	Sec. 24, T. 17 S., R. 6 E.....	14	.35
15105.....	....do.....	.....do.....	8	.21
15108.....	....do.....	.....do.....	50	.19
15110.....	....do.....	.....do.....	4	.69
15113.....	Last Chance.....	Sec. 30, T. 17 S., R. 7 E.....	8	.26
15114.....	Giant.....	Sec. 19 & 30, T. 20 S., R. 7 E.....	6	.11
15116.....	....do.....	Sec. 24 & 25, T. 20 S., R. 6 E.....	8	.19
15119.....	Juanita No. 9.....	Sec. 30, T. 17 S., R. 7 E.....	7	.11
15120.....	Lone Eagle.....	Sec. 1, T. 17 S., R. 6 E.....	4.5	.37
15123.....	San Juan.....	Sec. 30, T. 17 S., R. 7 E.....	20	.18
15128.....	Lone Eagle.....	Sec. 1, T. 17 S., R. 6 E.....	4	.43

Mines Checked With Ultraviolet Lamp Which Showed No Evidence of Scheelite Mineralization

Paradise claim	Sec. 19, T. 17 S., R. 31 E.
Martin patented claim	.....Do.....
Harris mine	Sec. 32, T. 16 S., R. 31 E.
Doran mine	Sec. 29, T. 16 S., R. 31 E.
Ajax mine	Sec. 30, T. 16 S., R. 31 E.
El Tigre mine	Approximate sec. 28, T. 17 S., R. 30 E., unsurveyed.
Name unknown	Secs. 1 & 12, T. 15 S., R. 28 E.
King of Lead	Sec. 18, T. 16 S., R. 30 E.

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