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REPORT ON THE GEOLOGY AND ORE RESERVES

OF THE

NEVADA SCHEELITE MINE

WITH RECOMMENDATIONS FOR EXPLORATION

BY

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FEBRUARY 1955

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INTRODUCTION

Earlier Reports

1. Heron, Charles M., Report on the Nevada Scheelite Mine, near Rawhide, Mineral County, Nevada, M.S. Report September 1947.
2. Geehan, Robert W. and Trengove, Russell R., Investigation of Nevada Scheelite Inc. Deposit, Mineral County, Nevada, U.S. Bureau of Mines, Report of Investigation 4681, April 1950.

Purpose of Present Investigation; Field Work

The purposes of the investigation on which the present report is based were to form an opinion about the future ore possibilities of the mine, to give recommendation for exploration and development, and to prepare an estimate of the ore reserves. The work done was almost entirely geological, and was carried out from November 14 to December 14, 1954, and from January 7 to 31, 1955. The surface geology was inspected briefly. The 200, 300 and 400 levels and all accessible stopes were mapped geologically, and a number of geological cross-sections prepared. The resulting maps and sections, which form a part of this report, are listed on a foregoing page as "Illustrations."

Acknowledgments

The writer thanks Messrs. Donald C. McKenna, President of Nevada Scheelite Corporation, A. R. McGuire, General Manager, Ray Henricksen, Consulting Engineer, Ernest Colwell, General Superintendent, Harry Manny, Mine Foreman, and E. A. Hollingsworth, Mining Engineer, for many courtesies received. Mr. Hollingsworth helped greatly by his intimate knowledge of the mine and by practical assistance in underground mapping, surveying and preparation of some of the maps.

Use was made of maps and sections prepared by the U. S. Geological Survey during 1943 - 44, and of geological maps prepared by Mr. Charles, Mining Engineer for the company around 1950, as well as of the reports listed at the head of this chapter.

The diamond drill core logs prepared by various engineers during the past few years at the Nevada Scheelite mine were used extensively in the

drawing of the geological maps and sections. The cores have all been thrown away, there being no space for storage, so it was impossible to verify their accuracy. For the uses of this report it was assumed almost without exception that they had been correctly logged.

Location, Access, Climate

These factors are fully discussed in the earlier reports. The mine and camp are in secs. 1 and 12, T. 13 N., R. 32 E., Mount Diablo base line and meridian, on the east flank of the Sand Springs Mountains, about 5 miles east of Rawhide, Mineral County, Nevada. From Fallon, the mine is reached by following U. S. Highway No. 50 east 35 miles, thence a dirt road south about 20 miles. The altitude of the mine is around 5,000 feet above sea level.

The rainfall in the region is very small, and the snowfall seldom exceeds a few inches a year. Water is obtained from wells in the Gabbs Valley, 3 miles from the mine. There is no timber locally.

Property, History, Production

The mining property is said to comprise 16 unpatented mining claims and 2 mill sites. Most of the ore production has come from the Don claim, staked by W. H. Leonard in 1935. The production of the mine from 1935 to 1947, mostly by Nevada Scheelite, Inc., is given by Heron (page 9) as follows:

Table 1. PRODUCTION OF NEVADA SCHEELITE MINE, 1935 - 1947

<u>Year</u>	<u>Units W03 produced</u>
1935	15.64
1936	36.40
1937	532.72
1938	2,282.24
1939	4,321.91
1940	3,583.82
1941	12,852.06
1942	10,818.00
1943	10,900.31
1944	12,420.39
1945	10,033.27
1946	4,271.83
1947	<u>217.66</u>
Total	<u>78,660.35</u> Units W03

The ore production during the same period was 94,487 tons having an

average grade of 1.32% W03. The recovery was 63%, giving 0.83 unit W03 recovered per ton ore, with 0.49 unit W03 left in the tailings.

Kennametal, Inc. (Nevada Scheelite Division) owned and operated the property from the latter part of 1951 to near the end of 1954, when a subsidiary company of Kennametal, Nevada Scheelite Corp., took over the operation. The ore production statistics during the operation by Kennametal, Inc., as prepared by Mr. Ray Hendricksen, are given below:

Table 2 -

ORE PRODUCTION OF NEVADA SCHEELITE MINE
FROM LATE 1951 TO NOV. 26, 1954.

	<u>Source</u>	<u>Tons Ore</u>	<u>Grade % W03</u>	<u>Units W03 in Ore</u>
<u>200 level</u>	720 section	<u>2927</u>	<u>0.705</u>	<u>2063.99</u>
<u>300 level</u>	250 A	5129	1.030	
	250 B	3916	1.169	
	550 Xcut	620	0.663	
	550 A	5889	1.456	
	550 B	1859	1.120	
	800 Sill	<u>3444</u>	<u>1.508</u>	
	800 Stope	11521	1.456	
	900 Stope	3002	1.073	
	280 Stope	3212	1.206	
	560 Stope	<u>1958</u>	<u>0.728</u>	
	<u>Total 300 Level</u>	<u>40550</u>	<u>1.268</u>	<u>51,419.48</u>
<u>400 level</u>	340 Stope	4064	0.994	
	580 Stope	3752	0.847	
	400 Drift	1783	1.043	
	620 Stope	11958	0.961	
	685 Stope	1047	0.623	
	745 Stope	6996	1.282	
	1000 Xcut	53	1.1	
	1050 Stope	<u>323</u>	<u>1.42</u>	
	<u>Total 400 Level</u>	<u>29,976</u>	<u>1.0245</u>	<u>30,711.75</u>
	<u>Grand Total</u>	<u>73,453</u>	<u>1.146</u>	<u>84,195.22</u>

The production, if any, during the years 1948 - 1951 is not known to the writer.

The total known ore production from 1935 to Nov. 26, 1954 is summarized below:

Table 3 - TOTAL KNOWN ORE PRODUCTION, NEVADA SCHEELITE MINE
1935 - NOV. 26, 1954

<u>Period</u>	<u>Ore Produced, Tons</u>	<u>Average Grade Ore % WO₃</u>	<u>Units WO₃ contained in Ore</u>
1935 - 1947	94,487	1.32	124,722.84
Late 1951 to Nov. 26, 1954	<u>73,453</u>	<u>1.146</u>	<u>84,195.22</u>
<u>Total</u>	<u>167,940</u>	<u>1.24</u>	<u>208,918.06</u>

GEOLOGY

Resume

The general geology of the mine area is described by R. Stopper, on pp. 4-5 of U.S. Bureau of Mines Report of Investigation 4681 (1950). The oldest rocks of the area are metavolcanic, including andesites, basalts and tuff, in which there lies an interbedded stratum of crystalline limestone or marble having a maximum thickness of 500 feet. These rocks are thought to belong to the Excelsior formation of middle Triassic Age. They have been intruded by a granite stock cropping out over an area of one square mile, and by many granite dikes and sills. Tactite bodies occur along contacts of granite and limestone, and tuff has been altered to hornfels along granite contacts. Tertiary volcanic rocks locally intrude and overlie the other rocks.

Rock Formations

The distribution and geologic relations of the various rocks in the mine are shown in the accompanying maps and sections.

In the mine itself the following rocks are exposed:

Basic igneous dikes (youngest)
Tactite
Granite and granite porphyry
Limestone and hornfels (oldest)

The dikes are black, gray or dark green, with sharp contacts against the other rocks. They may be diabase or microdiorite, somewhat altered. Although here referred to as "dikes", they are mostly of complicated shape, and are both

large and small. Often they follow the contacts of ore and granite. Presumably they correspond to the Tertiary intrusions referred to by Stopper.

A hasty microscopic examination of a typical granite specimen revealed the presence of well-zoned euhedral feldspar and euhedral biotite, which might indicate orthomagmatic origin of the granite. No evidence was seen of the transformation of the sedimentary rocks into granite.

The limestone or marble is finely- to coarsely-crystalline and white, gray or black. Bedding can be seen occasionally. Hornfels is dense, hard and usually greenish. Underground, it is easily confused with dike rock unless careful examination is made of each occurrence, and there may be mistakes in the accompanying geological maps on this account.

Ore

* Scheelite, the ore mineral, occurs in the tactite along the granite-limestone contacts. It is widely and rather evenly distributed. The associated minerals are: garnet, epidote, diopside, wallastonite, quartz, calcite, sulfides and oxidation products. The sulfides are pyrite, chalcopyrite and molybdenite, the latter rather scarce. The oxidation minerals include limonite and copper carbonates. The limonite often contains several per cent of WO_3 . Oxidation of the ore deposit extends quite generally to the 200 level, and even below it in some places. The scheelite contains an average of 0.5% molybdenum.

* The ore deposit is a contact-metasomatic deposit, formed by the reaction at and near the contacts of limestone with metalliferous solutions emanating from the intrusive granitic magma. The granite-limestone contact itself is thus the primary locus of the ore.

Structural Geology of the Ore Deposit

* In the vicinity of the mine, the limestone beds dip steeply, and strike about northeast. About 110 feet north of the main shaft, at the surface, a pre-granite fault, striking northwest and dipping about 40 degrees to the northeast, cuts across the limestone beds nearly at right angles, and appears to displace the limestone on the northeast side of it at least 400 feet northwest (as measured on the 200 level). The surfaces of movement of this fault

are no longer visible; they have been metamorphosed, intruded by granite, and mineralized, but the existence of the dislocation is certain because of the visible offset of the limestone beds.

* At some time subsequent to the formation of this fault, granite was intruded into the limestone. The granite contact follows the northwest fault in the central part of the mine. Northeast and southwest of the fault, the contact follows the northeast strike of the limestone (but cuts across it somewhat on the dip). As a consequence, the granite-limestone contact in the mine, as viewed in plan, has the zig-zag form shown diagrammatically in Sketch 1, in which the three distinct parts of the contact, trending respectively northeast, northwest, and northeast, are labelled 1, 2, 3, respectively.

* Ore was formed at many places along the contact, but the largest ore masses were formed along the northwest fault where the limestone presumably was somewhat shattered, and where the granite cut sharply across the bedding, and the ore-solutions thus more easily penetrated the bedding-planes, effecting a more extensive replacement of the limestone. Conditions for ore deposition were likewise especially favorable in those northeast-trending parts of the contact lying contiguous to the northwest fault. It may be stated quite confidentially, therefore, that the more productive ore bodies are related directly to the northwest fault, and that the future of the mine be dependent very largely on the structural behaviour of the fault at greater depth.

See Sketch 1. Part 1 of the contact dips essentially vertically; part 2, the northwest fault, dips about 40 degrees to the northeast; and part 3 dips around 60 degrees to the southeast. The geometrical consequence of this downward convergence of the two northeast-trending contacts is that the northwest part becomes shorter and shorter as greater depth is attained, and would ultimately disappear entirely. The Northwest-trending part of the contact, considered as an area, is roughly triangular with apex pointing downward. The diminution of the length of the northwest section with increasing depth is clearly shown in the geological plan of levels 200, 300 and 400 (see figs. 2, 3 and 4). On 200 level, the northwest part is about 400 feet long; on 300 level, perhaps around 250 feet; and on 400 level, perhaps around 100 feet. The northwest contact thus has decreased in length by about 150 feet for each additional

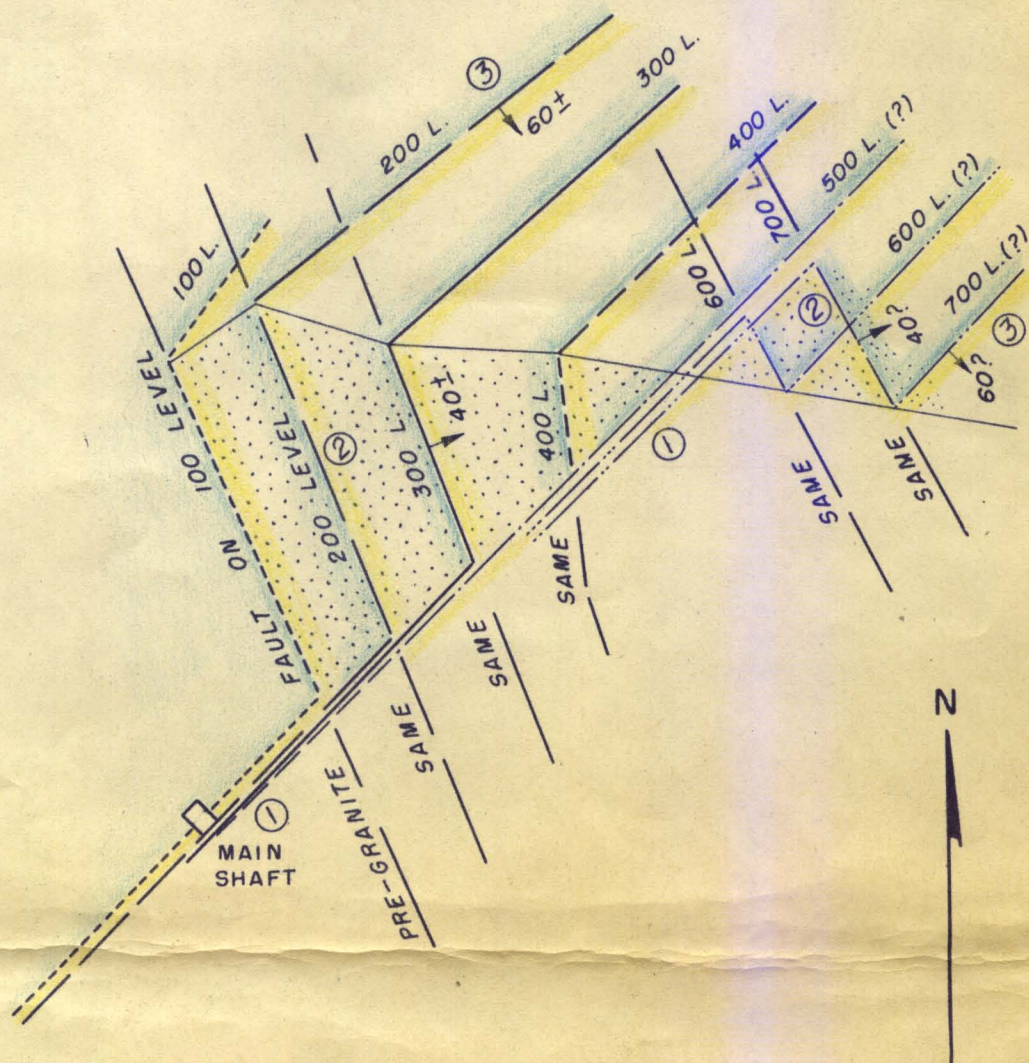
SKETCH 1

DIAGRAMMATIC PLAN OF NEVADA SCHEELITE MINE SHOWING POSITIONS OF GRANITE-LIMESTONE CONTACT ON THE UPPER FOUR LEVELS AND HYPOTHETICAL POSITIONS OF CONTACT ON FUTURE LOWER LEVELS.

NUMBERS 1,2,3 INDICATE THE THREE MAIN SECTIONS OF THE CONTACT, THE NW-TRENDING SECTION BEING CONTROLLED BY A PRE-GRANITE FAULT.

BLUE INDICATES LIMESTONE SIDE AND YELLOW, THE GRANITE SIDE OF THE CONTACT ON EACH LEVEL.

STIPPLING INDICATES THE PART OF THE CONTACT SURFACE MOST FAVORABLE FOR ORE. IT CORRESPONDS TO THE PRE-GRANITE FAULT SURFACE.



APPROX. SCALE
1" = 200 FEET

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100 feet of depth.

It is not possible to predict the behaviour of the contact beneath the lowest level of the mine. It is possible, for example, that the granite may cut beneath the limestone, obliterating entirely the geological structure on which the ore depends in the present levels. There is, however, no evidence of this as yet. If, however, the known structure of the contact should persist without major deviation to greater depths, a situation like that illustrated in Sketch 1 would obtain. At, or somewhat above, the future 500 level, the two northeast contacts would meet, and the northwest contact would have diminished to a point. The entire contact at this level would thus be roughly a straight line running northeast, without a northwest - striking section at all. Beneath the 500 level, however, the two northeast contacts would diverge, and the northwest part would again come into existence, this time as a triangle with apex upward, and the northwest-trending section of the contact would increase in length on each successively deeper level. Also, on the northwest contact below 500 level, the limestone would form the hanging wall and the granite the footwall, which is exactly the opposite of the relations obtaining in the upper levels. The zig-zag pattern on each level below the 500 level would be reversed from what it is on 400 level and above (Sketch 1).

If this geometrical concept should prove to be the fact, what might the consequences be as regards the ore body? The ore would be expected to follow the contact as before. On 500 level, it would strike northeast, without major deviations. Below 500, the reverse zig-zag pattern would come into effect, and the biggest bulges of ore might occur along the northwest contact, as before, with the difference that the fingers of ore would run into the hanging wall rather than into the footwall. If it should eventuate that the 500 level is not so productive as any of the levels above, this should be attributed to the convergence of the two northeast contacts, but it should not cause undue discouragement, at least until the 600 level has been thoroughly explored and found wanting. The prospects for good ore in depth, however, seem favorable, and there is no presently known reason for concern.

* The form of the ore body, insofar as known and insofar as can be surmised

is shown on the geological maps, and sections accompanying this report.

Description of parts of the ore body is given in the ensuing chapters about mine working and ore possibilities. Although as viewed in any single plan or section the ore appears discontinuous, yet it is believed that if all three dimensions were fully explored, the ore would be found to be an essentially continuous single body (with a few minor exceptions), if extraneous accidents, such as dikes and later faults, are disregarded. The form of the body is complex where it follows the northwest fault, but tends to be tabular on the two northeast contacts.

Faults

* A number of northeast faults, younger than the dikes, cut the ore deposit and divide it into segments. These faults appear to have suffered strike-slip movement principally. The displacements are not great - perhaps a few yards at most. On the geologic maps and sections, the faults are labelled A, B, C, etc. in order to identify them.

DESCRIPTION OF ACCESSIBLE STOPE

200 Level

Stope 2-250 is the only stope on 200 level that can be safely entered throughout its extent. The geology of the sill of this stope is shown in fig. 2 (Geologic plan of 200 Level), and of the stope itself in fig. 5 (stope plans). There appears to be plenty of ore in this stope, but the limits of it are unknown because the adjoining stopes are backfilled and cannot be mapped. Above the 9th floor, in the raise, ore is reported to continue upward to about 100 level. It appears that there should be no unusual difficulty in mining this remaining ore wherever it appears, both on the sides and in the back of the stope, and it is likely that several thousand tons may be available here. Very high grade ore was seen at one place in the back.

Southwest Stope - An old stope lying at the extreme southwest end of 200 level was mapped on the first floor (see fig. 5). Five additional floors were visible above but were not entered because the timbers did not appear sound. At the southeast end of the stope is an ore pillar, separating the Northwest stope

from another old stope a few yards to the southeast.

300 Level

Stope 390 - Only the first floor of this stope is accessible, and the geology of it is shown in fig. 6. The stope reportedly extends all the way to 200 level. A half-set of ore was excavated in the floor of 300 level, and the ore is known to continue farther downward from diamond drill holes that cut it below.

Stope 3-560 - These workings consist of five stopes: 560, 560E, and inclined stope connecting with 560E, 560W, and a fifth stope lying a few yards west of 560W, and connecting with it above the level. Only part of 560W is accessible, and this part was mapped, as well as the other stopes in their entirety. See fig. 3 (Geologic plan of 300 level), fig. 6 (stope plans), and fig. 14 (Section VII).

The tactite in and near where these stopes are situated has been penetrated by the following listed 18 diamond drill holes:

3-65A	3-165A
66A	166A
68A	167A
97A	168A
98A	169A
161A	170A
162A	171A
163A	172A
164A	173A

From the logs of these holes, as well as from the geology visible in the stopes, the plans of the 560 stopes (shown in fig. 6) were constructed.

DD Hole 3-67A passes beneath the ore, as shown in Section VII, and this fact would appear to indicate that the ore along this section, and probably also that lying west of it, does not extend vertically downward very far, but rather plunges at a gentle inclination to the east, entering the west end of Stope 4-620B. The absence of ore sections in DD Holes 4-120A, 4-121A, and 4-156A, all on 400 level (fig. 4) does not, however, prove that the ore does not continue vertically downward because these holes are not long enough to reach it if it did.

Judging from DD Holes 3-163A and 3-166A, part of the tactite body extends upward at least 50 to 60 feet above 300 level. Farther up, it is probably cut

off in an irregular way by the big dike seen in the corresponding part of the 200 level (see fig. 2).

The ore body in which the 560 stopes are excavated appears to be a great, irregular lobe, extending westward from the granite contact and lying mainly in limestone.

In the stopes (fig. 6), the ore is cut into three or more segments by a large dike that is probably connected to the similar intrusive body on 200 level. The presence of this dike complicates the problem of mining the ore, but nevertheless some of the ore segments have been large enough to be stoped individually.

Stope 560 lies on the granite contact, which locally arches above the first floor, forming a roof. The tactite beneath Stope 560, as well as the tactite immediately north and east of it, dip into stope 620B and also into the footwall of this stope.

Stopes 800 and 900 - See fig. 3, 6, 9, 10 and 11, which illustrate the geology of these stopes. The ore is an upward continuation of the ore in stopes 4-745 and 4-685. It occurs as a thick lens, striking about northeast and dipping from 35° to 50° to the southeast. The footwall is limestone and the hanging wall of the stope is demarcated by Fault B, which flattens markedly in stope 800 (see Section IV). The ore at most places butts up against this fault. In and above the fault is a persistent dike, strongly sheared. The fault seems to have followed this dike. Above the fault and the dike is granite, presumably. There exists, however, the certainty that a segment of the ore body lies south of (above) the fault, in one or more places. This is shown by the ore section in and near the end of DD H 3-139A (see fig. 3) which clearly lies south of Fault B. There is an excellent chance of a good ore body here, and extending southwestward along the fault, as well as upward in the hanging wall of stopes 800 and 900, and this possibility should be investigated.

The ore in the back of stopes 800 and 900 should continue upward until cut off by the dike showing in the 200 level drift.

400 Level

Stope 4-340 extends all the way from 400 to 300 levels. The two upper floors beneath 300 level, were mapped and the geology is shown in fig. 6. Additional ore has been found by diamond drilling east of Fault G, below 300 level.

Stope 4-580 is a timbered unfilled stope extending upward from the 400 level, on the same ore body as that mined in the adjacent stopes, 580W and 580E. It is inaccessible. A granite hanging wall was found 6 sets up.

Stope 4-580W - The geology is shown in figure 7 (stope plans) and in figures 13 and 15 (Sections VI and VIII). The supposed outline of the ore on the 400 level is shown in fig. 4.

See Section VI. On the south, the ore is bounded by Fault D and by granite; below by a flat-dipping limestone floor, and above by Fault E, which dips gently to the south, apparently as a link between Fault D and Fault C. Granite and dike rock lie above Fault E, insofar as is known, but there is the probability of ore above this fault nearer its junction with Fault C. The ore presently exposed in the north face of the stope on the 2nd floor is believed to extend all the way to Fault C near the edge of stope 4-620B.

The north face of the stope on the 2nd floor shows a horse of limestone with good ore below and above, up to the Fault E, above which is granite. This face should be advanced in spite of the limestone, which can be drilled and blasted separately from the ore.

See Section VIII. The ore in 580W is the continuation of that in stopes 580 and 580E. Above the top of 580 and south of Fault C there is the possibility of more ore perhaps connecting somehow with the ore in the sill of 300 level beneath stope 3-460.

Stope 4-580E - This stope lies south of Fault C and immediately south of No. 620-C, with which it connects on several of the upper floors. The geology is shown in fig. 7 (stope plans) and figures 11, 12 and 15 (Sections IV, V, and VIII).

The bottom of the ore seems to be on the 400 level, upward for 3 floors, the ore extends as a rather narrow lens bounded on the northwest by limestone

and by Fault C and on the southeast by granite. On the 4th floor, the southeast contact swells abruptly outward into the granite, forming a much wider body.

The northeast end of this ore lens lies against granite on the 400 level, at the end of the drift. The pitch of this termination of the lens is about 45° to the southwest, so that the ore extends farther and farther to the northeast as the tope is ascended floor by floor.

These observations indicate the possibility of an important ore reserve directly above and also to the northeast of the present top of stope 580E. It is possible that this ore connects in some way, perhaps circuitously, with the ore lying in the sill of 300 level directly beneath stope No. 3-460 (See Section VIII).

The southwest face of 580E is in ore that forms a pillar between 580E and 580. This pillar can be mined. On the 3rd floor, south side, a pocket of extremely rich ore is visible in granite. Its extent is unknown, but probably small. It should be investigated by mining outward a set.

Stope 4-620B - Stope 620B adjoins 620C on the northwest, extending upward from 400 level 12 floors, nearly to the 300 level. All but the 11th and 12th floors are backfilled and therefore inaccessible. Two raises connect the 11th floor of 620B with the 5th floor of 620C, below. The geology of the accessible parts of this stope is shown in fig. 6 (stope plans) and in figures 12 and 13 (Sections V and VI).

Fault B crosses stope 620D, dipping about 40° to the south (see fig. 6) and ore has been mined on both sides of the fault.

See Sections V and VI. Both show all the ore lying in the footwall (north) of Fault B, which may be correct insofar as the planes of these sections are concerned. The plan of floor 11 (fig. 6) shows additional ore lying south of Fault B. Stope 620A, entirely inaccessible, is said to be situated south of Fault B, but its outlines are unknown. In any case, it is likely that the ore lying south of Fault B is somehow continuous with the ore in the sill of stope 3-460. Likewise it might be continuous with the ore in stopes 580E and 580W.

Ore appears all along the northeast face of the stope on the 11th floor, north of Fault B, and also near Raise 620. It extends to the east and west, and is continuous with the ore north of Fault B in stopes 4-620C and 4-685.

Tactite remains in the back of floors 11 and 12, up to the 300 level, although apparently cut by a dike (fig. 13, Section VI). This ore probably will be left as a pillar until a later stage of the life of the mine.

Stope 4-620C - The geology of this stope is illustrated in fig. 7 (stope plans) and figures 11 and 12 (Sections IV and V). Most of the ore produced to date has been mined from an important segment lying between Faults B and C, and this segment extends westward into stope 620-B. A pillar of ore separates the two stopes.

Above the 5th floor of 620-C, ore extends upward to Faults B and C, which appear to converge and join above the stope (See Sections IV and V).

Between Faults B and C, at the east face of the stope, there is ore on the 2nd and 3rd floors, which should extend several yards farther west. On the 4th and 5th floors, this ore has already been mined up to a limestone wall.

North of Fault B (see fig. 7), there is additional ore that represents an extension of the ore visible in stope 4-685, to the northeast, and of the ore lying north of Fault B in stope 4-620B, above, and to the west.

To the south, beyond Fault C, is stope 4-580E, which also contains important quantities of ore.

Stope 4-685 - The geology is illustrated in fig. 7 (stope plans), fig. 11 (Section IV) and fig. 16. The ore visible in the stope is an extension of that seen in the northwest corner of stope 4-745 (see fig. 7).

Above the 5th floor, at the raise, a limestone hanging wall is visible, dipping gently to the southwest. Above the limestone is the same dike that forms the roof of stope 4-745. More ore should be found above the dike.

The visible ore (Section IV) extends upward and to the northeast between limestone walls. It should be mined both upward and outward, likewise on all floors toward the east (until connection is made with stope 4-745) and west (until connection is made with stope 4-685 (see fig. 7)).

Stope 4-745 - The geology of this stope is shown in plan in figures 4 and 7, and in section in figures 10 and 16. It is limited above by the same dike as that forming the footwall of stope 4-1050. The northwest wall is limestone and the southeast wall is composed of granite, limestone and dike rock, all lying northwest of and close to Fault B. The ore extends up to the fault at some points, and there exists the possibility that part of the ore body lies on the other side of the fault, which, in the locality of this stope, has not been explored.

The form of the ore body is irregular (see fig. 7, stope plans). It seems to extend from the northwest part of the stope into the adjoining stope, 4-685, whence it runs farther west into that part of stope 620C lying north of Fault B.

Beneath stope 4-745, ore lies in the sill of 400 level.

The ore remaining in stope 4-745 is: a) above 6th floor and below the overlying dike; b) in pillar between stope and stope 4-685; c) a bulge of ore, pitching gently westward, at the extreme west end of the stope. Additional ore lies above the dike.

Stope 4-1000 - The ore on which this stope is excavated was first found in 4-1000 crosscut Northwest (fig. 4), on which a raise was driven and a stope excavated up 4 floors (Jan. 21, 1955). As may be seen in fig. 4, this ore in the stope is geologically part of the same body as that mined in stope 4-1050. Although the physical continuity of the ore is interrupted by a partition of granite, "horses" of limestone and intrusions of basic dike material. In the neighborhood of 1000 X-cut (Section II) the southeast limit of the ore is formed of a thick wedge of marble. The northwest wall is limestone. Ore, proven by drifting and diamond drilling, lies immediately to the northeast, and also to the southwest, where, however, its length is as yet unexplored.

Stope 4-1050 - This stope was commenced in Nov. 1954 in a wedge of ore lying between Fault A and Fault B (see fig. 4) and overlying a basic dike, visible at several places on the level, striking about WNW and dipping around 20° to the north. The ore in this stope is a continuation of that mined in stope 4-745, but separated from it only by the dike, which forms a natural footwall.

of the stope (see fig. 7, floor 13, also fig. 16). To the northwest, the stope joins with No. 4-1000 stope, which was commenced in December 1954. The ore mined in these two stopes is actually parts of a single body separated locally by a mass of limestone that probably tapers out upward, so that the ore sections merge (see Section II, fig. 9) and continue upward to the 300 level as a single mass.

Fault B (see Sections I and II) apparently form the limit of the ore on the southeast, beyond which the available information indicates the presence of granite and dike rock. There is, however, the distant possibility that additional ore lies southeast of Fault B, and the faults should therefore be crossed at several points in order to prospect the other side. In any case, the ore should be mined right up to Fault B, unless intervening rock (dikes, etc.) locally appears.

Upward, following the dike as a footwall, the ore extends all the way to the 300 level, over a strike length of at least 175 feet (the distance between Sections I and IV), and constitutes an important ore reserve.

Beneath the dike that forms the natural footwall of stope 4-1050, additional ore exists in stopes 4-745 and 4-685 (see descriptions of) and also in the 400 level sill, beneath the lower contact of the dike (see Section I, fig. 8).

Northwest of the stope, across Fault A, is additional ore, which might be mined from stope 4-1000 or from another new stope to be started farther to the northeast, in the wide part of the 400 level drift (See fig. 4).

ORE RESERVES

The ore reserves include only that ore of which there is conclusive evidence of its existence (from direct observation, diamond drill core logs, etc.), and which has been sufficiently explored to allow the forming of a reasonably secure conception of its size, shape and grade. Obviously, then, the reserves do not embrace all the ore in and around the mine, which is an unknown quantity at the present stage of development. There probably exist important tonnages of ore in excess of the calculated reserve, but they have not been explored enough to permit any but a rough and unreliable guess about their size.

Geological factors naturally influence the reliability of the reserve calculations. The ore deposit is highly irregular in form, subject to abrupt and (in detail) unpredictable pinches, swells and terminations. This is owing to its nature as a contact metasomatic deposit. Furthermore, there exist in the deposit masses of tactite containing very little scheelite. It is impossible, at the present time at least, to foresee where these might occur. Finally, the original complications of form are further complicated by the presence of intrusive igneous bodies of irregular shape, which penetrate the ore at many places, and also by the existence of a number of longitudinal post-ore faults that slice the deposit into individual segments. With these geological conditions, the only ore that can be considered as truly "positive" must be so thoroughly punctured by workings and drill holes that little remains of it. In the computation of "probable" ore, a little more latitude is permitted, and the observable geological features are projected short distances, unless there is evidence that such extensions cannot exist. Furthermore, as is evident, the reserves must be limited to those parts of the mine open to inspection and which were actually inspected.

The quantity of ore that is ultimately mined from a reserve block depends partly on the care and thoroughness with which the ore is followed and excavated in the stopes. In the figures given, there is no allowance made for pillars, because it is believed that stope pillars are unnecessary if square-set mining is carried on properly. Drift pillars will probably be left at many places, but should be eventually recoverable.

The grade assigned to the various reserve blocks is a composite figure derived mainly from ore car assay and DD core assays. Tonnages are calculated from the geologic maps and sections. The average specific gravity of the ore is about 3.1, which gives a factor of 10.35 cubic feet per short ton in place. The ore blocks were calculated entire and then, in some places, a certain small proportion of the tonnage was allowed as

"positive" ore, the balance being assigned to "probable" ore. Possible ore is excluded from the reserves.

Finally, it should be stated that the estimate is only a preliminary one. The careful channel sampling and measurements necessary to a proper reserve estimate were not made, partly from lack of time and mostly from doubt as to the practical value of such work, especially when the necessary time and expense are considered.

BLOCK I extends, on the 400 level, from Section I near Raise 1050, north-eastward to the place in the wide part of the drift where the ore narrows abruptly, and upward from 400 to 300 level. This block is penetrated, on 400 level, by DD Holes 4-196-A, 4-197-A and 4-255A, and by 3-230-A just above the level. Narrow bands of ore were intersected by three flat DD Holes (3-270A, 3-272A and 3-273A) on 300 level, which determine the position of the upper edge of the ore block. Two thousand tons probable ore are computed in this block, with average grade of 1.1% WO_3 , taking into account the grade of ore from stope 1050 and of the ore sections out in the DD Holes, as well as of the ore visible in the drift.

BLOCK II lies between cross-sections I and II, above stope 1000 and 1050, up to the 300 level. The ore reserve in this block is estimated at 5500 tons, after deducting the tonnage mined to Jan. 22, 1955. The average grade is estimated at 1.3% WO_3 , based on the production from stopes 1000 and 1050.

BLOCK III is between Sections II and III, above the dike that forms the foot-wall of stope 1050, southwest of the present (1/22/55) faces of stopes 1000 and 1050, and beneath the sill of 300 level, which is in ore throughout the length of the block. DD Holes 4-150A and 4-263A cut this ore above the dike and below 300 sill (See fig. 16). The estimated reserve is 15,000 tons, with the possibility of an additional 15,000 tons. The grade, estimated from production of stopes 4-745, 4-1000 and 4-1050, as well as from the grade of the ore mined from the 300 sill below stopes 800 and 900, and that of the ore sections in DD Holes 4-150A and 4-263A, is estimated at 1.5% WO_3 .

BLOCK IV is the wedge of ore between Section III and IV (See fig. 3) in the sill of 300 level and above the dike visible is the backs of stopes 4-745 and 4-685, which is the same dike as that forming the footwall of stope 4-1050. The reserve in this block is 2700 tons with average grade of 1.5% WO_3 .

BLOCK V lies beneath 300 level, on the north side of Fault B, and extends from Section IV westward to Section VI, near the northeast face of stope 4-620B. The lower limit of the block at Section IV is the top of the dike exposed in the roof of stope 4-685 (7th floor). On Section VI, the lower limit of the ore block is Fault B, which seems to reverse to dip in stope 4-620B (See Section VI).

On Section IV the ore is assumed to form a single body. At Section VI it appears that a wide partition of limestone separates the tactite into two branches. The lower branch is exposed on the 11th floor of 620B, in the short crosscut to the new Raise 620. It is also exposed in the northwest part of stope 4-620C, north of Fault B, on floors 2, 3, 4 and 5 (See fig. 7), and it has been cut by DD Holes 4-245 and 4-247 on the 400 level (See fig. 4). The upper branch shows on the northeast wall of 4-620B, 11th floor (See fig. 6).

Ore is known to lie in the sill of 300 level at the upper limit of the block.

The outlines of the ore in this block are rather indefinite, and the ore reserve computed here is limited to a block extending 20 feet downward below 300 level, and which is calculated to contain 5700 tons, with average grade of 1.2% WO_3 . This grade is a compromise between the grade of ore mined in the 3-800 stope sill (1.5%) and that recently mined a short distance beneath the dike in stope 4-685 (0.73%). There is the possibility of additional ore (possible ore) amounting to as much as 15,000 tons.

BLOCK VI includes the ore in the back of stope 4-620C from the 6th floor, between and up to the supposed junction of Faults B and C (See Section V), and the ore in the pillar separating this stope from 620B, as well as the

ore extending northeast from the stope, between the two faults. It excludes ore lying north of Fault B and south of Fault C (See fig. 7). Block VI is estimated to contain 2200 tons with average grade of 0.9% WO_3 . The recent production from 620C has assayed 0.91% WO_3 .

BLOCK VII surrounds stope 4-685, beneath the roof dike exposed on the 7th floor, extending to stope 4-745 and also 25 feet westward, toward stope 4-620C, as well as down to the 400 level. Excluding the ore mined from November 26, 1954 to January 14, 1955 from this block, the reserve is estimated at 3000 tons, with average grade of 0.8% WO_3 . There is the possibility of additional ore.

BLOCK VIII is south of Fault C, in the back of stope 580E above the 5th floor, and to the northeast. It includes also the ore pillar separating the stope from stope 580. Extending the ore 20 feet upward as well as northeastward, the reserve is computed as 2000 tons, with average grade of 1% WO_3 . The ore mined from the stope to 1/21/55 averaged 1.04% WO_3 . There is the good possibility of much more ore than here calculated.

BLOCK IX is the northward extension to Fault C, below Fault E, of ore visible in the north faces of stope 580W, on the first and second floors. The estimated tonnage is 2000 tons with grade of 0.7% WO_3 .

BLOCK X lies beneath 300 level, west of Section VII, in the wide, irregular ore body that has been partly mined in the 560 stopes. As before stated (see description of stope 3-560), this ore is believed not to extend vertically downward very far, but rather to plunge at a low angle to the east, entering the west end of stope 4-620B. Assuming a downward extent of 10 feet, this block contains 2000 tons. Additional, possible, ore lies below that. The average grade, judged from the stope production and assay of ore sections in the DD Holes is 0.6% WO_3 .

BLOCK XI is in the same mass of ore as Block X, but lies above the 300 level, as well as west of Section VII. Part of it has been stoped in 560E and 560W.

The average grade of the stopes was:

560E	0.51%	WO ₃
560W	0.37%	WO ₃
560W extension	0.66%	WO ₃

Taking DD core assays also into account, the average grade of the block is estimated at 0.6% WO₃, and the probable tonnage, up to the 6th floor, at 4000 tons. There may be ore in excess of this.

The part of the tactite body lying between Sections VI and VII on 300 level (fig. 3) appears to be largely too low-grade to mine, and it is therefore excluded from the ore reserve.

BLOCK XII comprises the ore in the back of stope 800E extended up the dip for a distance of 40 feet above the 6th floor. The reserve is estimated as 2000 tons with grade of 1.4% WO₃. There is the possibility of additional ore.

BLOCK XIII comprises the ore in stope 900A projected 60 feet up the dip toward 200 level. The estimated tonnage is 1500 with grade of 1% WO₃.

BLOCK XIV represents the ore above the 3rd floor of stope 900B projected up the dip 60 feet. There are 750 tons of ore reserve with grade of 1% WO₃.

There may possibly be additional ore above Blocks XIII and XIV.

BLOCK XV is the ore visible (assuming short extensions) in the walls and back of stope 2-250, which should easily exceed 2000 tons with grade of 1%.

BLOCK XVI extends downward from the 400 to the 500 level between Sections I and II, and 10 feet on either side of the sections. The calculation is based on geologic cross-sections I and II constructed from DD cores and from the geology of 1000 shaft, mapped by E. A. Hollingsworth. The reserve of probable ore in this block amounts to 6000 tons with average grade of 1.2% WO₃.

Table 4

SUMMARY OF ORE RESERVES AS OF JANUARY 22, 1955

(Preliminary estimate only)

Block No.	Positive Ore Tons	Probable Ore Tons	Total Ore Reserves Tons	Grade % WO ₃	Total Units WO ₃	Units WO ₃ recoverable at 83%
1100 I		2,000	2,000	503 1.1%	2,200	1,820
4700-1050 II	500	5,000	5,500	734 1.3	7,150	5,930
745A III	2,000	13,000	15,000	645 1.5	22,500	18,700
745A IV	700	2,000	2,700	1.5	4,050	3,360
620B V		5,700	5,700	518 1.2	6,840	5,670
620C VI	500	1,700	2,200	0.9	1,980	1,640
685 VII	500	2,500	3,000	178 0.8	2,400	1,990
580-580E VIII	500	1,500	2,000	1.0	2,000	1,660
4-580W IX		2,000	2,000	180 0.7	1,400	1,160
X		2,000	2,000	0.6	1,200	995
3-560 XI		4,000	4,000	745 0.6	2,400	1,990
3-800E XII	500	1,500	2,000	127 1.4	2,800	2,320
3-900A XIII	500	1,000	1,500	180 1.0	1,500	1,240
3-700B XIV	250	500	750	1.0	750	620
2-250 XV		2,000	2,000	166 1.0	2,000	1,660
500 br. N15 XVI		6,000	6,000	117 1.2	7,200	5,970
Totals	5,950	52,400	58,350	1.17	68,370	56,725

OTHER ORE POSSIBILITIES AND CORRESPONDING RECOMMENDATIONS FOR EXPLORATION

In this chapter of the report, a list is given of the additional ore possibilities (exclusive of ore reserves) that exist in the mine. The numerous items in this list fall into two categories:

(a) Possible ore includes the following:

- i) ore penetrated by workings or core drill holes, but which is insufficiently explored to permit forming an adequate idea of size, shape and grade
- ii) projections of known ore bodies, based on geological inference.
- iii) known tactite bodies that are too low-grade to mine according to present information, but which might contain commercial ore in some part of them as yet insufficiently explored.

(b) Other ore possibilities about which there are no specific data:

The enumeration follows, with recommendations for exploration where called for:

Locality

Above 100 Level: 1) The surface geology, as mapped by the U. S. Geological Survey in 1943 - 1944, is shown in Figure 1. Maps of the 50 and 100 levels and part of the 200 level were also prepared at that time by the U.S.G.S., and are filed in the engineering office at the mine. The 50 and 100 levels were not studied during the present investigation. They are reported to be mostly inaccessible. In the absence of maps revealing the extent and geology of the old stopes, it is not possible to formulate a definite idea of the ore possibilities on these levels.

200 Level: 2) With one exception, the numerous stopes above the 200 level are inaccessible or mostly inaccessible. Southwest of the main shaft, however, are several timbered, unfilled stopes, now unsafe to enter, which could be easily repaired enough to make mapping possible. The filled stopes are permanently inaccessible unless, at some future time, it is decided to mine them again.

3) Ore has been found in the granite, apparently rather far from the limestone, by diamond drilling on 300 level. Equal possibilities exist on the 200 level.

4) See Figure 2 (Geological Map of 200 Level). DDH 2 - 32A penetrates ore at a point well beyond the limits of the old stopes in this vicinity. This may represent a segment of the orebody sheared off and isolated east of the hanging wall fault, known from old maps to be present in this part of the mine.

5) See Fig. 2. In the crosscut running west from spad 15A there is tactite on the south wall, beneath a thick, gently-dipping porphyry dike. It probably extends southwestward into the limestone as indicated by DD Holes 2-89A and 2-73A, but does not seem to be very important.

6) See Fig. 2. In and near the second crosscut west (Spad 20A), there are three places where ore runs westward or southwestward out into the limestone walls. These are drift pillars beneath old stopes.

Exploration Recommendations

1) Unless high price for tungsten can be foreseen for some time into the future, it is doubtful whether the reopening of these levels is called for. All the available geological information should, however, be gathered and plotted when there is time for it.

2) The unfilled stopes southwest of the main shaft should be retimbered enough to make the back and sides safely accessible, and should thereafter be mapped and sampled. Subsequent exploratory work would depend on the results shown by the geological study.

3) Systematic diamond drilling of the granite should be done on 200 level as soon as convenient. The drill sites and directions of the holes can be decided by the management, and the resident mine engineer.

4) Crosscut east from the haulageway, through the old caved workings to the position occupied by the ore at the end of the DDH. If the ore appears important, follow it with a drift. Alternatively, it should be possible to gain an adequate idea of this ore by diamond drilling several holes upward and to the west from Level 300, near the foot of Raise 3-550B (see composite plan of levels, Fig. 1).

5) The tactite should be sampled. If of ore grade, it should be explored by a short drift southwestward.

6) The extent of these pillars should be investigated and they should eventually be mined.

7) Generally speaking, the limestone lying southwest of the northwest trending part of the 200 Level haulageway has been insufficiently explored for possible further footwall projection of the main ore body. Although there are no positive ore indications (except the southwestward striking ore protruberances mentioned in 6), above (Fig. 2), it is advisable to diamond drill this footwall rather thoroughly.

8) Northeast of the 2d crosscut (spad 20A) the drift lies largely in dike rock. This intrusive mass is large and irregular in form, due partly to faulting, and has obscured the ore possibilities in this part of the level. Insofar as can be seen, the intrusive dips from 45 to 65 degrees to the southeast. It cuts off the ore extending upward from the corresponding section of the 300 Level, and it likewise cuts off the ore extending downward from the surface. (See Cross-sections IV, V, V and VII.) Because of this dike, there is no ore to speak of on this part of the 200 level, except at the end of it, in and near 1000 X cut north, where a small orebody has been partly mined in the footwall of the intrusion. Beneath the dike, however, there should be plenty of ore, judging from the powerful ore body exposed below in the 300 Level drift and stopes.

Above the 200 Level there are several stopes, but they are inaccessible and their size and ore content are unknown.

9) At the northeast end of the level, ore shows in the workings and in several of the diamond drill holes (see Fig. 2), and the bothersome dike seems to be diminishing in width.

300 Level: 10) Near spad 309, some tactite of ore grade was found in DD Holes 3-281A, 3-278A, 3-282A, and 3-283A, above the level, and bands of tactite were found in the adjacent holes 3-279-A and 3-280A. These intercepts probably are on the same small body as appears in the drift, between limestone walls, a few feet from the collar of the holes.

7) From the second crosscut (at spad 20A) drill four 150-foot holes: a) flat hole due south, b) flat hole S 25E, about parallel to haulageway, c) up 20 degrees, S15E, d) down 20°, S15E.

From the first crosscut (about 30 feet in from spad 15A, drill three 150-foot holes: 1) flat hole N25W, about parallel to haulageway, 2) up 20 degrees N15W, 3) down 20° N15W.

8) The exploration of the ore possibilities below the dike are described in the exploration recommendation for 300 Level.

Above the 200 Level, it is first necessary to put the stopes in an accessible, safe condition, insofar as possible, so that they can be mapped and a definite idea formed of the ore possibilities in this locality. It would probably be a mistake to assume that all the profitable ore had already been mined. After mapping and sampling, an adequate diamond drilling program, or other exploratory program, could be laid out.

9) The drift should be continued at least 100 feet to the northeast, exploring further the ore found in the DD holes, and following the contact between granite and limestone.

10) An exploratory raise should be driven 80 feet, about 80 degrees above the horizontal, following the tactite body as indicated in the DD cores.

11) Near spad 309, four wildcat holes (3-274, 275, 276, 277) were bored southeast into the granite at angles of plus 10 to plus 30 degrees following the inspiration of the resident engineer, E. A. Hollingsworth, and an 18-foot section of ore, assaying 0.67% WO₃, was cut in No. 3-276, 67 feet from the granite-limestone contact.

Several additional holes must be drilled to ascertain the importance of this discovery, but nonetheless it brings clearly to light the possibility of the existence of ore bodies in the granite, rather far removed from the contact.

12) Near spad 311 (Fig. 3) DD Hole 3-11A was drilled in July 1951. A 17-foot section of ore was cut directly below the sill, and has not been further investigated. It might be part of the 3-280 - 3-550 ore body, isolated south of Fault D.

13) See Fig. 3. At the end of the short drift running northeast from a point near the foot of Raise 3-320 M, a segment of rich ore is visible in the back and walls, abutting against Fault G, which cuts it off. The ore directly above this drift has been stoped, reportedly, but the drift is blocked and the stope cannot be entered. The geology of this local area definitely suggests the possibility of finding more ore on this level, and this inference is sustained by the results of DD H 3-286A, drilled downward at 33° below 300 Level (see Fig. 3). Two ore sections were found in this hole; the first, from 63 to 73 feet may correspond to the ore mined in and above the 300 Level in the northeast part of Stope 3-390. The second ore section, extending from 88 to 98 feet in the drill hole, is believed to correspond to the faulted part, east of Fault G, of the ore exposed at the end of the aforementioned short drift. Both ore sections in the DD core are in granite. The possibilities of a large and valuable ore body on and above 300 Level (as well as below), to the east of Fault G and southeast of Stope 390 are thus very good.

14) An even further northeastward extension of this same possible ore body may be represented by the 10-foot ore section found (from 117 to 127 feet) in DD H 3-296A.

11) DD holes 100 feet long or more should be driven on either side, as well as above and below the ore intercept in DD H 3-276. If the results are promising a crosscut should be driven out on 300 Level (already begun - Jan./55) and the ore body further explored and then developed if warranted.

Beyond this particular occurrence, it is necessary to drill other holes into the granite hanging wall on 300, 400 and lower levels, in a systematic way.

12) A shallow winze could be sunk from the DD station on 300 Level, or several DD holes could be bored steeply upward from the 400 Level crosscut north of spad 408, in order to get a preliminary idea of the importance of this body.

13) Clean out the short drift. Advance the heading N45E about 80 feet, following ore after it is found. Raise on the ore.

14) After further exploratory drilling, the ore-bearing area could best be reached by a further northeastward extension of the new drift proposed under 13) above.

15) Tactite was intersected in DD H 3-168A a few yards southwest of Stope 560 W. It may be a continuation of the large body partly mined in that stope.

16) North of the wide 500 ore body on 300 Level, narrow tactite sections have been cut in DD Holes 3-95A, 3-64A, 3-177A and 3-174A (see Figure 3 and Section VI). The connection, if any, with the main ore body, is not known. The ore possibilities here are fairly good.

17) DD Hole 3-139A crossed Fault B below the northeast end of Stope 800 and ore sections aggregating 24 feet were found on the south side (see Fig. 3). This ore is a faulted segment of the ore in 800 and 900 stopes. Its extent is unknown but might be great. It may extend upward above the hanging wall of 800 and 900 stopes, as well as downward; and it may extend southwestward along Fault B, possibly connecting with the ore in the southeast corner of Stope 620 C, above 400 Level.

18) Narrow ore sections were found in DD Holes 3-270, 3-272 and 3-273, at the northeast end of 300 Level (see Fig. 3). These represent the upper edge of Ore Reserve Block No. 1 (see preceding description of ore reserves). Lateral and upward continuations may exist.

19) Many of the stopes on 300 Level are no longer accessible, so it is impossible to judge their possibilities of additional ore. There are many drift pillars along the level, between old stopes, that might contain in the aggregate a worthwhile tonnage of ore.

20) Between Section VI and Section VII (Figs. 13 and 14), immediately above and beneath 300 Level, is a wide body of tactite bounded on the south by Fault B (see Fig. 3). The hanging wall part of it, near the fault, has been partly mined on stopes 3-560 (above the level) and in 4-620B, below the level. Near the footwall, a small part of it was mined

15) Drift southwest 50 feet from the end of the level beneath Stope 560 W.

16) Crosscut to the ore, then follow it with a drift. Diamond drill this area from 300 Level both downward and upward.

17) The south side of Fault B on 300 and 400 levels should be intensively explored by diamond drilling and cross-cutting. The drill sites and direction of the holes can be selected by the resident engineer.

18) Drift at least 100 feet northeast on contact from the northeast end of the level near Spad 337 I. Raise on ore if good ore widths are found.

19) Where old stopes can easily be made accessible, this should be done, and they should be mapped and sampled. Further exploration or development could proceed, or not, upon the basis of these findings. The drift pillars on the level should be closely examined and a complete list made of them for reference during future pillar-robbing operations. Filled stopes must presumably remain inaccessible until it is decided to reopen them to mine residual ore, if any is supposed to exist.

20) This block may contain minable quantities of ore, and it should be investigated by two raises driven in the tactite on 300 Level.

Below the level, it could best be explored by a sublevel drift, with short crosscuts where necessary, running north-

in Stope 560E (Figs. 3 and 6). In the footwall drift extending east from Stope 560E toward spad 337D, the grade of the tactite appears to be very low.

Above the 300 Level, the following DD holes were bored with indicated results:

DDH 3-100A	Plus 45°	- grade submarginal.
3- 99A	Plus 20°	- grade marginal
3-101A	Plus 20°	- grade marginal
3-102A	Plus 45°	- grade submarginal.

Below the 300 Level, the following DD holes were bored with the indicated results:

3-103A	-60°	grade submarginal
3-104A	-58°	ore
3-64A	- 5°	ore?
3-69A	-24°	marginal

It will be seen from this data that part of the tactite below the level appears to be ore, and the rest is marginal or submarginal. This block has accordingly been left out of the ore reserve because of its apparent general low grade, and the uncertainty of how much ore it might contain. Ore that may possibly lie as a floor pillar in the back of the stope 620B has also been omitted from the ore reserve because the back is timbered and the ore cannot be seen.

On Section VI (Fig. 13) it will be noted that the ore appears to be divided by a limestone partition into an upper branch directly beneath Fault B and a lower branch. The lower branch might be low grade, corresponding to the low grade section in the footwall part of the body in the 300 Drift above.

21) The possibilities of ore additional to that estimated in ore reserve Blocks XI, XII, XIII, and XIV have already been alluded to in the description of the ore reserves.

westerly from the new raise 620, on the 11th floor of Stope 620B. Alternatively this drift could be driven from one of the upper floors of Stope 620C.

400 Level: 22) Near the main shaft, west of the short crosscut starting at spad 404, tactite was intersected in DD Holes 4-41A, 4-48A, and 4-49A. Most of it has a low W03 content. At this place the granite contact makes a pronounced curve (see Fig. 4) and the possibility of an important ore body is rather good, in spite of the low assays obtained so far. The mining of whatever ore exists would presumably be postponed until the end of the life of the mine, because of the proximity to the main shaft.

23) At the end of the short contact drift running east from spad 408, beneath Stope 340E, good ore, although narrow, is visible (see Fig. 4 and the sketch of the face thereon). This ore appears to be a part of the same body as was intersected in DD H 4-115A and in 3-285A (see Section VII), and its extension even farther northeastward is indicated by the log of DDH 3-286A.

The downward extension of the ore in the sill of Stope 3-390 is definitely indicated by DDH 3-284A, and 3-285A. It would appear that this body merges with the one lying immediately to the south at some place between 300 and 400 levels (see Section VII (Fig. 14) and Fig. 3).

There is here, therefore, the strong possibility of an ore body of great importance.

24) In this sill of 300 Level (see Fig. 3), several small ore bodies can be seen below Stope 3-550. This ore extends below 300 Level, as shown by ore sections in DD Holes 3-77A and in 3-290A and 3-293A. In 3-293A, the ore was found from 65 to 75 feet below the level. In DD Holes 4-106A, 4-107A, 4-108A, and 4-109A, what is apparently the same ore was intersected at reduced widths, on the 400 Level (see Fig. 4).

25) Ore is reported to be on 300 Level, directly beneath Stope 3-460, but the downward extent and direction of this ore are problematical (see Sections VII and VIII). DD Holes 3-72A, 3-75A, and 3-76A intersected tactite some of which was of ore grade. Judging from the DD H logs it seems likely that the ore body flattens somewhat below the sill,

22) Further diamond drilling, upward and downward from 400 Level is recommended.

23) On 400 Level, drift west 80 feet following the contact or the ore. Drive a raise on the ore to connect with the 300 Level drift proposed in 13) above, which presumably would follow the same ore body.

Additional diamond drilling should be done from the 400 drift between spads 410 and 411, in directions south and southeast, horizontally, as well as inclined upward and downward.

24) This ore can be explored by crosscutting 40 feet northeast from the end of the old 400 Level crosscut (spad 408A) to the ore as shown in DDH 4-107A, and by drifting on the ore a short distance, with a raise to 300 Level.

25) This possibility may be best explored by diamond drilling steeply downward along the line of Section VII on 300 Level, between spads 315 and 317 (see Fig. 3), and some of the holes should be inclined toward the east. If a worthwhile ore body is delineated, mining might conveniently proceed from Stope 4-580W, after it has been

and plunges at a moderate angle into Fault B, on the south side of Stope 4-620B (see Fig. 6, plan of 620B Stope, 11th floor above 400 Level). Possibly, also, the ore may terminate before it reaches Fault B. There is an excellent chance of a large mass of ore in this area directly beneath 300 Level sill, and abutting against Fault B.

26) Directly above ore reserve Block VIII which lies mainly in the back of Stope 4-580E (see earlier descriptions of Stope 4-580E and of Block VIII), as well as upward to the northeast and to the southwest, additional ore may very well lie along the hanging walls of Faults B and C (see Sections IV and V). There is the scant possibility that the ore visible in the northeast face of Stope 580E, on the 4th and 5th floors (Fig. 7) pitches gently upward, more or less following Faults C and B on their south sides to a union with the ore found south of Fault B on 300 Level, DDH 3-139A (see Fig. 3).

27) Northwest of Raise 4-620M (Fig. 4), in DD Holes 4-156A and 4-157A, good ore sections were cut, lying south of the projection of Fault B. This ore appears to lie directly beneath Stope 620B, although the position of this stope is not known exactly except on the upper floors. Presumably this ore abuts against Fault B on the northeast and continues some unknown distance toward the southwest (see Fig. 4). The ore mined in Stope 4-685 continues southwestward along the 400 Level drift, and runs into the northwest wall of the drift near the point where Fault B crosses the drift. A short distance northwest of the drift, the same ore was found in DD Holes 4-144A, 4-245A, and 4-247A. Apparently this ore continues southwestward until it is cut off by Fault B. Additionally, there may be even more ore to the north of this body.

The ore lying north of Fault B in this locality is the downward extension of the ore visible in the northwest part of Stope 620C, which in turn connects with the ore seen along the northeast face of Stope 620B (11th floor) and also with that visible in the crosscut to Raise 620, in the same stope (see Fig. 6 and Fig. 12, Section V). This mass of ore is probably large, but it has been little explored.

extended north to Fault B (see Section VI).

26) Stope 580E, as it is continued upward and outward, should eventually show what ore continuations are possible, as long as the stope is made to extend always to the walls of the ore and the geology is carefully observed and mapped.

Diamond drilling should be carried out from the 11th floor of Stope 620B with the holes pointed southeast along Section V, and south along Section IV, at vertical angles of minus 30, zero, and plus 30 degrees. These holes might possibly be substituted by some of those recommended under 17) above.

27) The ore lying both northeast and southwest of Fault B should be followed by a drift running 100 feet southwest from spad 415. It should also be crosscut and drifted on the 3rd and 6th floors of Stope 620C, and stoped from the 400 level if the grade warrants.

28) The ore showing in 1000 crosscut, 400 Level, below 1000 Stope, extends southwestward an unknown distance. It might possibly connect with the bulge of tactite that runs out into the limestone at the foot of Raise 745R.

29) The possibility of ore in some places south of Fault B in Stope 4-1050 has been mentioned (see description of Stope 4-1050).

30) The ore in the drift at the northeast end of the 400 level is very narrow, but further exploration of the contact in a northeastward direction should be done.

31) The possibility of additional ore, above and beyond that estimated in the ore reserve, has been mentioned under Blocks III, V, VII, VIII, and X. (See corresponding description of these ore reserve blocks, given in an earlier section of this report.)

Below 400 Level: 32) In the chapter on Geology, mention has been made of the possible structure of the ore deposit at greater depth, below the 400 level (see Sketch 1). The ore possibilities here are favorable. There has been little exploration in depth, except in the immediate vicinity of the 1000 shaft. Elsewhere only an occasional DD hole descends below the elevation of the 400 Level.

28) Drift southwest on ore from 1000 crosscut.

30) Continue drift northeast along contact at least 100 feet.

32) There are many possibilities for diamond drilling below 400 Level, because this deeper part of the deposit has remained almost unexplored. One scheme, that may give a great deal of information in a short time, is the following:

On 400 Level, crosscut 80 feet to the southeast from the drift at a point near spad 419R, to a point near coordinates:

10400 N
10600 E

Here a diamond drill station should be cut, and DD holes drilled as follows to intersect the downward extensions of the ore:

Vertical	
North	minus 30, 45, 60 degrees
Northwest	minus 30, 45, 60 degrees
West	minus 30, 45, 60 degrees
Southwest	minus 30, 45, 60 degrees

All holes should be drilled at least 200 feet or so. Once the ore has been roughly delineated by these holes, additional holes should be bored to complete the picture and

Lateral Extensions: 33) The granite-limestone contact to the northeast and to the southwest of the mine workings was examined only briefly at the surface. Diamond drilling southwest of the mine from the surface, in 1954, resulted disappointingly.

The probability is that by far the greater part of the more profitable ore is localized along and near the pre-granite, northwest fault, and that the exploration of the contact at distances of more than 400 or 500 feet to the northeast or southwest of this fault would not result in important discoveries. There remains, however, the possibility that another similar pre-granite fault might occur somewhere near the mine, and might make ore. The surface geology (Fig. 1) does not indicate the presence of another such fault, however.

Ore in Granite: 34) The existence of ore in the granite at some distance from the contact has been noted on earlier pages. Other ore deposits of the contact-metasomatic type have been known to include ore bodies in the intrusive rock rather far removed from the contact itself, so this occurrence is not unique. It requires additional study.

to extend the explored area. It may be possible, with close drilling, to block out a sizeable tonnage in this way.

The 1000 shaft, which has reached 500 Level, should be continued down to 600 Level as quickly as possible.

33) The possibilities of lateral extensions of the ore beyond the present limits of the mine should receive more extended consideration than it is possible to give on the basis of the present study. Nonetheless, drifting northeast on 200, 300 and 400 levels for short distances should proceed in accordance with the recommendations given earlier in this report.

34) The surface occurrences of ore in granite should be studied, mapped, and, if they seem important, their extensions should be explored by diamond drilling from the surface.

The desirability of underground diamond drilling outward into the granite at various levels has been noted in foregoing recommendations.

MAIN CONCLUSIONS AND RECOMMENDATIONS

1. The ore reserve, estimated in a preliminary way as of January 22, 1955, is 58,350 short tons with an average grade of 1.17% WO₃. Assuming 100% recovery in the mine and 83% recovery in the mill, this ore should yield concentrates containing a total of 56,725 short-ton units of WO₃ having a gross value, at the price of \$63.00 per unit, of about \$3,570,000.00. This ore reserve would be sufficient to feed the mill for about one year and four months at the rate of 125 tons per day.
2. The ore possibilities above the 400 Level, in addition to the reserve, are excellent. Specific localities have been listed in the foregoing chapter. The careful exploration of these localities might well block out an additional reserve of 25,000 to 100,000 tons.
3. No geological evidence was seen that indicated that the ore would cut off at the shallow depth below 400 Level. The possibilities in depth now seem favorable, but the reality will depend largely on the structural behaviour of the contact at depth, especially of the pre-granite fault.
4. Many recommendations for exploration and development have been given in the preceding chapter. In addition to these, more diamond drilling should be carried out in the ore reserve blocks themselves, in order to verify the conclusions about tonnage and grade given in this report.
5. The ore drilling in the future should be consciously divided into two classes:
 - a) Close drilling, to help establish ore reserves and to determine the size, shape and grade of each ore occurrence in advance of mining, thus permitting the planning of the most advantageous method of development and mining.
 - b) Wildcatting, to explore areas where ore might exist, but of which there is no definite indication.

6. Drifting, crosscutting and raising for purposes of exploration and development should likewise be carried out in places where diamond drilling has already delineated ore, and in other places where the diamond drilling method is somehow handicapped.
7. The exploration of working stopes by systematic geologic mapping is very important in this mine, in order that ore is not inadvertently left in the stopes when they are backfilled.
8. The geology of the mine is complicated enough to require the continuous services of a trained and experienced mining geologist, or of a mining engineer with ample experience in geological and exploratory work. It seems essential that such a man be hired. His duties would include:
 - a) The geological mapping of new workings
 - b) Review of the geology of old workings
 - c) The preparation of geological maps and sections in such a way that new information is always posted up to date, and a comprehensive view of the known geology of the mine can always be easily had
 - d) The logging of drill cores
 - e) Petrographic and mineralogical investigations
 - f) The preparation of ore reserve estimates every six months
 - g) The direction of the exploration and development program, under the general supervision of the management.
9. Every six months, an exploration and development program for the next six months' period should be prepared by consultation among the managers and technical staff. The program should be reduced to writing and should give a description of each project proposed as well as its immediate objective. Once determined, the program should be followed rather rigorously. Progress reports should be prepared monthly showing projects completed

and in progress, results achieved, and the percentage completion of the entire program. A final report also should be made. The chief objective of this continuing exploration program would be to discover and block out ore reserves sufficient to keep the mill operating at least two to three years into the future. A second objective is to promote more efficient mining through a greater knowledge of the geology, and a third objective is to increase the selling price of the mine in the event that it should be decided to sell it. Practical obstacles that may exist to the realization of the various necessary exploration projects should be analyzed and steps taken to solve them.

10. Diamond drill cores, at least those containing ore, should be saved, labelled and stored for future reference. This means that the tactite cores must be split before assaying. This precaution is necessary to be able to prove ore discoveries and reserve calculations to any future prospective purchaser of the mining property.
11. An additional diamond drill should be bought.
12. Detailed petrographic and mineralogical studies should be made of the ore and rocks. Chemical or spectrographic analyses of the ore should be made to determine whether other valuable constituents than tungsten are present.

WALTER C. STOLL

Seattle, Washington

February 18, 1955

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TUNGSTEN DEPOSITS NEAR RAWHIDE

MINERAL COUNTY, NEVADA

Konrad Krauskopf

Robert Stopper

U.S. Geological Survey
July 19, 1943

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Introduction

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Several contact-metamorphic tungsten deposits, of which the most important is one worked by the Nevada Scheelite Company, are located a few miles east of the nearly deserted town of Rawhide, Nevada. The area is in the Regent mining district in the extreme northern part of Mineral County, at elevations between 5000 and 6000 feet (Secs. 1 and 12, T13N, R32E, Mt. Diablo B & M). It is about 25 miles airline east of Schurz and about 40 miles airline southeast of Fallon. The region is shown near the south border of the Carson Sink quadrangle.

The best road into the district is a 22-mile dirt road which leaves U.S. Highway 50 about 35 miles east of Fallon. Nearly as good is a 30-mile dirt road connecting Rawhide with Schurz, the nearest railroad point. The area can also be reached by poor desert roads from Luning and Hawthorne.

The two mills at present operating in the district are located near a small playa, where an adequate water supply is obtained from wells. The Moore mill is about seven miles from the chief tungsten deposits and the Nevada Scheelite mill about nine miles.

Field work for this report occupied three weeks in June, 1943. The work involved underground mapping (tape and Brunton) of the principal deposits, detailed surface mapping near the Nevada Scheelite mine and the "Glory Hole", and a brief reconnaissance of the areal geology. In the summer of 1942 the Stanford Geological Survey under the direction of M.B. Kildale prepared a geologic and topographic map of the district, together with underground maps of part of the Nevada Scheelite workings. These maps and the report of the Stanford Survey were freely drawn upon in the preparation of this report. The Stan-

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ford maps were carefully checked in the field, however, so that the present authors assume full responsibility for errors.

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History and Production

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The region was prospected many years ago for gold, silver and copper, but scheelite was evidently not recognized until about 1930. No extensive development was undertaken until 1936, when the Nevada Scheelite Company built a small mill at Dead Horse wells. Most of the production of the district dates from 1939, since which time the Moore mill has been constructed and the Nevada Scheelite mill enlarged.

Four deposits in the area have produced tungsten. By far the largest is the Nevada Scheelite mine, from which about 48,000 tons of ore have been mined and about 40,000 units of WO_3 recovered. The Nevada Scheelite Company has operated two other properties, the "Glory Hole" from which about 3000 tons of ore were taken and the Hooper No. 1 mine from which about 1500 tons were taken; probably at least 5000 units of WO_3 were obtained from these operations. The Hooper No. 1 mine was subsequently worked by Beverly Moore, who reports a recovery of about 1800 units of WO_3 from 5000 tons of ore. The Yankee mine, operated for a brief period in the spring of 1943 by Goldfield Consolidated, has produced about 200 tons of ore from which 200 units of WO_3 were recovered.

The Nevada Scheelite mine is the only one in active production at present. A little ore is being taken from the Yankee mine by its owners, Leo and Eugene Grutt. Owners of the Summit King gold mine are said to have taken an option on the Hooper No. 1 mine. A fifth property, the Eed-a-how claim, will probably be in production shortly.

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Total production from the district (July 1, 1943) is close to 50,000 units. The present rate of production, almost entirely from the Nevada Scheelite mine, averages about 1000 units per month.

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Geology

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The general geology near the tungsten deposits is shown on the areal map (Fig. 1), which is taken in large part from the Stanford Survey maps. Scheelite occurs in tactite bodies along the granite-marble contacts. In addition to marble, the metamorphic rocks intruded by granite include hornfels, mica schist, metavolcanic rocks, amphibolite and metadolerite; these are given a single symbol on the map. The granite contact is irregular, deeply embayed, and at least locally faulted. Tertiary volcanic rocks are widespread immediately north and west, but appear on the mapped area only near the north border.

Rocks. The metalimestones range from coarse white marble to dark gray rocks with crystals only barely visible to the naked eye. For the most part they are nearly pure calcite rocks, but locally grade into mica schist and hornfels. Chert nodules are locally conspicuous. The less metamorphosed parts have easily recognizable bedding, but over large areas near contacts the bedding is obliterated. These rocks are exposed in two principal areas, a strip along the north border of the map and in the region near and southwest of the Nevada Scheelite mine. In general the beds have steep dips and an east-west trend; near the Nevada Scheelite mine the trend becomes NE-SW, and in the western part of the area dips are low. Complex crumpling is rare, even near intrusive contacts.

The other metamorphic rocks are dark and fine grained, locally

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schistose but often without directional structure. Some are biotite-quartz rocks derived from sandstones and shales; some with small feldspar phenocrysts, faint banding and breccia structures are probably metamorphosed tuffs; greenish types with well preserved amygdules are metamorphosed lavas; coarser, structureless varieties with conspicuous plagioclase crystals are probably derived from intrusive dolerite and fine gabbro. Metaconglomerate with round granitic pebbles was found just north of the Yankee mine. Fine amphibolites and amphibole-pyroxene-epidote rocks, probably derived from impure limestone, occur locally as patches in the limestone or near its contacts. Altho typical specimens of these various rocks can be readily distinguished in hand specimen, accurate boundaries between them could be drawn only after more extensive study with the aid of thin sections. On the map they are all indicated by the symbol "msv", with suffixes to indicate the dominant rock in each area. Thus hornfels predominates in the strip south of the marble belt near the north border of the map, metavolcanic rocks in the hill west of the Nevada Scheelite mine, metadolerite west of the Glory Hole, and amphibolite and schist near the south border of the map.

The felsic intrusive rocks designated "granite" include varieties ranging from true granite to granodiorite. The rock is fine to medium grained with normal granitic texture. Biotite is the most abundant mafic mineral, often the only one, altho hornblende predominates locally near contacts. Foliation is practically absent. Dikes in the granite and near its contacts include porphyries and fine-grained rocks of normal granitic texture; typical aplites and pegmatites were not found in the mapped area. The principal granite body underlies the hill east of the Nevada Scheelite mine and extends $\frac{1}{4}$ -mile southwest of the mine; a small mass borders the Glory Hole and several tiny outliers appear

elsewhere.

Locally north of the Nevada Scheelite mine the older rocks have been hydrothermally altered to soft, conspicuously iron-stained material consisting chiefly of sericite, quartz, clay minerals and pyrite. Sometimes original textures are sufficiently preserved to make possible identification of these rocks as schist, metadolerite or granite, but more often the alteration is so complete that original textures are not recognizable. Probably the alteration is associated with Tertiary vulcanism.

Contact metamorphism. Near the granite contacts the effects of baking and addition of material from solution are superposed on the general regional metamorphism of the intruded rocks. ^{The} Hornfels~~es~~ shows an increase in grain size and locally have^s conspicuous metacrysts. The limy rocks either become coarsely crystalline marble or are converted into tactite.

"Tactite" is used here as a general term for any silicate rock derived from limestone by addition of material from the intrusive. The commonest type is a dark brown garnet-diopside-epidote rock, often with quartz, calcite, pyrite and scheelite. Some varieties have little or no garnet, consisting chiefly of diopside, epidote, quartz and often plagioclase. Fine soft oxidized material obviously derived from metamorphic rocks rich in pyrite is mapped as tactite. The fresh tactite is normally a coarse-grained rock, often with euhedral crystals of garnet and epidote. It appears locally along the granite contact as pods and irregular masses, sometimes extending out away from the contact along bedding planes or other planes in the limestone, rarely as small masses in limestone away from the contact, still more rarely as small isolated masses in granite. A little tactite is found along borders of dikes, both

granite dikes and the older metadolerite dikes.

Structure. Time did not permit an adequate study of structures in the metamorphic rocks. The two belts of marble separated by hornfels in the northern part of the map may represent a normal sedimentary sequence, but the original attitude is unknown. Steep dips are visible in marble beds north of the Nevada Scheelite mine and gentle dips about one-half mile southwest, but bedding is nearly obliterated between. The dark metamorphic rocks immediately west of the Nevada Scheelite mine apparently cut across marble beds in several places; whether this means that these rocks are in part intrusive or that pre-granite faulting is responsible cannot be decided on present evidence.

The granite contacts are for the most part sharp. Only at one place, near the Yankee mine, is an extensive intrusive breccia developed; here thru a thickness of 100 feet the granite is thickly strewn with angular blocks of hornfels and marble ranging from very small to several tens of feet in diameter. The granite contact is well exposed in three dimensions only in the underground workings of the Nevada Scheelite and Hooper No. 1 mines, where it is either vertical or dips under the granite. Locally in the former mine the dips toward the intrusive are as low as 30°.

The only conspicuous faults are those exposed in mine workings near the granite contacts. These in general follow the contacts, often curving sharply in three dimensions; occasionally a fault leaves the contact and cuts granite, tactite or marble. The greater number of the prominent faults have a northeast-southwest trend, but this may mean only that the principal mine is on a part of the contact with this trend. It seems unsafe to infer regional structures from the present limited information about directions of faulting.

Tungsten Deposits. Scheelite, the only tungsten mineral observed, occurs as crystals ranging from very small to over an inch in diameter. In ordinary light it is colorless to dirty yellow; in ultraviolet light most of it has a pale yellow fluorescence, altho parts of large crystals are often white. Its usual associates are the minerals of tactite -- garnet, epidote, diopside, quartz and calcite. Pyrite is a common associate on the 200-foot level of the Nevada Scheelite mine, but in most of the ore nearer the surface sulfides are completely oxidized. Small areas of copper stain are found occasionally. Neither powellite nor molybdenite was recognized; the 0.5% MoO_3 which appears in Nevada Scheelite concentrates probably comes from the scheelite.

Most of the scheelite is disseminated thru tactite. Sometimes it lies in vaguely defined bands parallel to adjacent contacts or shears, and a little is found in sharply defined seams. Scheelite is often somewhat concentrated in finely pulverized material along shears, appearing both as fine powder and as distinct crystals. In one spot scheelite was found in a quartz veinlet cutting a zone of gouge. Small crystals are often scattered thru granite and marble immediately adjacent to tactite.

Restriction of scheelite to tactite bodies and their immediate vicinity suggests that the solutions responsible for forming tactite were those which carried tungsten. Occurrence of scheelite as undeformed crystals in shear zones and in veinlets cutting shear zones indicates that deposition of scheelite continued after the formation of tactite. Concentration of scheelite in shear zones and in streaks parallel to shear zones is evidence that deposition in part at least was guided by fractures. Probably deposition of scheelite occupied a considerable period in the cooling history of the intrusive, beginning with the for-

mation of tactite and continuing thru a time of recurrent fracturing. Post-mineral shears have to a large extent followed the earlier fractures.

Localization of tactite masses and of scheelite ore bodies within tactite follows no clearly defined rules. Whatever factors favor formation of large amounts of tactite seem also to favor concentration of scheelite, since most of the small, isolated tactite bodies away from the principal deposits are nearly barren. In three respects conditions at the two largest deposits (Nevada Scheelite and Hooper No. 1) are similar: (1) the ore occurs in or near a zone of extensive shearing, (2) the ore occurs at or near abrupt curves in the granite contact, (3) the ore occurs at or near places where the contact dips at low angles under the granite. It is an attractive hypothesis that ore-forming and tactite-forming solutions were concentrated where shear along a curved contact created wide zones of weakness and where overlying granite formed a partial trap. While some such set of conditions may favor formation of a large deposit, it is certainly not essential for a small one, since one or more of these conditions is not fulfilled at the Glory Hole, the Yankee mine and the Red-a-how claim. The small deposit of good ore in the Hooper No. 2 workings is not even near a visible intrusive contact.

In the larger deposits the ore is concentrated in vaguely defined shoots. It shows no consistent preference for hanging wall, foot wall or interior of a tactite mass, nor is there any consistent relation between amount of scheelite and composition of tactite. The relationship of scheelite to quartz is rather odd: altho scheelite occurs with quartz both in tactite and in occasional veinlets, large masses of honeycombed, limonite-stained quartz found occasionally in the tactite are completely barren.

Tungsten Properties

Nevada Scheelite Mine

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Introduction. Nevada Scheelite, Inc. (Mr. Arthur J. Mills, president; associated with Mills Alloys Company of Los Angeles) owns the following sixteen claims:

Gussie L.	Blanco #1	Tungsten #1	Princess
Blue Bell	Blanco #2	Titan	Turtle
Lead Mountain	Don	Titan #1	Ma Parker
Blanco	Tungsten	Duke	Viking's Daughter

extending from the Glory Hole south beyond the Nevada Scheelite mine. The mine is on the Don claim, the Glory Hole on the Viking's Daughter. The mill is nine miles south of the mine at Dead Horse Wells.

Both mine and mill are well equipped. The mill consists of two units, each with a 30-ton roll mill, crushers, classifiers, and several tables. Concentrates are cleaned in three magnetic separators. Recovery averages between 60 and 70%, the principal loss being in slimes. Concentrates average better than 75% of WO_3 . With the mill running three shifts and the mine one shift, the present production rate is a little over 30 units per day from about 40 tons of ore.

The surface geology near the mine is shown in Fig. 2, the underground workings in Figs. 3 - 12. Workings consist of a shaft 285 feet deep, 250 feet of drift on the 50-foot level, 1250 feet of drift and crosscuts on the 100-foot level, 1050 feet of drift and crosscuts on the 200 level, seven large stopes and several smaller ones. One of the stopes (2A) connects with an old shaft and small tunnel dating from early exploration for gold and silver. The level map for the 100-foot level (Fig. 6) was copied, with a few minor changes, from the Stanford Survey report; sections of stopes 2B (inaccessible because of recent

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caving) and 1A (inaccessible because of filling) were likewise taken from the report.

Geology. Between the Nevada Scheelite and Hooper No. 1 workings a tongue of granite nearly 1000 feet wide extends westward into the marble (Fig. 1). The Nevada Scheelite mine is on the contact at the north base of the tongue, the Hooper No. 1 mine at the south base. Thus the contact at the Nevada Scheelite mine has a general northeast-southwest trend, swinging to nearly east-west just south of the mine.

The mine workings explore a part of the contact where the general NE-SW trend is interrupted by a broad S-turn. The S-turn is shown by the orange lines on Fig. 3, these lines being "contours" at three levels on the principal granite contact. As the contours show, the contact is steep or vertical at either end of the "S", but dips at moderate angles under the granite around the bend. The thickest masses of tactite are along the gently-dipping part of the contact. The principal concentrations of scheelite are in this thick tactite and in the immediately adjacent thinner bodies on the steep contacts at either end of the "S".

One mass of tactite extending away from the principal contact has been stoped (upper part of stope 2A). On the surface, outcrops of tactite, some rich in scheelite, appear more than 100 feet from the principal contact (Fig. 2). Many of these tactite outcrops are associated with shears and with small granite dikes. The NE-SW orientation of several of the shears and dikes suggests a set of parallel fissures as a possible factor in ore control; but the present workings indicate that more important factors were the curve and low dip of the granite contact and extensive shears parallel to the contact.

Most of the tactite along the contact is intimately sheared.

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Usually a prominent shear separates tactite from granite, altho a normal contact is occasionally found. With a few conspicuous exceptions, the other principal shears are approximately parallel to the contact. The main shear between granite and tactite in places turns thru large angles, both horizontally and vertically, altho at the sharper turns of the contact the shearing is usually taken up by branching faults. Shears which follow marble-tactite and tactite-granite contacts occasionally leave the contacts and pass out into one of the adjacent rocks. Only the principal, more continuous shears are shown on the maps; nearly all parts of the tactite and much of the adjacent granite are broken by minor fractures in apparently random directions.

Much of the ore mined up to the present has been soft, brown, limonite-rich material, evidently the result of oxidation of sheared and crushed tactite. Harder, pyrite-rich tactite is common on parts of the 200-foot level and will probably become increasingly abundant at lower levels. Altho both composition of the tactite and concentration of scheelite vary greatly from place to place, much of the ore is remarkably uniform thru considerable widths and thicknesses.

Boundaries of four vaguely-defined ore shoots are shown by purple lines on the vertical projection, Fig. 4. The boundaries are greatly generalized; actual boundaries are so irregular and so hazy that even the existence of the shoots is questionable. At best, they express merely a general tendency for the principal ore concentrations to lie in areas raking steeply northeastward. Around the bend of the S-turn, this rake is the dip of the contact; at either end of the "S", the rake reflects the fact that the turn in the contact is shifted northward on successively lower levels.

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Ore shoot I includes the stope connecting the 50 and 100-foot levels

just south of the main shaft, the stope on the 200-foot level near the shaft, and ore taken from around and beneath the 200-foot station. Probably the shoot extends to the surface in the rich ore exposed at the top of the old incline to the 50-foot level, altho reports are that the small raises from this level passed out of ore into barren tactite. The tactite in this shoot ranges up to 10 feet thick, altho most of it is under six feet. Southwest of the shoot on the 100 and 200-foot levels is only barren tactite with occasional patches of 0.5-1% ore; on the surface practically no tactite is exposed up to the outcrop in the extreme southwest corner of Fig. 2.

Ore shoot II includes stopes 1A, 1B and 2B and appears on the surface in small outcrops a little north of the shaft. It covers the part of the contact on and near the first major bend in the S-turn. On the 50-foot level good ore appears to be continuous from shoot I to shoot II, but on lower levels an area of poor and barren tactite intervenes. Little of this shoot is visible, since the drifts are timbered, stope 1A is almost completely filled, and stope 2B is caved. The tactite is said to have ranged up to 60 feet thick in parts of stope 2B.

The existence of ore shoot III as shown on Fig. 4 depends on two assumptions: (1) that stopes 3B and 4B are in the same ore body, and (2) that this ore body is continuous with the one explored by stope 2A. Neither assumption can be proved correct from the present workings. If this ore body is a unit, it has a low dip (30°) in its lower part (stope 3B) and breaks away from the contact in its upper part (stope 2A). Probably the small outcrop of rich ore just south of the old shaft is a surface expression of this shoot. The tactite ranges up to 35 feet thick in parts of stopes 2A and 3B. Ore at present being sent to the mill is coming from the lower part of this shoot (stopes 3B and 4B).

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West of ore shoot III the granite contact is largely unexplored. The 100-foot drift cuts thru granite from this shoot to stope 3A. The 200-foot level has progressed only a short distance beyond stope 4B; here the tactite thins to two small stringers. The main granite contact is probably exposed at the end of the old drift (18-foot level); here the tactite is irregular and the ore is poor and spotty. On the surface a little tactite with 2% WO_3 is exposed just west of the old shaft, then no more up to the pit above stope 3A.

Ore shoot IV, on the steep part of the contact near the north bend of the "S", is penetrated only by stope 3A on the 100-foot level. Perhaps the ore in the large pit above the south end of the stope is part of this shoot; if so, the shoot becomes narrow and impoverished upward. For the most part tactite in stope 3A was under six feet thick, but a greater thickness was encountered in the middle of the stope.

Good ore apparently not connected with any of these ore shoots is exposed on the surface (1) in the pit 200 feet west of the main shaft; (2) about 70 feet west of the old shaft; (3) about 60 feet northwest of the old shaft. None of these bodies is explored by the underground workings, altho the last is almost cut by the old drift 40 feet below the surface. Ore of lower grade (0.5% average) in the outcrop at the southwest corner of Fig. 2 is developed by an open cut and two short shafts.

Grade of ore: Accurate production records are available for three

years:	Tons of ore mined	Pounds of concentrate	Units of WO_3
1940	11,556	260,900	9,436
1941	13,867	353,100	12,852
1942	<u>14,804</u>	<u>279,300</u>	<u>10,618</u>
	40,227	893,300	32,906

With an average mill recovery of 65%, these figures mean that the average

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grade of ore mined has been about 1.3%. This grade is consistent with analyses quoted by Mr. Mills and with the results of an examination of the mine with ultraviolet light. Probably little ore with less than 0.7% WO_3 has been mined; most of it has averaged between 1 and 2%; and occasional rich pockets have contained ore running 5% or higher. Percentages shown on the level maps are estimates made with ultraviolet light.

Reserves include (1) ore remaining on walls and roofs of drifts and stopes, (2) ore not removed from stope 2B before its roof caved, (3) the ore body being tapped by stopes 3B and 4B, (4) ore below stope 3A, and (5) ore below the present 200-foot level. Further exploration may reveal additional reserves below the more promising surface exposures or beyond the ends of the present workings.

(1) Ore remaining in drifts is conspicuous along most of the accessible part of the 50-foot level, on the 100-foot level between the shaft and a point 120 feet southwest, on the 100-foot level west of stope 2A, and on the 200-foot level between stopes 3B and 4B. Considerable ore is visible on the roof of the stopes just south of the shaft, on the roof of stope 1B and along the manway connecting this stope with the 100-foot level. Stopes 2A and 3A show some patches of 1% ore, but evidently most of the good ore has been removed. Visible tantalite in stopes 3B and 4B averages 2% of WO_3 . Ore in these various exposures is assumed to extend five feet behind visible faces in the computation of measurable reserves. The somewhat less certain amounts of ore in the ore shoots beyond the present stopes (in ore shoot I below the 100-foot level and between the 50-foot level and the surface, in ore shoot II near the surface and below the 100-foot level, in ore shoot III near the surface) are listed with indicated ore.

(2) The ore left in stope 2B, estimated by the mine superintendent

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at 2000 tons containing 2% of WO_3 , probably cannot be recovered except at prohibitive cost. This is considered as indicated ore.

(3) The tactite mass being explored by stopes 3B and 4B is the only assured large body of ore remaining above the 200-foot level. Reserves are computed on the assumption that this ore body is continuous with the one in stope 2A. Most of the ore will be regarded as inferred ore, since the assumption is far from proved; only ore between the two stopes and between them and the 200-foot level will be treated as indicated ore. Material for five feet beyond visible faces will be included with measurable ore.

(4) Ore shoot IV may be reasonably assumed to extend below stope 3A for 40 feet. This block will be considered as indicated ore.

(5) With present information, an estimate of ore below the 200-foot level must be almost pure guesswork. The shaft, penetrating 85 feet below the 200-foot station, is said to be in ore all the way. There is no indication on the 200-foot level that the contact is becoming steeper, that the tactite is pinching out, or that the ore is growing leaner. Hence it seems reasonable to include in indicated ore a guess that the ore extends 20 feet below this level, and in inferred ore a guess that it extends 100 feet below this level. Treatment of ore from lower levels will probably require changes in milling procedure, since the present mill cannot handle material rich in pyrite.

Hence reserves may be summarized as follows:

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Measurable ore

	Tons	%WO ₃	Units WO ₃
Walls of drifts and stopes	2200	1-2	3300
	275	3-5	1100
Blocked out by drifts & stopes	160	5	800
	440	1	440
Stopes 3B and 4B	2500	2	5000
		<u>Total</u>	<u>10,600</u>

Indicated ore

Stope 2B	2000	2	4000
Stopes 3B and 4B	2500	2	5000
Between drifts and stopes	4500	1-2	6700
Below stope 3A	1600	1-2	2400
Below 200-foot level	17000	1-2	25000
Surface outcrops	1000	1-2	1500
		<u>Total</u>	<u>44,600</u>

Inferred ore

Stopes 3B and 4B	8000	2	16000
Below 200-foot level	66000	1-2	100000
		<u>Total</u>	<u>116,000</u>

Total reserves above 200-foot level: approximately 30,000 tons averaging 1.5% of WO₃, or about 45,000 units

Total reserves between 200 and 300-foot levels: approximately 85,000 tons averaging 1.5% of WO₃, or about 125,000 units

If lower grade material could be handled, at least 10,000 tons of 0.5% ore are available in addition.

Further exploration is desirable both for developing the mine and for improving estimates of reserves. Some points on which information is particularly needed are the following:

(1) Delimiting the region of possible ore bodies. At present it seems that ore is restricted to the S-curve in the principal contact and its immediate vicinity, but this needs confirmation. Altho the probability seems small, there may be ore bodies beneath the exposure of 0.5% ore at the southwest corner of Fig. 2 and beneath the cuts near the north border of Fig. 2.

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(2) Extent of the ore body beyond stopes 3B and 4B. Most probably ore is fairly continuous to stope 2A. On the other hand, the ore may rake another direction, leading toward the unexplored part of the granite contact between stopes 2A and 3A.

(3) Possible ore along the contact between stopes 2A and 3A. Except for an outcrop of 2% ore 60 feet northwest of the old shaft, surface exposures above this area are barren.

(4) Downward extension of ore shoot IV. Very possibly further drifting along the contact on the 200-foot level will lead into a part of this shoot below stope 3A.

(5) Possible ore bodies beneath surface outcrops away from the main contact. Especially promising are the large pit 200 feet west of the main shaft and the tactite 70 feet west of the old shaft.

(6) Downward extension of ore below the 200-foot level.

The Glory Hole

The "Glory Hole" is located about 1/2 mile north of the Nevada Scheelite mine. Technically it is not a glory hole but an open pit with a short adit into one face. The property is owned by Nevada Scheelite, Inc., and was operated by this company for a short time in the late 1930's. Production, according to Mr. Mills, was about 3000 tons of ore averaging between 1 and 2% of WO_3 . A total of about 5000 tons of material has been removed from the main pit, the adit, and adjacent small pits.

The deposit is an irregular tactite mass at the southeast border of a small, isolated area of granite (Figs. 1 and 13). Tiny outcrops of granite a few hundred feet south of the Glory Hole suggest that a larger body may lie a short distance below. The main mass of tactite occupies the large pit; to the east, separated from the main mass by a small gran-

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ite dike and in places by marble and quartz, is a smaller body; isolated exposures of tactite appear in the small pit south of the main one and at other places on the hillside. Examination with ultraviolet light shows that only the main mass contains appreciable amounts of scheelite.

Most of the ore has come from a horseshoe-shaped area which outlines the bottom of the pit. One side of the horseshoe is the small dike mentioned above; the other side is a nearly vertical fault contact with the main granite mass. The interior of the horseshoe contains some marble and a large amount of honeycombed, limonite-stained quartz. A similar body of quartz with less limonite appears in the adit and on the east rim of the main pit. Neither mass of quartz contains scheelite. Several minor faults cut the rocks in the pit, but none have any apparent relation to ore localization.

Since the bottom of the horseshoe is filled with debris, scheelite-bearing tactite is exposed only in disconnected patches on the walls. Under ultraviolet light none of this ore appears to average over 1% of WO_3 . According to Mr. Mills, considerable ore was left in the bottom of the pit, the workings being abandoned because the walls were becoming dangerously high and because better ore had been found at the present mine.

Reserves depend entirely on the downward extension of the horseshoe-shaped ore body. The erratic structure of the tactite gives little basis for guessing its possible downward continuation. Probably no more than 500 tons of 1% ore and 1000 tons of 0.5% ore can be counted on.

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Hooper No. 1 Workings

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The Primrose group of eight unpatented claims (Suzanne Ellen, Primrose, Primrose Extension, Homer, Ajax, and Ajax #2, 3 and 4), owned by J.H. Hooper, adjoin the Nevada Scheelite holdings on the south.

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Production is reported from only the Ajax #3 claim, on which are located the workings variously known as Hooper No. 1, Moore Lease shaft, and Primrose mine. This property is on the road about $\frac{1}{4}$ mile south of the Nevada Scheelite mine. The original shaft was sunk during the first world War, ostensibly in a search for copper. Nevada Scheelite, inc. in the late 1930's took about 1500 tons of 2% scheelite ore from the upper part of the mine. In 1940 the property was leased to Beverly Moore, who recovered about 1800 units of WO_3 from 5000 tons of ore. The property has been idle for a year or so, but the Summit King Mining Company is said to have taken an option on it recently.

Mr. Moore's mill, about seven miles from the mine, consists of a crusher, small roll mill, trommel, two tables and a magnetic separator. A recovery of 80% is claimed and concentrates average between 70 and 75%. The mine workings (Figs. 14 and 15) consist of a 100-foot shaft, a 200-foot drift at the 100-foot level, and extensive stopes between the drift and the surface.

This property is on the south side of the granite tongue which lies south of the Nevada Scheelite mine. As at the latter mine, the ore here is developed near a turn in the granite contact, in an area of extensive faulting, and under a contact dipping at moderate angles toward the granite. Similarly also, a prominent shear in most places separates granite from tactite.

Altho abrupt turns in the granite-marble contact may have some general connection with thick masses of tactite and scheelite ore bodies, this mine shows well that the association cannot be depended upon in detail: on the 100-foot level just southeast of the shaft, several complex turns in the contact are accompanied by little tactite and only low-grade ore.

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The richest ore came from the upper stopes just south of the shaft. Enough remains on the walls of the stopes to confirm Mr. Mills' estimate of a 2% average grade. According to Mr. Moore, fairly good ore was taken from the stope farthest to the south, from the 25-foot level to the 100-foot level, altho the ore became spotty toward the bottom. The other stopes were disappointing. The best ore remaining in the mine, as shown by ultraviolet light, is a small strip on the south wall of the southernmost stope (probably cut off by marble a short distance south) and a thin layer of tactite beneath the main layer, exposed in the winze and in a pocket on the 100-foot level. (The occurrences of ore suggest a poorly defined shoot raking southeastward and becoming lean and spotty with depth.)

Clearly indicated reserves total no more than a few hundred tons of 0.5% ore. Nor is there any basis from which to infer undeveloped ore bodies. Exploration southward does not seem profitable, since neither on the surface nor in the 100-foot level are there indications of much tactite or scheelite. Exploration downward would be a pure gamble. Only northwestward from the shaft does there seem a small chance of finding more ore, a chance based simply on the fact that the principal turn in the contact is in this direction. Alluvium hides the surface north of the shaft; the one small stope in this direction is in a thick body of tactite which would average less than 0.5% of WO_3 .

Hooper No. 2 Workings

The Hooper No. 2 workings (locally called the "inclined shaft") are on the Ajax claim, about 1000 feet south of Hooper No. 1. Workings consist of a 110-foot inclined shaft, 140 feet of drift on the 110-foot level, and a 16-foot winze leading to 20 feet of drift on a slightly lower level.

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The workings follow a tactite layer in a somewhat foliated biotite hornfels (Fig. 16). The general attitude of the beds is $N40^{\circ}E60^{\circ}S$. Marble beds are exposed about 20 feet northwest of the shaft; scattered tiny outcrops of granite appear in the hornfels about 100 feet east of the shaft; the nearest contact with a large granite mass is under alluvium several hundred feet to the east. The tactite layer ranges from one to at least ten feet thick. Minor shears cut the layer and locally separate it from hornfels. Near the end of the underground workings the layer makes a nearly 90° turn.

Much of the tactite is fairly coarse, with large epidote prisms and quartz crystals. Euhedral scheelite crystals up to half an inch in diameter have been found.

The distribution of scheelite is erratic. Most of the tactite in the shaft contains a little, somewhat concentrated toward the foot wall; two rich spots contain 3 or 4% ore, but short drifts cut thru them into barren material. The best ore is a block with minimum dimensions of 15 x 5 x 2 feet in the pillar at the turn in the drift, which would average about 4% of WO_3 . The winze and the lower drift show that this body of ore does not continue downward along the bend in the tactite.

Reserves consist simply of the few hundred tons of ore visible on the walls of the shaft and drift. There is no basis for projecting these exposures into larger ore bodies; on the contrary, the workings show fairly conclusively that the only ore to be expected is in small isolated pockets.

The Eed-a-how Claim

The Eed-a-how claim, owned by W.A. Adams and leased to J.A. Madison, adjoins the Nevada Scheelite holdings on the east. Workings consist of a 50-foot inclined shaft (Fig. 17). Mr. Madison expects to have ore from

the mine concentrated at the Moore mill.

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The shaft follows a tactite layer on the hanging wall of a marble xenolith at least 300 feet from the nearest granite contact. Dimensions of the xenolith cannot be accurately determined since the surface is thickly strewn with granite boulders. Tiny tactite outcrops appear 100 feet west and 35 feet east of the shaft; if the xenolith is continuous between these exposures, its minimum surface dimensions are 135 x 15 feet. Elongation of the xenolith is EW and it dips approximately 70°S. The tactite layer exposed in the shaft ranges from zero to four feet in thickness, the thickness varying both horizontally and vertically. Both tactite and the adjacent rocks show considerable shearing, but the shears do not consistently follow the contacts. Scheelite is unevenly distributed thru the tactite and appears as scattered specks in granite and marble. According to analyses made for Mr. Madison, material taken from the shaft averages 0.4%; about halfway down a small area contains 2% ore and samples from near the bottom run a little over 1%. Examination with ultraviolet light confirms these analyses. Probably the tactite as a whole would average at least 0.5%, and 1% ore could be sorted from it.

Reserves depend chiefly on the extent of the xenolith. If it extends 40 feet eastward, as seems probable, roughly 400 tons of 0.5% ore are available above the 50-foot level, from which about 100 tons of 1% ore could be sorted. If the xenolith continues 100 feet to the west, these figures can be more than doubled, but most of this ore is on Nevada Scheelite property. Possible extension of the xenolith downward and possible ore on its footwall may increase the reserves considerably.

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The Yankee Mine

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The Yankee (or Yankee Girl) mine, owned by Leo and Eugene Grutt, is about $\frac{1}{2}$ mile northeast of the Nevada Scheelite mine. Workings include about 200 feet of drift, a 20-foot and a 30-foot raise, a 25-foot winze, and a small stope (Fig. 17). Early this year (1943) the property was leased for a few months to Goldfield Consolidated. Production includes 50 tons of 1% ore mined by the Grutt brothers and 150 tons of 1.5% ore mined by Goldfield Consolidated. Of the latter, 50 tons went to Metals Reserve in Salt Lake City and 100 tons was concentrated at the Moore mill. The Grutt brothers are working the mine by hand methods at present.

The mine explores a series of marble xenoliths along a granite-hornfels contact, the series probably representing a once-continuous limy layer in the clastic sediments which formed the hornfels. The granite here is studded with inclusions of marble, tactite, hornfels, and others so altered that their identity is uncertain. Their size ranges from very small to 20 feet long. The general strike of the hornfels is N80°E and it dips steeply north; this is approximately also the attitude of the contact. Both granite and intruded rocks contain many minor shears, but the shears have no demonstrable connection with ore deposition.

Scheelite is distributed erratically thru the tactite around the marble inclusions. The best ore body, now exhausted, was in the small stope just inside the entrance. An area about 6 x 8 feet of 1% ore is exposed in the small winze, and considerable 0.5% ore appears on the walls of the north branch of the tunnel. The south branch beyond the winze, apparently remaining south of the main line of xenoliths, is entirely in barren granite and hornfels.

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Reserves depend on the number and size of xenoliths encountered by

future development. Visible ore at present amounts to only a few tens of tons. Other pockets of ore can probably be found by drifting along the contact, but chances of finding a continuous ore body suitable for large-scale mining seem remote.

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Other Prospects

The granite tongue extending westward into the marble between the Nevada Scheelite and Hooper No. 1 mines has several small tactite masses on its borders. The only ones showing more than a trace of scheelite in ultraviolet light are the outcrop at the southwest corner of Fig. 2, and another 1000 feet southwest of this one on the other edge of the tongue. The former is penetrated by two shafts, ten feet and 35 feet deep, while the latter is developed only by shallow surface cuts. Both tactite bodies show considerable 0.5% ore and a little 1% ore; both might repay further development, but the possibilities do not look bright.

The tactite outcrop on the hillside northwest of the Eed-a-how claim is said to contain a little scheelite. None was visible in daylight, and the outcrop was not examined in ultraviolet light.

Small exposures of tactite along the granite-limestone contact at the base of Big Kasock Mountain ($\frac{1}{2}$ mile north of the edge of Fig. 1) have been explored by small pits. Several samples from the most promising outcrops were completely barren in ultraviolet light.

Reserves

The following table summarizes estimates of reserves discussed on preceding pages. Many of the estimates must be understood to indicate order of magnitude only.

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Property**CONFIDENTIAL**ReservesFOR USE OF
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ONLYMeasurable
Tons UnitsIndicated
Tons UnitsInferred
Tons Units

Nevada Scheelite

3-5% ore

435 1900

1-2% ore

5140 8700

0.5% ore

28600 45000 74000 116000
3000 1500 10000 5000

Glory Hole

1% ore

500 500

0.5% ore

200 100 300 150 500 250

Hooper No. 1

2% ore

120 240

0.5% ore

300 150 500 250

Hooper No. 2

3-5% ore

40 160

0.5% ore

150 75 300 150

Eed-a-how

1% ore

20 20 100 100

0.5% ore

50 25 250 125 1000 500

Yankee

1% ore

10 10

0.5% ore

50 25 100 50 300 150

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DON CLARE MINE - TUNGSTEN

Engineer's Report

By

Otis A. Kittle, Jan. 1956

SUMMARY AND RECOMMENDATION

The main mine workings of economic importance on the Don Clare mining property consist of a 100' vertical shaft sunk in a foot-wall block of meta-sediments at its point of contact with a granitic intrusive. An irregular drift runs 225' along the contact in an Easterly direction from the bottom of this shaft and 35' West of the shaft into a prominent shear zone. This drift served as haulage level for a complex system of stopes from which ore was mined all the way to the surface. Pillars of ore remaining in this large stoped out area indicate values of the mined ore to be in the range of 0.8% to 1.6% WO_3 .

The structure of this contact metamorphic scheelite deposit is quite similar to those found in many places in both Nevada and California but has been complicated in this occurrence by both faulting and shearing. The previous operators of this property limited their exploration and mining operations to a comparatively shallow zone along the contact of the lime and granitic rock on the 100' level drift and from thence to the surface by 45° stopes in a foot-wall fault block of metamorphics overlain by a hanging-wall fault block of granitic rock. There is no evidence indicating that economic values are cut off at the 100' level. To the contrary, the structural geology of this occurrence, along with the findings of the adjacent Nevada-Scheelite mine on their 500' level, indicate that good values can be expected for 200' to 300' upon exploration in depth below the 100' level. Due to the nature of the scheelite bearing horizons in this occurrence diamond core drilling is recommended in the first stages of exploring to further depth. Exact points at which drilling should be started are covered later in this report.

The General Services Administration of the United States Government has been purchasing tungsten concentrates that met specifications at the fixed price of \$63.00 per unit of contained tungstic oxide since 1951. As the commitment under which this program will be completed limits this agency as a market to May or June of 1956, further marketability of this mine's product becomes a major consideration. The consensus of tungsten producers is that the Government will extend its tungsten buying program at some price between \$40.00 and \$50.00 per unit. This price, with export and import duties, ranges close to the world market price of January 1956. Around 35% of domestic production for G. S. A. market is in the marginal

category of from \$4.00 to \$7.00 per unit profit at G. S. A. price. Therefore, a drop in guaranteed price to the maximum that can be expected of \$50.00 would eliminate 35% of current domestic production. As the property herein considered produced much ore of better than 1% in grade and provides much evidence of an extension of such production, it is strongly advised that current cloudy market conditions be minimized in the immediate planning regarding the further exploitation of this mine.

Considering the long profitable record of production of the Nevada-Scheelite mine and its contiguity to that of the Don Clare mine, along with the superficial exploitation of this mine by its previous operators, further exploration at depth is strongly recommended.

LOCATION AND TITLE

The Don Clare Mining Company mine properties are located 20 miles South of Highway 50 with access by graded gravel road from this highway at a point 1 mile West of Frenchman's Station. These properties are located to the North and South and adjacent to the Nevada-Scheelite property being close to the Northern boundary of Mineral County, Nevada. Both the Corwin group and Aida group of claims are held by lease and option agreements by the Don Clare Mining Co.

GEOLOGY

At the 100' vertical shaft workings on the Aida group the major geologic structures consist of a fine grained granitic intrusive in contact with interbedded limestone and marble, with the strike of this contact being generally S. 70° E. and N. 70° W. This contact zone runs a few feet South of the bottom of the shaft and some few feet North of the collar of the shaft, indicating both roll and a generally steep dip to the South. (See attached map: "Geology Of Surface & 100' Level") A large thrust fault block of the granitic has its West hanging wall face exposed at the surface cutting the vertical shaft at the collar and from thence running S.S.-E. 260' to the "Millard" fault, where it is displaced 30' to the East. This Easterly dipping hanging wall fault face of the granitic will be referred to hereafter as the "slickenside" fault.

The slickenside fault dips at 45° to the East and is underlain by interbedded lime-marble-tactite strata showing considerable deformation and crushing where exposed in the series of stopes connecting the 100' level drift with the surface. The attitude of these strata, despite much minor faulting and local deformation, conforms to that of the slickenside fault. Strata of scheelite bearing tactite are exposed in these stopes in many places, occurring as crushed iron oxide-stained layers of from 1½' to 5' in thickness and from 12' to 30' in length. The slickenside fault block movement appears to have crushed these one time

limestone beds making them amenable channels for the transportation and deposition of silica and tungsten bearing solutions originating from the granitic intrusive contact zone mentioned in the above paragraph. These scheelite bearing tactite members generally occur in this mine as faulted segments sandwiched in between two strata of marbleized limestone. The furthestest point away from the East-West contact zone at which such a tactite member was mined as ore is exposed 55' South of the contact, midway between the 100' level and the surface in the stope known as the "square-set" and is shown on the map in dark green, the stope outline, as survey point No. 3-4.

The geologic evidence exposed in the mine workings indicates that there are two major axis' of mineralization in the vicinity of which scheelite bearing tactite members can be expected to be found. These consist of the East-West contact zone and the foot wall member of the slickenside fault. Ore has been mined from stopes into chutes discharging along the entire Western 75% of the 100' level drift. Ore has been mined from the 100' level to the surface from the footwall block of the slickenside fault, extending like a huge fan of stopes in a series of successive offset blocks from top to 100' level.

The geologic evidence on the surface indicates that there may be an axis of mineralization in the zone of the slickenside fault displacement by the Millard fault. (See survey point No. 7-1 on the map) Both surface trenching and shallow hole diamond core drilling should disclose the location of scheelite bearing tactite in this zone. Surface cuts along the Millard fault indicate strong crushing and shearing action along with significant solution penetration, as evidenced by a 5' thick rust stained zone along the fault.

POTENTIAL ORE

A comprehensive examination of all scheelite bearing exposures in this mine with the aid of the ultra violet mineral lamp, along with careful study of the sample record of assays made by previous qualified engineer examiners, indicates 600 to a 1,000 tons of ore of around 0.9% grade in sight in stope pillars and other very inaccessible locations. From known geologic evidence in the mine and the production experience of the closely adjacent Nevada-Scheelite mine from their 200' to their 500' levels, there is every reason to expect considerable tonnages of ore in the 1% category as exploration and development proceed downward. The elevation of the Nevada-Scheelite shaft collar is about 100' above that of the 100' vertical shaft collar on the property herein reported. This is specifically pointed out as a strong indication that valuable ore continues at depth. An estimate of ore below the 100' level based on the previous stoping operation from the 100' level to the surface and the experience of the adjacent Nevada-Scheelite mine, along with the above mentioned favorable geology, indicates a potential ore reserve of from 5,000 to 10,000 tons of an average 1% grade.

RECOMMENDED EXPLORATION

It is recommended that the following steps be taken to explore this property below the 100' level. The letters opposite the following major subdivisions appear circled on the attached map:

A. Drill the following holes and core from this diamond drill set-up #1 located opposite the winz in the 100' level drift:

	<u>Horiz. Angle</u>	<u>Vert. Angle</u>	<u>Min. Depth</u>
1. South		-45°	100'
2. South		/45°	100'
3. West		/45°	150'

B. From diamond drill set-up #2:

1. West	-45°	100'
2. S. 60° W.	-30°	100'

If showings are favorable in B. 1. & 2. drill at the C set-up#3 NEXT following:

C. From diamond drill set-up #3:

1. N. 75° W.	-60°	100'
2. S. 70° W.	-60°	100'

D. Tractor trench accross Millard fault.

E. Tractor Trench accross slickenside fault.

F. From surface diamond drill set-up #4:

1. S. 75° W.	-70°	150'
2. dit	-40°	150'
3. N. 70° W.	-70°	150'
4. dit	-40°	150'

NOTE: Let the findings disclosed in holes 1. and 3. of F. dictate the advisability of completing holes 2. and 4.

For additional surface exploration core drill minimum 80' holes West at -75° from shaft collar contour survey points 6 and 7 where shown on the map.

EXPLORATION COST ESTIMATE

The foregoing 1,500' of diamond core drilling at \$4.00 per foot	\$6,000.00
Dozer rental for 8 hours at \$12.00	96.00
150 tungsten assays at \$3.50	525.00
Misc. exploration costs	<u>1,500.00</u>
TOTAL EXPLORATION COSTS	\$8,121.00

CORWIN MINE RECOMMENDATION

An examination of the Corwin underground workings, located just 30' over the claim boundary of the Nevada-Scheelite holdings, disclosed a steeply dipping thin mineralized stoped out zone from which considerable ore was hoisted via an 80° inclined shaft. This mine has been quite methodically worked out to the 220' level. As Nevada-Scheelite's current production is coming from their 500' level at a point underground some 50' or 60' from these Corwin workings; and their run of mine ore is said to be well over 1%; it is strongly advised that this property be diamond drilled to at least 400' of depth from the adjacent canyon bottom to explore for the extension on Corwin ground of the high grade body being mined on N-S ground. It is felt that such a drilling program would serve one of two purposes: (1) Disclose the ore body on Corwin ground; or (2) Make a matter of pressing importance the purchase by N-S from Don Clare Mining Co. the Corwin lease and option. With this possibility in mind, it is recommended that the Corwin option be amended in such fashion that any time in the next four years the property may be purchased outright for not over \$20,000.00 cash. It is not unlikely that the N-S Co. might offer upward of \$50,000.00 for this property in due course.

CONCLUSION

Upon completion of the diamond core drilling program recommended for the 100' level of the vertical shaft workings a careful estimate of the total tonnage of ore encountered should be prepared by making vertical section maps for each hole drilled. Upon study of these vertical sections it may prove necessary to drill additional holes to complete the blocking out of the several ore bodies encountered. When substantial blocks of ore have been so located and delimited below the 100' level, the shaft should be sunk to the 150' level, haulage drifts to the indicated areas prepared, man-ways and ore chutes raised to each block of ore and full ore production again resumed. Further exploration at depth should be vigorously pushed with the aim of providing adequate reserve ore tonnages for methodical uninterrupted future production.

In recognition of current controlling economic factors it is strongly advised that both shaft sinking and ore production be planned on the "contract" system. When actual stoping of ore is commenced, this would base the miner contractor's pay per cube on a minimum shift's production of minimum grade ore and increase his pay per cube as the grade of ore increased. No other system has proven as remotely successful as this in tungsten mines in the United States.

In general, this property gives evidence of excellent potential as a tungsten producer. Thorough exploration at depth, in progressive steps of 50' each, as production proceeds, is strongly recommended. It is considered that this property will be able to maintain profitable production for many years, due to quantity and grade of ore, regardless of the minor ups and downs of the tungsten market.

* * * * *

The mine examination which provided the geologic and engineering data upon which this report is based was authorized by the Board of Directors of the DON CLARE MINING CO. It is hereby submitted for their study and information in two exact signed copies, a third copy being retained by the undersigned.

586 West Line
Bishop, Calif.
Phone: 4221

Otis A. Kittle
Otis A. Kittle,
Registered Professional
Mining Engineer, State
of Nevada, No. 415

GEOLOGY OF SURFACE & 100' LEVEL

Don Clare Mine Workings At Shaft No. 1
Mineral County, Nevada

- lm Lime, Marble & Metamorphics
- = g Granitic Rock
- Faults
- Contacts
- 100' Level Workings
- Stope Traverse & Sketch of Stopes
Between 100' Level & Surface.

BY: O. A. Kittle, Jan. '56 Scale: 1" = 40'

← Z →

5' Drift on Quartz
Vein in Granite

12

4974' Contour

11

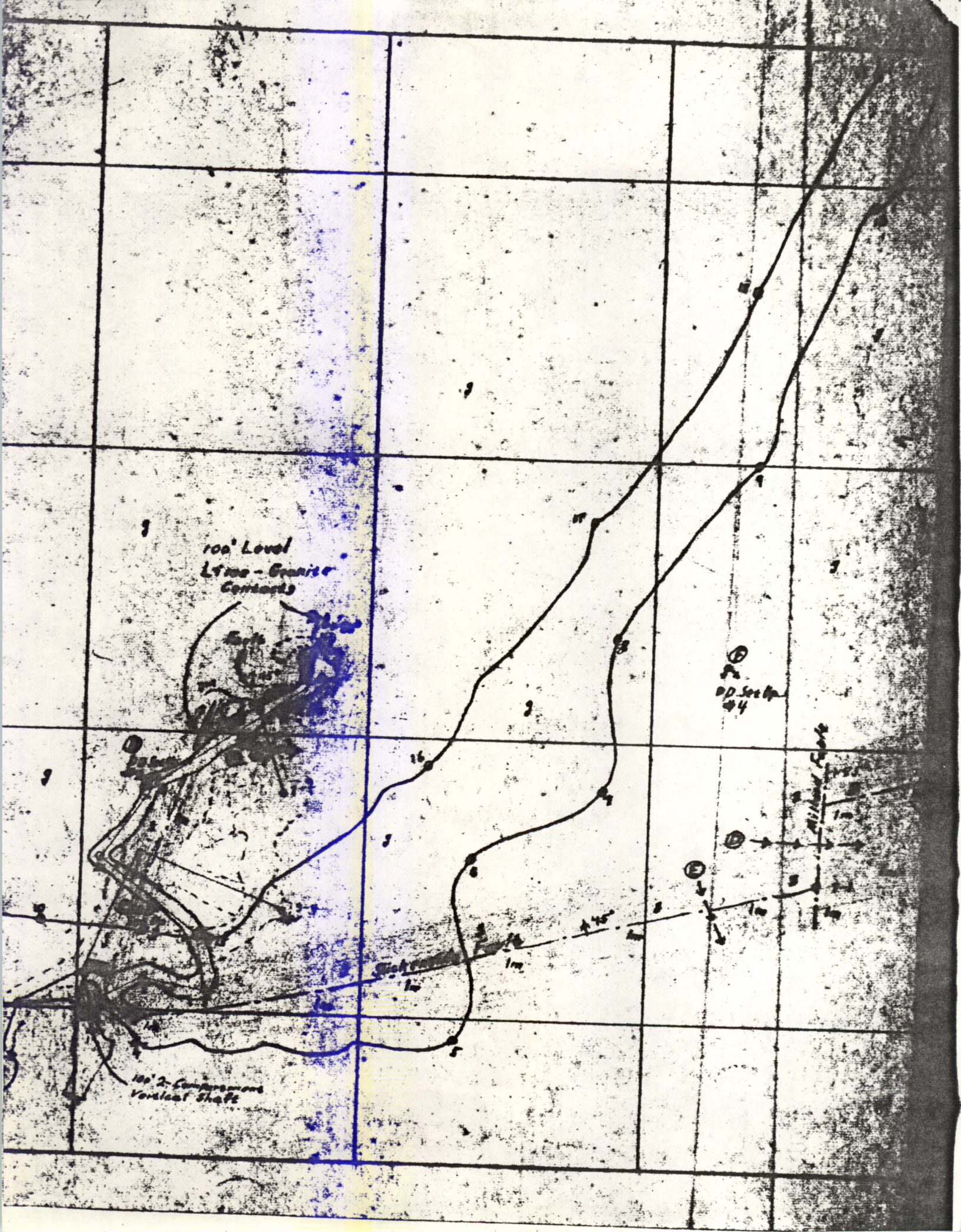
10

3

Shaft Collar Contour, Elevation 4984'

2

2' from
surface



SUPPLEMENTAL REPORT

To

Mr. J. H. Engineer's Report - San Clare Mine

The San Clare Mine has been re-examined by the writer on three occasions since the foregoing report was completed, the last such occasion being May 23, 1956. The attached maps show the progress of development on the 100' level and the newly opened high grade slusher stopes on the 70' level.

Development And Production

160 tons of ore averaging about 1.4% has been mined, shipped and milled from the new 70' level stope. This ore was shipped to the Red Hill Mill at Bishop, California where net recovery on the lot will average a little better than 1%. The mine crew are currently drifting south on a 3' to 5' thick face of ore that samples indicate should break at about 1.2% WO_3 . This body of ore is dipping steeply to the east into the floor of the slusher stope drift and will be mined out by raising from the new south drift on the 100' level in due course.

Geology

Scheelite bearing tactite, thoroughly crushed, showing much iron oxide staining and exhibiting strong evidence of solution staining and penetration, is beginning to appear in the upper east portion of the face of the new south drift. As illustrated by the cross-section map, through A-A' on the plan map of mine workings, this point is directly below the face of good ore now being mined from the slusher drift. There are two implications arising from this juxtaposition: (1) There is some evidence supporting the possibility that post-mineral faulting across the Slickenside fault has thrust a portion of the foot-wall tungsten bearing zone into hanging-wall territory; and in the thrust displacing the ore segment some distance to the south. This could account for the vein of ore in the slusher drift stope; (2) There is little evidence, however, of reverse faulting at the 70' level between the old stoped out area and this new stope. There is, therefore, a strong possibility that significant scheelite bearing tactite members do exist in the hanging-wall side of the Slickenside fault and that the vein in the new stope is entirely separate from the several veins of good ore found near the upper margin of the foot-wall block, several pillars of which are still exposed in the old stoped out area.

Potential Ore

The grade and quantity of ore mined and milled from the new stope since the writer's examination in January and the strong evidence pointing toward a sizable new ore horizon

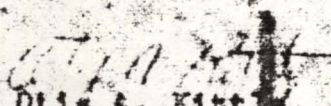
In hanging-wall country changes the writer's previous estimate of potential ore (See page 3 of the Jan '56 Report) from a probable 5,000 to 10,000 tons to a quite probable 15,000 to 20,000 tons. Should the segment of ore currently being mined be continuous to the surface, assuming a 75' ore shoot at an average thickness of 3 1/2' and the distance from the 100' level to the surface at 140', it alone would account for an additional 2,500 tons. The projection of this new ore body below the 100' level to a depth comparable to that from which good ore is being mined in the adjacent Nevada-Scheelite mine will easily account for an additional ore potential of 7,000 or 8,000 tons.

Conclusion

As development continues to disclose good grade ore on this property it now becomes a reasonable certainty that the Don Clare Mine will enjoy a productive and remunerative future. Should the price of tungsten concentrates drop to that of the world market when the G. S. A. buying program is completed, with ore of the grade of that being currently produced, the Don Clare Mine should be able to continue profitable operations for many years to come.

May 25, 1956

Room 204
10 West Second St.
Reno, Nevada


Otis A. Kittling
Registered Professional
Mining Engineer, State
of Nevada, No. 415

ECONOMIC GEOLOGY OF THE THORNE TUNGSTEN PROPERTY

INTRODUCTION

The present strong market trend for tungsten metal has stimulated interest in mines that have a history of production and that display good potential for immediate development.

The Thorne tungsten property qualifies highly in both respects. It has produced 30,000 units, has a good exposure of ore (44 feet wide), lends itself to an initial open pit operation (economical mining) and lies adjacent to a mill (immediate return on capital investment).

In addition the ore has a substantial silver, gold, copper and molybdenum content that may be chemically extracted.

This report summarizes data taken from maps, assay sheets, production records and reports by the following licensed mining engineers and geologists: Albert Silver, Ray Hickman, Don Finlayson, Jim Perkins, Peter Joralemon, Otis Kittle and the author, who has been a consultant to the minerals industry for the past sixteen years.

HISTORY

The area was first worked in the 1870's for gold and silver. The gold boom at Rawhide in the early 1900's produced \$1.5 million (Vandenburg, 1937).

The boom was overshadowed by the discovery of scheelite (WO_3 , the trioxide of tungsten). By 1956, production totalled about 300,000 short ton units (at today's market equivalent to \$25 million). One short ton unit of WO_3 equals 20 pounds. The average grade of ore treated has been about 1 percent of WO_3 . (1 unit per ton). (Ross, 1961)

The Thorne property produced about 30,000 units, mostly during World War I. No attempt was made to recover the gold or silver which is present in all the ores in this district.

In 1955 an investment group, headed by Clarence Thorne, reopened the mine to the 100-foot level (the deepest exploration to date). Mining consultants set up a drilling program and shipped development ore to various custom mills for metallurgical testing (See Table I).

Encouraged by these results, the engineers recommended sinking the shaft another 100 feet, back-filling to recover an estimated 40,000 tons and building a mill. Both Union Carbide and Twentieth Century Fuels became interested and the group opted to sell to the latter.

A few months later, the stockpile-support program was dropped. The price of scheelite fell from \$62.00 per unit to \$12 per unit. Twentieth Century Fuels closed all its U.S. holdings and the property reverted back to the owners.

In 1974, Geosurveys, a mining consulting group employed by the Thornes discovered a new ore body on the surface. They acquired a lease and ran the ore at the adjacent Kennametal mill (See Table I). This was under lease to Rawhide Mining Company, which was unable to keep the mill supplied with their own ore. They soon folded and Kennametal resumed ownership of their property.

A stock association acquired the Kennametal and Thorne properties in a "package" deal in 1975, turned quickly from investment to speculative trade and once again the project collapsed.

The last activity was in 1976 when the Thorne mine was reopened and the open pit area was stripped and cleared to the ore zone.

MILL TEST DATA

TABLE I

Mill	Location	Tons	Gross Returns	Unit Returns	Unit Cost
Metallurgical Development Co. (1956)	Gardnerville, Nevada	145	3684.59	25.41	19.50
Yaney Mill	Gabbs, Nevada	140	3613.50	25.81	15.50
Red Hill Mill	Bishop, California	316	12,449.01	39.03	19.35
Kennametal Mill (1974)	Scheelite, Nevada	470	17,665.40	37.59	18.79

Note: Head assays indicated low returns from the custom mills.
Recovery averaged 60%.

DATA OUTLINE
THORNE TUNGSTEN MINE

NAME: Also known as Moonlight, Ada or Don-Clare Mine.

OWNERSHIP: Thorne brothers and Geosurveys.

CLAIMS: Four unpatented lode - Moonlight Nos. 1, 2, 3 and 5. Area total 80 acres.

LOCATION: Regent Mining District next to Nevada Scheelite Mine, 100 miles east of Reno.

ACCESS: Year-round via paved road from Fallon, Nevada.

WORKINGS: Vertical shaft to 100-ft. level with 200 feet of drift and stopes to the surface. Incline shaft 100 feet with 100 foot of drift.

GEOLOGY: Contact metamorphic deposit (granitic stock intruding limestone) with scheelite-bearing tactite at the main shaft. Upper level of tactite oxidized. Structural control (intersection of shear zone and reverse fault). Related to adjacent Nevada Scheelite ore body, may be part of roof pendant plunging north, which has been worked below the 500 foot level. Mineralization is primarily scheelite with minor powellite (molybdenum mineral), copper, gold and silver.

PRODUCTION: Estimated at 30,000 tons (Also see Table I).

PROJECTION: Surface ore - 5,000 tons averaging 0.6% WO_3 (3,000 units). Underground near surface (above 100-foot level) 10,000 tons averaging 1.1% WO_3 (11,000 units). Below 100-foot level to depth of 500 feet - 160,000 tons averaging 1.2% WO_3 (192,000 units).

Total number of units projected - 206,000 - equivalent to about \$17 million.

SCHEELITE TAILINGS

CLAIMS: One 20-acre placer and one 100-acre associated placer.

OWNERSHIP: George Wilson

LOCATION: Below Kennametal mill and Thorne mine.

PROJECTION: 300,000 tons estimated from production data and aerial and ground surveys. Assays range from 0.4% (commercial labs) to 0.3% (U.S. Bureau of Mines) WO_3 . (105,000 units). Gross value equivalent \$8.6 million.

CONCLUSIONS:

The unique history of this mine, the documented data on production and projections justify a modest exploration program (\$25,000). Verification of data would then easily justify the major acquisition, mining and milling costs which would total \$250,000 to \$500,000 depending on the size of the mill.

George M. Wilson
Consulting Geologist

REGENT DISTRICT

PRODUCTION IN UNITS

YEAR	CRYSTAL	EAGLEVILLE	NEUSCH SEVENTH	HOOPER	LEONARD	RAWHIDE	THORNE
1937	21 22				358		
38				13,000	2,271		
39	} ± 30				4,521		
40				1,100 486	9,534		
41				619	12,426		70,167
42					10,570		
43				26	10,935 ⁶⁷		
44				28 35	12,440 ²¹⁵		
45					5,636		
46					9,809		
47					1,940		
48					9,737		
49					6,538		
50					6,509	16	
51					9,489	—	
52							
53	90				164 19,561	18	
54		8			125 41,157	18	
55	64		DS		29 45,823	91	
56	99				36,821	40 217	
57					1,229		
58					331		
59					126		
1960					2,886		
61							
62							
63							
64							
65							
66							
67							
68							
69							
70							
71							
72					8,375		
73					8,844		
74					6,006		92
75					97 607		24
76					442		
77							153
78							27 43
79							
80					1,078		
81					?		
82					?		
	283	8	5	(5,294) 1,194 ?	5 286,746 286,751	382	339
							288,917

206
Item 22

copy

REPORT ON THE GEOLOGY AND ORE RESERVES

OF THE

NEVADA SCHEELITE MINE

WITH RECOMMENDATIONS FOR EXPLORATION

BY

WALTER C. STOLL

FEBRUARY 1955

REPORT ON THE GEOLOGY AND ORE RESERVES
OF THE
NEVADA SCHEELITE MINE
WITH RECOMMENDATIONS FOR EXPLORATION

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INTRODUCTION

Earlier Reports

1. Heron, Charles H., Report on the Nevada Scheelite Mine, near Rawhide, Mineral County, Nevada, M.S. Report September 1947.
2. Goshan, Robert W. and Tringove, Russell R., Investigation of Nevada Scheelite Inc. Deposit, Mineral County, Nevada, U.S. Bureau of Mines, Report of Investigation 4681, April 1950.

Purpose of Present Investigation; Field Work

The purposes of the investigation on which the present report is based were to form an opinion about the future ore possibilities of the mine, to give recommendation for exploration and development, and to prepare an estimate of the ore reserves. The work done was almost entirely geological, and was carried out from November 14 to December 14, 1954, and from January 7 to 31, 1955. The surface geology was inspected briefly. The 200, 300 and 400 levels and all accessible stopes were mapped geologically, and a number of geological cross-sections prepared. The resulting maps and sections, which form a part of this report, are listed on a foregoing page as "Illustrations."

Acknowledgments

The writer thanks Messrs. Donald C. McKenna, President of Nevada Scheelite Corporation, A. R. McGuire, General Manager, Ray Henriksen, Consulting Engineer, Ernest Colwell, General Superintendent, Harry Manny, Mine Foreman, and E. A. Hollingsworth, Mining Engineer, for many courtesies received. Mr. Hollingsworth helped greatly by his intimate knowledge of the mine and by practical assistance in underground mapping, surveying and preparation of some of the maps.

Use was made of maps and sections prepared by the U. S. Geological Survey during 1943 - 44, and of geological maps prepared by Mr. Charles, Mining Engineer for the company around 1950, as well as of the reports listed at the head of this chapter.

The diamond drill core logs prepared by various engineers during the past few years at the Nevada Scheelite mine were used extensively in the

drawing of the geological maps and sections. The cores have all been thrown away, there being no space for storage, so it was impossible to verify their accuracy. For the uses of this report it was assumed almost without exception that they had been correctly logged.

Location, Access, Climate

These factors are fully discussed in the earlier reports. The mine and camp are in secs. 1 and 12, T. 13 N., R. 32 E., Mount Diablo base line and meridian, on the east flank of the Sand Springs Mountains, about 5 miles east of Rardin, Mineral County, Nevada. From Fallon, the mine is reached by following U. S. Highway No. 50 east 35 miles, thence a dirt road south about 20 miles. The altitude of the mine is around 5,000 feet above sea level.

The rainfall in the region is very small, and the snowfall seldom exceeds a few inches a year. Water is obtained from wells in the Gabbs Valley, 3 miles from the mine. There is no timber locally.

Property, History, Production

The mining property is said to comprise 16 unpatented mining claims and 2 mill sites. Most of the ore production has come from the Don claim, staked by W. H. Leonard in 1935. The production of the mine from 1935 to 1947, mostly by Nevada Scheelite, Inc., is given by Heron (page 9) as follows:

Table 1. PRODUCTION OF NEVADA SCHEELITE MINE, 1935 - 1947

<u>Year</u>	<u>Units W03 produced</u>
1935	15.64
1936	36.40
1937	532.72
1938	2,282.24
1939	4,321.91
1940	3,583.82
1941	12,852.06
1942	10,818.00
1943	10,900.31
1944	12,420.39
1945	10,033.27
1946	4,271.83
1947	217.66
Total	<u>73,660.35</u> Units W03

The ore production during the same period was 94,437 tons having an

average grade of 1.32% WO₃. The recovery was 63%, giving 0.83 unit WO₃ recovered per ton ore, with 0.49 unit WO₃ left in the tailings.

Kennametal, Inc. (Nevada Scheelite Division) owned and operated the property from the latter part of 1951 to near the end of 1954, when a subsidiary company of Kennametal, Nevada Scheelite Corp., took over the operation. The ore production statistics during the operation by Kennametal, Inc., as prepared by Mr. Ray Hendricksen, are given below:

Table 2 -

ORE PRODUCTION OF NEVADA SCHEELITE MINE
FROM LATE 1951 TO NOV. 26, 1954

	<u>Source</u>	<u>Tons Ore</u>	<u>Grade % WO₃</u>	<u>Units WO₃ in Ore</u>
<u>200 level</u>	720 section	2927	0.705	2063.99
<u>300 level</u>	250 A	5129	1.030	
	250 B	3916	1.169	
	550 Xcut	620	0.663	
	550 A	5889	1.456	
	550 B	1859	1.120	
	800 S111	3444	1.508	
	800 Stope	11521	1.456	
	900 Stope	3002	1.073	
	200 Stope	3212	1.206	
	560 Stope	1958	0.728	
	<u>Total 300 Level</u>	<u>40550</u>	<u>1.268</u>	<u>51,419.48</u>
<u>400 level</u>	340 Stope	4064	0.994	
	500 Stope	3752	0.847	
	400 Drift	1783	1.043	
	620 Stope	11958	0.961	
	685 Stope	1047	0.623	
	745 Stope	6996	1.282	
	1000 Xcut	53	1.1	
	1050 Stope	323	1.42	
	<u>Total 400 Level</u>	<u>29,976</u>	<u>1.0245</u>	<u>30,711.75</u>
	<u>Grand Total</u>	<u>73,453</u>	<u>1.146</u>	<u>84,195.22</u>

The production, if any, during the years 1948 - 1951 is not known to the writer.

The total known ore production from 1935 to Nov. 26, 1954 is summarized below:

Table 3 - TOTAL KNOWN ORE PRODUCTION, NEVADA SCHEELITE MINE
1935 - NOV. 26, 1954

<u>Period</u>	<u>Ore Produced, Tons</u>	<u>Average Grade Ore % WO₃</u>	<u>Units WO₃ contained in Ore</u>
1935 - 1947	94,487	1.32	124,722.84
Late 1951 to Nov. 26, 1954	<u>73,453</u>	<u>1.146</u>	<u>84,195.22</u>
<u>Total</u>	<u>167,940</u>	<u>1.24</u>	<u>208,918.06</u>

GEOLOGY

Resume

The general geology of the mine area is described by R. Stopper, on pp. 4-5 of U.S. Bureau of Mines Report of Investigation 4681 (1950). The oldest rocks of the area are metavolcanic, including andesites, basalts and tuff, in which there lies an interbedded stratum of crystalline limestone or marble having a maximum thickness of 500 feet. These rocks are thought to belong to the Excelsior formation of middle Triassic Age. They have been intruded by a granite stock cropping out over an area of one square mile, and by many granite dikes and sills. Tactite bodies occur along contacts of granite and limestone, and tuff has been altered to hornfels along granite contacts. Tertiary volcanic rocks locally intrude and overlie the other rocks.

Rock Formations

The distribution and geologic relations of the various rocks in the mine are shown in the accompanying maps and sections.

In the mine itself the following rocks are exposed:

- Basic igneous dikes (youngest)
- Tactite
- Granite and granite porphyry
- Limestone and hornfels (oldest)

The dikes are black, gray or dark green, with sharp contacts against the other rocks. They may be diabase or microdiorite, somewhat altered. Although here referred to as "dikes", they are mostly of complicated shape, and are both

large and small. Often they follow the contacts of ore and granite. Presumably they correspond to the Tertiary intrusions referred to by Stopper.

A hasty microscopic examination of a typical granite specimen revealed the presence of well-zoned euhedral feldspar and euhedral biotite, which might indicate orthomagmatic origin of the granite. No evidence was seen of the transformation of the sedimentary rocks into granite.

The limestone or marble is finely- to coarsely-crystalline and white, gray or black. Bedding can be seen occasionally. Hornfels is dense, hard and usually greenish. Underground, it is easily confused with dike rock unless careful examination is made of each occurrence, and there may be mistakes in the accompanying geological maps on this account.

Ore

Scheelite, the ore mineral, occurs in the tactite along the granite-limestone contacts. It is widely and rather evenly distributed. The associated minerals are: garnet, epidote, diopside, wollastonite, quartz, calcite, sulfides and oxidation products. The sulfides are pyrite, chalcopyrite and molybdenite, the latter rather scarce. The oxidation minerals include limonite and copper carbonates. The limonite often contains several per cent of WO_3 . Oxidation of the ore deposit extends quite generally to the 200 level, and even below it in some places. The scheelite contains an average of 0.5% molybdenum.

The ore deposit is a contact-metasmatic deposit, formed by the reaction at and near the contacts of limestone with metalliferous solutions emanating from the intrusive granitic magma. The granite-limestone contact itself is thus the primary locus of the ore.

Structural Geology of the Ore Deposit

In the vicinity of the mine, the limestone beds dip steeply, and strike about northeast. About 110 feet north of the main shaft, at the surface, a pre-granite fault, striking northwest and dipping about 40 degrees to the northeast, cuts across the limestone beds nearly at right angles, and appears to displace the limestone on the northeast side of it at least 400 feet northwest (as measured on the 200 level). The surfaces of movement of this fault

are no longer visible; they have been metamorphosed, intruded by granite, and mineralized, but the existence of the dislocation is certain because of the visible offset of the limestone beds.

At some time subsequent to the formation of this fault, granite was intruded into the limestone. The granite contact follows the northwest fault in the central part of the mine. Northeast and southwest of the fault, the contact follows the northeast strike of the limestone (but cuts across it somewhat on the dip). As a consequence, the granite-limestone contact in the mine, as viewed in plan, has the zig-zag form shown diagrammatically in Sketch 1, in which the three distinct parts of the contact, trending respectively northeast, northwest, and northeast, are labelled 1, 2, 3, respectively.

Ore was formed at many places along the contact, but the largest ore masses were formed along the northwest fault where the limestone presumably was somewhat shattered, and where the granite cut sharply across the bedding, and the ore-solutions thus more easily penetrated the bedding-planes, effecting a more extensive replacement of the limestone. Conditions for ore deposition were likewise especially favorable in those northeast-trending parts of the contact lying contiguous to the northwest fault. It may be stated quite confidently, therefore, that the more productive ore bodies are related directly to the northwest fault, and that the future of the mine be dependent very largely on the structural behaviour of the fault at greater depth.

See Sketch 1. Part 1 of the contact dips essentially vertically; part 2, the northwest fault, dips about 40 degrees to the northeast; and part 3 dips around 60 degrees to the southeast. The geometrical consequence of this downward convergence of the two northeast-trending contacts is that the northwest part becomes shorter and shorter as greater depth is attained, and would ultimately disappear entirely. The Northwest-trending part of the contact, considered as an area, is roughly triangular with apex pointing downward. The diminution of the length of the northwest section with increasing depth is clearly shown in the geological plan of levels 200, 300 and 400 (see figs. 2, 3 and 4). On 200 level, the northwest part is about 400 feet long; on 300 level, perhaps around 250 feet; and on 400 level, perhaps around 100 feet. The northwest contact thus has decreased in length by about 150 feet for each additional

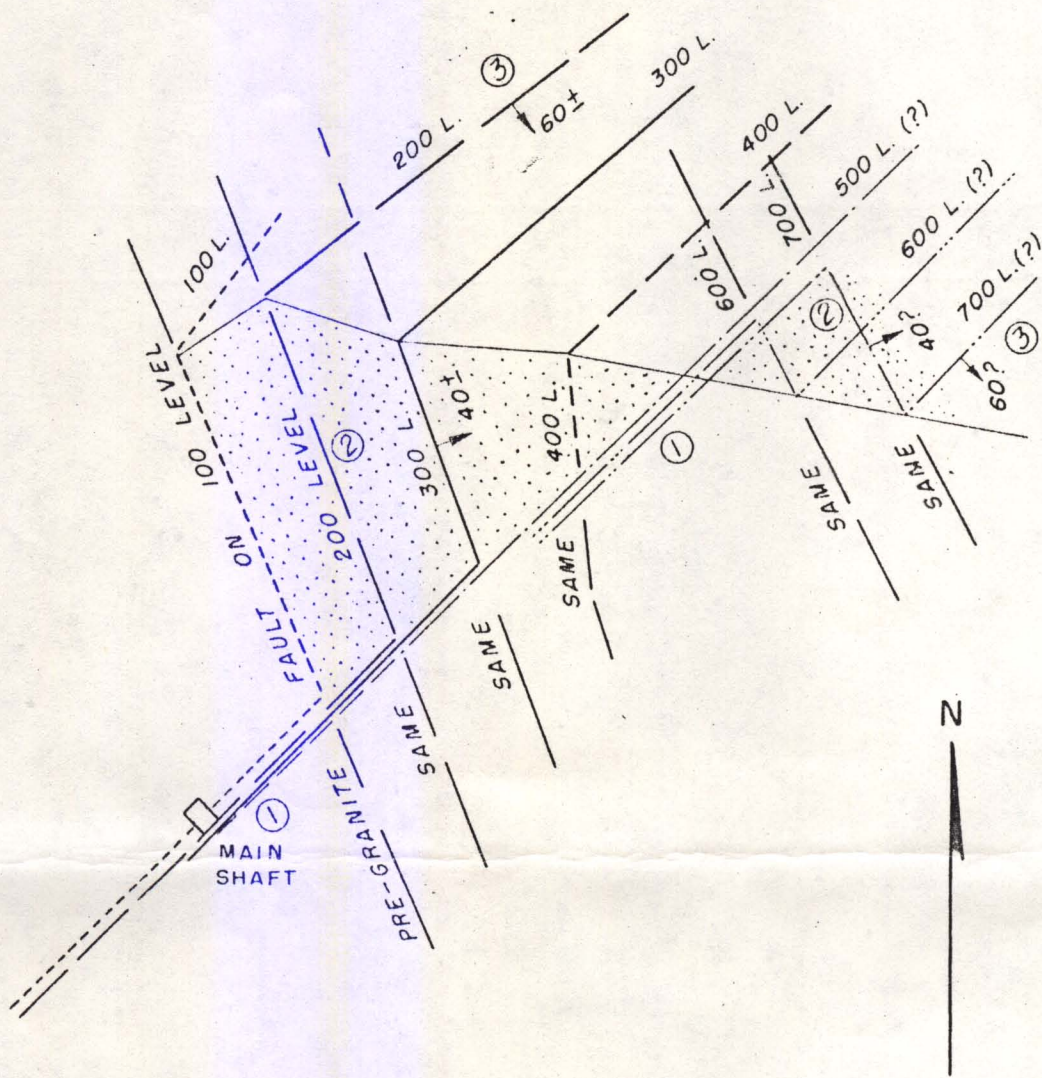
SKETCH

DIAGRAMMATIC PLAN OF NEVADA SCHEELITE MINE SHOWING POSITIONS OF GRANITE-LIMESTONE CONTACT ON THE UPPER FOUR LEVELS AND HYPOTHETICAL POSITIONS OF CONTACT ON FUTURE LOWER LEVELS.

NUMBERS 1,2,3 INDICATE THE THREE MAIN SECTIONS OF THE CONTACT, THE NW-TRENDING SECTION BEING CONTROLLED BY A PRE-GRANITE FAULT.

BLUE INDICATES LIMESTONE SIDE AND YELLOW, THE GRANITE SIDE OF THE CONTACT ON EACH LEVEL.

STIPPLING INDICATES THE PART OF THE CONTACT SURFACE MOST FAVORABLE FOR ORE. IT CORRESPONDS TO THE PRE-GRANITE FAULT SURFACE.



APPROX. SCALE
1" = 200 FEET

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100 feet of depth.

It is not possible to predict the behaviour of the contact beneath the lowest level of the mine. It is possible, for example, that the granite may cut beneath the limestone, obliterating entirely the geological structure on which the ore depends in the present levels. There is, however, no evidence of this as yet. If, however, the known structure of the contact should persist without major deviation to greater depths, a situation like that illustrated in Sketch 1 would obtain. At, or somewhat above, the future 500 level, the two northeast contacts would meet, and the northwest contact would have diminished to a point. The entire contact at this level would thus be roughly a straight line running northeast, without a northwest - striking section at all. Beneath the 500 level, however, the two northeast contacts would diverge, and the northwest part would again come into existence, this time as a triangle with apex upward, and the northwest-trending section of the contact would increase in length on each successively deeper level. Also, on the northwest contact below 500 level, the limestone would form the hanging wall and the granite the footwall, which is exactly the opposite of the relations obtaining in the upper levels. The zig-zag pattern on each level below the 500 level would be reversed from what it is on 400 level and above (Sketch 1).

If this geometrical concept should prove to be the fact, what might the consequences be as regards the ore body? The ore would be expected to follow the contact as before. On 500 level, it would strike northeast, without major deviations. Below 500, the reverse zig-zag pattern would come into effect, and the biggest bulges of ore might occur along the northwest contact, as before, with the difference that the fingers of ore would run into the hanging wall rather than into the footwall. If it should eventuate that the 500 level is not so productive as any of the levels above, this should be attributed to the convergence of the two northeast contacts, but it should not cause undue discouragement, at least until the 600 level has been thoroughly explored and found wanting. The prospects for good ore in depth, however, seem favorable, and there is no presently known reason for concern.

The form of the ore body, insofar as known and insofar as can be surmised

is shown on the geological maps, and sections accompanying this report. Description of parts of the ore body is given in the ensuing chapters about mine working and ore possibilities. Although as viewed in any single plan or section the ore appears discontinuous, yet it is believed that if all three dimensions were fully explored, the ore would be found to be an essentially continuous single body (with a few minor exceptions), if extraneous accidents, such as dikes and later faults, are disregarded. The form of the body is complex where it follows the northwest fault, but tends to be tabular on the two northeast contacts.

Faults

A number of northeast faults, younger than the dikes, cut the ore deposit and divide it into segments. These faults appear to have suffered strike-slip movement principally. The displacements are not great - perhaps a few yards at most. On the geologic maps and sections, the faults are labelled A, B, C, etc. in order to identify them.

DESCRIPTION OF ACCESSIBLE STOPES

200 Level

Stope 2-250 is the only stope on 200 level that can be safely entered throughout its extent. The geology of the sill of this stope is shown in fig. 2 (Geologic plan of 200 Level), and of the stope itself in fig. 5 (stope plans). There appears to be plenty of ore in this stope, but the limits of it are unknown because the adjoining stopes are backfilled and cannot be mapped. Above the 9th floor, in the raise, ore is reported to continue upward to about 100 level. It appears that there should be no unusual difficulty in mining this remaining ore wherever it appears, both on the sides and in the back of the stope, and it is likely that several thousand tons may be available here. Very high grade ore was seen at one place in the back.

Southwest Stope - An old stope lying at the extreme southwest end of 200 level was mapped on the first floor (see fig. 5). Five additional floors were visible above but were not entered because the timbers did not appear sound. At the southeast end of the stope is an ore pillar, separating the Northwest stope

from another old stope a few yards to the southeast.

300 Level

Stope 300 - Only the first floor of this stope is accessible, and the geology of it is shown in fig. 6. The stope reportedly extends all the way to 200 level. A half-set of ore was excavated in the floor of 300 level, and the ore is known to continue farther downward from diamond drill holes that cut it below.

Stope 3-560 - These workings consist of five stopes: 560, 560E, and inclined stope connecting with 560E, 560W, and a fifth stope lying a few yards west of 560W, and connecting with it above the level. Only part of 560W is accessible, and this part was mapped, as well as the other stopes in their entirety. See fig. 3 (Geologic plan of 300 level), fig. 6 (stope plans), and fig. 14 (Section VII).

The tactite in and near where these stopes are situated has been penetrated by the following listed 18 diamond drill holes:

3-65A	3-165A
66A	166A
68A	167A
97A	168A
98A	169A
161A	170A
162A	171A
163A	172A
164A	173A

From the logs of these holes, as well as from the geology visible in the stopes, the plans of the 560 stopes (shown in fig. 6) were constructed.

DD Hole 3-67A passes beneath the ore, as shown in Section VII, and this fact would appear to indicate that the ore along this section, and probably also that lying west of it, does not extend vertically downward very far, but rather plunges at a gently inclination to the east, entering the west end of Stope 4-620B. The absence of ore sections in DD Holes 4-120A, 4-121A, and 4-156A, all on 400 level (fig. 4) does not, however, prove that the ore does not continue vertically downward because these holes are not long enough to reach it if it did.

Judging from DD Holes 3-163A and 3-166A, part of the tactite body extends upward at least 50 to 60 feet above 300 level. Farther up, it is probably cut

off in an irregular way by the big dike seen in the corresponding part of the 200 level (see Fig. 2).

The ore body in which the 560 stopes are excavated appears to be a great, irregular lobe, extending westward from the granite contact and lying mainly in limestone.

In the stopes (Fig. 6), the ore is cut into three or more segments by a large dike that is probably connected to the similar intrusive body on 200 level. The presence of this dike complicates the problem of mining the ore, but nevertheless some of the ore segments have been large enough to be stoped individually.

Stope 560 lies on the granite contact, which locally arches above the first floor, forming a roof. The tactite beneath Stope 560, as well as the tactite immediately north and east of it, dip into stope 620B and also into the footwall of this stope.

Stopes 800 and 900 - See fig. 3, 6, 9, 10 and 11, which illustrate the geology of these stopes. The ore is an upward continuation of the ore in stopes 4-745 and 4-685. It occurs as a thick lens, striking about northeast and dipping from 35° to 50° to the southeast. The footwall is limestone and the hanging wall of the stope is demarcated by Fault B, which flattens markedly in stope 800 (see Section IV). The ore at most places butts up against this fault. In and above the fault is a persistent dike, strongly sheared. The fault seems to have followed this dike. Above the fault and the dike is granite, presumably. There exists, however, the certainty that a segment of the ore body lies south of (above) the fault, in one or more places. This is shown by the ore section in and near the end of DD II 3-139A (see fig. 3) which clearly lies south of Fault B. There is an excellent chance of a good ore body here, and extending southwestward along the fault, as well as upward in the hanging wall of stopes 800 and 900, and this possibility should be investigated.

The ore in the back of stopes 800 and 900 should continue upward until cut off by the dike showing in the 200 level drift.

400 Level

Stope 4-340 extends all the way from 400 to 300 levels. The two upper floors beneath 300 level, were mapped and the geology is shown in fig. 6. Additional ore has been found by diamond drilling east of Fault G, below 300 level.

Stope 4-580 is a timbered unfilled stoppe extending upward from the 400 level, on the same ore body as that mined in the adjacent stopes, 580W and 580E. It is inaccessible. A granite hanging wall was found 6 sets up.

Stope 4-580W - The geology is shown in figure 7 (stoppe plans) and in figures 13 and 15 (Sections VI and VIII). The supposed outline of the ore on the 400 level is shown in fig. 4.

See Section VI. On the south, the ore is bounded by Fault D and by granite; below by a flat-dipping limestone floor, and above by Fault E, which dips gently to the south, apparently as a link between Fault D and Fault C. Granite and dike rock lie above Fault E, insofar as is known, but there is the probability of ore above this fault nearer its junction with Fault C. The ore presently exposed in the north face of the stoppe on the 2nd floor is believed to extend all the way to Fault C near the edge of stoppe 4-620B.

The north face of the stoppe on the 2nd floor shows a horse of limestone with good ore below and above, up to the Fault E, above which is granite. This stoppe should be advanced in spite of the limestone, which can be drilled and blasted separately from the ore.

See Section VIII. The ore in 580W is the continuation of that in stopes 580 and 580E. Above the top of 580 and south of Fault C there is the possibility of more ore perhaps connecting somehow with the ore in the sill of 300 level beneath stoppe 3-460.

Stope 4-580E - This stoppe lies south of Fault C and immediately south of No. 620-C, with which it connects on several of the upper floors. The geology is shown in fig. 7 (stoppe plans) and figures 11, 12 and 15 (Sections IV, V, and VIII).

The bottom of the ore seems to be on the 400 level, upward for 3 floors, the ore extends as a rather narrow lens bounded on the northwest by limestone

and by Fault C and on the southeast by granite. On the 4th floor, the southeast contact swells abruptly outward into the granite, forming a much wider body.

The northeast end of this ore lens lies against granite on the 400 level, at the end of the drift. The pitch of this termination of the lens is about 45° to the southwest, so that the ore extends farther and farther to the northeast as the top is ascended floor by floor.

These observations indicate the possibility of an important ore reserve directly above and also to the northeast of the present top of stope 580E. It is possible that this ore connects in some way, perhaps circuitously, with the ore lying in the sill of 300 level directly beneath stope No. 3-460 (See Section VIII).

The southwest face of 580E is in ore that forms a pillar between 580E and 580. This pillar can be mined. On the 3rd floor, south side, a pocket of extremely rich ore is visible in granite. Its extent is unknown, but probably small. It should be investigated by mining outward a set.

Stope 4-620B - Stope 620B adjoins 620C on the northwest, extending upward from 400 level 12 floors, nearly to the 300 level. All but the 11th and 12th floors are backfilled and therefore inaccessible. Two raises connect the 11th floor of 620B with the 5th floor of 620C, below. The geology of the accessible parts of this stope is shown in fig. 6 (stope plans) and in figures 12 and 13 (Sections V and VI).

Fault B crosses stope 620B, dipping about 40° to the south (see fig. 6) and ore has been mined on both sides of the fault.

See Sections V and VI. Both show all the ore lying in the footwall (north) of Fault B, which may be correct insofar as the planes of these sections are concerned. The plan of floor 11 (fig. 6) shows additional ore lying south of Fault B. Stope 620A, entirely inaccessible, is said to be situated south of Fault B, but its outlines are unknown. In any case, it is likely that the ore lying south of Fault B is somehow continuous with the ore in the sill of stope 3-460. Likewise it might be continuous with the ore in stopes 580E and 580W.

Ore appears all along the northeast face of the stope on the 11th floor, north of Fault D, and also near Raise 620. It extends to the east and west, and is continuous with the ore north of Fault B in stopes 4-620C and 4-685.

Tactite remains in the back of floors 11 and 12, up to the 300 level, although apparently cut by a dike (fig. 13, Section VI). This ore probably will be left as a pillar until a later stage of the life of the mine.

Stope 4-620C - The geology of this stope is illustrated in fig. 7 (stope plans) and figures 11 and 12 (Sections IV and V). Most of the ore produced to date has been mined from an important segment lying between Faults B and C, and this segment extends westward into stope 620-B. A pillar of ore separates the two stopes.

Above the 5th floor of 620-C, ore extends upward to Faults B and C, which appear to converge and join above the stope (See Sections IV and V).

Between Faults B and C, at the east face of the stope, there is ore on the 2nd and 3rd floors, which should extend several yards farther west. On the 4th and 5th floors, this ore has already been mined up to a limestone wall.

North of Fault B (see fig. 7), there is additional ore that represents an extension of the ore visible in stope 4-685, to the northeast, and of the ore lying north of Fault D in stope 4-620B, above, and to the west.

To the south, beyond Fault C, is stope 4-580E, which also contains important quantities of ore.

Stope 4-685 - The geology is illustrated in fig. 7 (stope plans), fig. 11 (Section IV) and fig. 16. The ore visible in the stope is an extension of that seen in the northwest corner of stope 4-745 (see fig. 7).

Above the 5th floor, at the raise, a limestone hanging wall is visible, dipping gently to the southwest. Above the limestone is the same dike that forms the roof of stope 4-745. More ore should be found above the dike.

The visible ore (Section IV) extends upward and to the northeast between limestone walls. It should be mined both upward and outward, likewise on all floors toward the east (until connection is made with stope 4-745) and west (until connection is made with stope 4-685 (see fig. 7).

Stope 4-745 - The geology of this stope is shown in plan in figures 4 and 7, and in section in figures 10 and 16. It is limited above by the same dike as that forming the footwall of stope 4-1050. The northwest wall is limestone and the southeast wall is composed of granite, limestone and dike rock, all lying northwest of and close to Fault B. The ore extends up to the fault at some points, and there exists the possibility that part of the ore body lies on the other side of the fault, which, in the locality of this stope, has not been explored.

The form of the ore body is irregular (see fig. 7, stope plans). It seems to extend from the northwest part of the stope into the adjoining stope, 4-685, whence it runs farther west into that part of stope 6200 lying north of Fault B.

Beneath stope 4-745, ore lies in the sill of 400 level.

The ore remaining in stope 4-745 is: a) above 6th floor and below the overlying dike; b) in pillar between stope and stope 4-685; c) a bulge of ore, pitching gently westward, at the extreme west end of the stope. Additional ore lies above the dike.

Stope 4-1000 - The ore on which this stope is excavated was first found in 4-1000 crosscut Northwest (fig. 4), on which a raise was driven and a stope excavated up 4 floors (Jan. 21, 1955). As may be seen in fig. 4, this ore in the stope is geologically part of the same body as that mined in stope 4-1050. Although the physical continuity of the ore is interrupted by a partition of granite, "horses" of limestone and intrusions of basic dike material. In the neighborhood of 1000 X-cut (Section II) the southeast limit of the ore is formed of a thick wedge of marble. The northwest wall is limestone. Ore, proven by drifting and diamond drilling, lies immediately to the northeast, and also to the southwest, where, however, its length is as yet unexplored.

Stope 4-1050 - This stope was commenced in Nov. 1954 in a wedge of ore lying between Fault A and Fault B (see fig. 4) and overlying a basic dike, visible at several places on the level, striking about WNW and dipping around 20° to the north. The ore in this stope is a continuation of that mined in stope 4-745, but separated from it only by the dike, which forms a natural footwall

of the stope (see fig. 7, floor 13, also fig. 16). To the northwest, the stope joins with No. 4-1000 stope, which was commenced in December 1954. The ore mined in these two stopes is actually parts of a single body separated locally by a mass of limestone that probably tapers out upward, so that the ore sections merge (see Section II, fig. 9) and continue upward to the 300 level as a single mass.

Fault B (see Sections I and II) apparently form the limit of the ore on the southeast, beyond which the available information indicates the presence of granite and dike rock. There is, however, the distant possibility that additional ore lies southeast of Fault B, and the faults should therefore be crossed at several points in order to prospect the other side. In any case, the ore should be mined right up to Fault B, unless intervening rock (dikes, etc.) locally appears.

Upward, following the dike as a footwall, the ore extends all the way to the 300 level, over a strike length of at least 175 feet (the distance between Sections I and IV), and constitutes an important ore reserve.

Beneath the dike that forms the natural footwall of stope 4-1050, additional ore exists in stopes 4-745 and 4-685 (see descriptions of) and also in the 400 level sill, beneath the lower contact of the dike (see Section I, fig. 8).

Northwest of the stope, across Fault A, is additional ore, which might be mined from stope 4-1000 or from another new stope to be started farther to the northeast, in the wide part of the 400 level drift (See fig. 4).

ORE RESERVES

The ore reserves include only that ore of which there is conclusive evidence of its existence (from direct observation, diamond drill core logs, etc.), and which has been sufficiently explored to allow the forming of a reasonably secure conception of its size, shape and grade. Obviously, then, the reserves do not embrace all the ore in and around the mine, which is an unknown quantity at the present stage of development. There probably exist important tonnages of ore in excess of the calculated reserve, but they have not been explored enough to permit any but a rough and unreliable guess about their size.

Geological factors naturally influence the reliability of the reserve calculations. The ore deposit is highly irregular in form, subject to abrupt and (in detail) unpredictable pinches, swells and terminations. This is owing to its nature as a contact metasomatic deposit. Furthermore, there exist in the deposit masses of tactite containing very little scheelite. It is impossible, at the present time at least, to foresee where these might occur. Finally, the original complications of form are further complicated by the presence of intrusive igneous bodies of irregular shape, which penetrate the ore at many places, and also by the existence of a number of longitudinal post-ore faults that slice the deposit into individual segments. With these geological conditions, the only ore that can be considered as truly "positive" must be so thoroughly punctured by workings and drill holes that little remains of it. In the computation of "probable" ore, a little more latitude is permitted, and the observable geological features are projected short distances, unless there is evidence that such extensions cannot exist. Furthermore, as is evident, the reserves must be limited to those parts of the mine open to inspection and which were actually inspected.

The quantity of ore that is ultimately mined from a reserve block depends partly on the care and thoroughness with which the ore is followed and excavated in the stops. In the figures given, there is no allowance made for pillars, because it is believed that stop pillars are unnecessary if square-set mining is carried on properly. Drift pillars will probably be left at many places, but should be eventually recoverable.

The grade assigned to the various reserve blocks is a composite figure derived mainly from ore car assay and DD core assays. Tonnages are calculated from the geologic maps and sections. The average specific gravity of the ore is about 3.1, which gives a factor of 10.35 cubic feet per short ton in place. The ore blocks were calculated entire and then, in some places, a certain small proportion of the tonnage was allowed as

"positive" ore, the balance being assigned to "probable" ore. Possible ore is excluded from the reserves.

Finally, it should be stated that the estimate is only a preliminary one. The careful channel sampling and measurements necessary to a proper reserve estimate were not made; partly from lack of time and mostly from doubt as to the practical value of such work, especially when the necessary time and expense are considered.

BLOCK I extends, on the 400 level, from Section I near Raise 1050, north-eastward to the place in the wide part of the drift where the ore narrows abruptly, and upward from 400 to 300 level. This block is penetrated, on 400 level, by DD Holes 4-196-A, 4-197-A and 4-255A, and by 3-230-A just above the level. Narrow bands of ore were intersected by three flat DD Holes (3-270A, 3-272A and 3-273A) on 300 level, which determine the position of the upper edge of the ore block. Two thousand tons probable ore are computed in this block, with average grade of 1.1% WO_3 , taking into account the grade of ore from stope 1050 and of the ore sections out in the DD Holes, as well as of the ore visible in the drift.

BLOCK II lies between cross-sections I and II, above stope 1000 and 1050, up to the 300 level. The ore reserve in this block is estimated at 5500 tons, after deducting the tonnage mined to Jan. 22, 1955. The average grade is estimated at 1.3% WO_3 , based on the production from stopes 1000 and 1050.

BLOCK III is between Sections II and III, above the dike that forms the foot-wall of stope 1050, southwest of the present (1/22/55) faces of stopes 1000 and 1050, and beneath the sill of 300 level, which is in ore throughout the length of the block. DD Holes 4-150A and 4-263A cut this ore above the dike and below 300 sill (See fig. 16). The estimated reserve is 15,000 tons, with the possibility of an additional 15,000 tons. The grade, estimated from production of stopes 4-745, 4-1000 and 4-1050, as well as from the grade of the ore mined from the 300 sill below stopes 800 and 900, and that of the ore sections in DD Holes 4-150A and 4-263A, is estimated at 1.5% WO_3 .

BLOCK IV is the wedge of ore between Section III and IV (See fig. 3) in the sill of 300 level and above the dike visible is the backs of stopes 4-745 and 4-685, which is the same dike as that forming the footwall of stope 4-1050. The reserve in this block is 2700 tons with average grade of 1.5% WO_3 .

BLOCK V lies beneath 300 level, on the north side of Fault B, and extends from Section IV westward to Section VI, near the northeast face of stope 4-620B. The lower limit of the block at Section IV is the top of the dike exposed in the roof of stope 4-685 (7th floor). On Section VI, the lower limit of the ore block is Fault B, which seems to reverse to dip in stope 4-620B (See Section VI).

On Section IV the ore is assumed to form a single body. At Section VI it appears that a wide partition of limestone separates the tactite into two branches. The lower branch is exposed on the 11th floor of 620B, in the short crosscut to the new Raise 620. It is also exposed in the northwest part of stope 4-620C, north of Fault B, on floors 2, 3, 4 and 5 (See fig. 7), and it has been cut by DD Holes 4-245 and 4-247 on the 400 level (See fig. 4). The upper branch shows on the northeast wall of 4-620B, 11th floor (See fig. 6).

Ore is known to lie in the sill of 300 level at the upper limit of the block.

The outlines of the ore in this block are rather indefinite, and the ore reserve computed here is limited to a block extending 20 feet downward below 300 level, and which is calculated to contain 5700 tons, with average grade of 1.2% WO_3 . This grade is a compromise between the grade of ore mined in the 3-300 stope sill (1.5%) and that recently mined a short distance beneath the dike in stope 4-685 (0.73%). There is the possibility of additional ore (possible ore) amounting to as much as 15,000 tons.

BLOCK VI includes the ore in the back of stope 4-620C from the 6th floor, between and up to the supposed junction of Faults B and C (See Section V), and the ore in the pillar separating this stope from 620B, as well as the

ore extending northeast from the stope, between the two faults. It excludes ore lying north of Fault B and south of Fault C (See fig. 7). Block VI is estimated to contain 2200 tons with average grade of 0.9% WO_3 . The recent production from 620C has assayed 0.91% WO_3 .

BLOCK VII surrounds stope 4-685, beneath the roof dike exposed on the 7th floor, extending to stope 4-745 and also 25 feet westward, toward stope 4-620C, as well as down to the 400 level. Excluding the ore mined from November 26, 1954 to January 14, 1955 from this block, the reserve is estimated at 3000 tons, with average grade of 0.8% WO_3 . There is the possibility of additional ore.

BLOCK VIII is south of Fault C, in the back of stope 580E above the 5th floor, and to the northeast. It includes also the ore pillar separating the stope from stope 580. Extending the ore 20 feet upward as well as northeastward, the reserve is computed as 2000 tons, with average grade of 1% WO_3 . The ore mined from the stope to 1/21/55 averaged 1.04% WO_3 . There is the good possibility of much more ore than here calculated.

BLOCK IX is the northward extension to Fault C, below Fault E, of ore visible in the north faces of stope 530W, on the first and second floors. The estimated tonnage is 2000 tons with grade of 0.7% WO_3 .

BLOCK X lies beneath 300 level, west of Section VII, in the wide, irregular ore body that has been partly mined in the 560 stopes. As before stated (see description of stope 3-560), this ore is believed not to extend vertically downward very far, but rather to plunge at a low angle to the east, entering the west end of stope 4-620B. Assuming a downward extent of 10 feet, this block contains 2000 tons. Additional, possible, ore lies below that. The average grade, judged from the stope production and assay of ore sections in the DD Holes is 0.6% WO_3 .

BLOCK XI is in the same mass of ore as Block X, but lies above the 300 level, as well as west of Section VII. Part of it has been stoped in 560E and 560W.

The average grade of the stopes was:

560E	0.51%	WO ₃
560W	0.37%	WO ₃
560W extension	0.66%	WO ₃

Taking DD core assays also into account, the average grade of the block is estimated at 0.6% WO₃, and the probable tonnage, up to the 6th floor, at 4000 tons. There may be ore in excess of this.

The part of the tectite body lying between Sections VI and VII on 300 level (fig. 3) appears to be largely too low-grade to mine, and it is therefore excluded from the ore reserve.

BLOCK XII comprises the ore in the back of stope 800E extended up the dip for a distance of 40 feet above the 6th floor. The reserve is estimated as 2000 tons with grade of 1.4% WO₃. There is the possibility of additional ore.

BLOCK XIII comprises the ore in stope 900A projected 60 feet up the dip toward 200 level. The estimated tonnage is 1500 with grade of 1% WO₃.

BLOCK XIV represents the ore above the 3rd floor of stope 900B projected up the dip 60 feet. There are 750 tons of ore reserve with grade of 1% WO₃.

There may possibly be additional ore above Blocks XIII and XIV.

BLOCK XV is the ore visible (assuming short extensions) in the walls and back of stope 2-250, which should easily exceed 2000 tons with grade of 1%.

BLOCK XVI extends downward from the 400 to the 500 level between Sections I and II, and 10 feet on either side of the sections. The calculation is based on geologic cross-sections I and II constructed from DD cores and from the geology of 1000 shaft, mapped by E. A. Hollingsworth. The reserve of probable ore in this block amounts to 6000 tons with average grade of 1.2% WO₃.

Table 4

SUMMARY OF ORE RESERVES AS OF JANUARY 22, 1955

(Preliminary estimate only)

Block No.	Positive Ore Tons	Probable Ore Tons	Total Ore Reserves Tons	Grade % WO ₃	Total Units WO ₃	Units WO ₃ recoverable at 83%
I		2,000	2,000	1.1%	2,200	1,820
II	500	5,000	5,500	1.3	7,150	5,930
III	2,000	13,000	15,000	1.5	22,500	18,700
IV	700	2,000	2,700	1.5	4,050	3,360
V		5,700	5,700	1.2	6,840	5,670
VI	500	1,700	2,200	0.9	1,980	1,640
VII	500	2,500	3,000	0.8	2,400	1,990
VIII	500	1,500	2,000	1.0	2,000	1,660
IX		2,000	2,000	0.7	1,400	1,160
X		2,000	2,000	0.6	1,200	995
XI		4,000	4,000	0.6	2,400	1,990
XII	500	1,500	2,000	1.4	2,800	2,320
XIII	500	1,000	1,500	1.0	1,500	1,240
XIV	250	500	750	1.0	750	620
XV		2,000	2,000	1.0	2,000	1,660
XVI		6,000	6,000	1.2	7,200	5,970
Totals	5,950	52,400	58,350	1.17	68,370	56,725

OTHER ORE POSSIBILITIES AND CORRESPONDING RECOMMENDATIONS FOR EXPLORATION

In this chapter of the report, a list is given of the additional ore possibilities (exclusive of ore reserves) that exist in the mine. The numerous items in this list fall into two categories:

(a) Possible ore includes the following:

- i) ore penetrated by workings or core drill holes, but which is insufficiently explored to permit forming an adequate idea of size, shape and grade
- ii) projections of known ore bodies, based on geological inference.
- iii) known taconite bodies that are too low-grade to mine according to present information, but which might contain commercial ore in some part of them as yet insufficiently explored.

(b) Other ore possibilities about which there are no specific data:

The enumeration follows, with recommendations for exploration where called for:

Locality

Above 100 Level: 1) The surface geology, as mapped by the U. S. Geological Survey in 1943 - 1944, is shown in Figure 1. Maps of the 50 and 100 levels and part of the 200 level were also prepared at that time by the U.S.G.S., and are filed in the engineering office at the mine. The 50 and 100 levels were not studied during the present investigation. They are reported to be mostly inaccessible. In the absence of maps revealing the extent and geology of the old stopes, it is not possible to formulate a definite idea of the ore possibilities on these levels.

200 Level: 2) With one exception, the numerous stopes above the 200 level are inaccessible or mostly inaccessible. Southwest of the main shaft, however, are several timbered, unfilled stopes, now unsafe to enter, which could be easily repaired enough to make mapping possible. The filled stopes are permanently inaccessible unless, at some future time, it is decided to mine them again.

3) Ore has been found in the granite, apparently rather far from the limestone, by diamond drilling on 300 level. Equal possibilities exist on the 200 level.

4) See Figure 2 (Geological Map of 200 Level). DDH 2 - 32A penetrates ore at a point well beyond the limits of the old stopes in this vicinity. This may represent a segment of the orebody sheared off and isolated east of the hanging wall fault, known from old maps to be present in this part of the mine.

5) See Fig. 2. In the crosscut running west from spad 15A there is tactite on the south wall, beneath a thick, gently-dipping porphyry dike. It probably extends southwestward into the limestone as indicated by DD Holes 2-89A and 2-73A, but does not seem to be very important.

6) See Fig. 2. In and near the second crosscut west (Spad 20A), there are three places where ore runs westward or southwestward out into the limestone walls. These are drift pillars beneath old stopes.

Exploration Recommendations

1) Unless high price for tungsten can be foreseen for some time into the future, it is doubtful whether the reopening of these levels is called for. All the available geological information should, however, be gathered and plotted when there is time for it.

2) The unfilled stopes southwest of the main shaft should be retimbered enough to make the back and sides safely accessible, and should thereafter be mapped and sampled. Subsequent exploratory work would depend on the results shown by the geological study.

3) Systematic diamond drilling of the granite should be done on 200 level as soon as convenient. The drill sites and directions of the holes can be decided by the management, and the resident mine engineer.

4) Crosscut east from the haulageway, through the old caved workings to the position occupied by the ore at the end of the DDH. If the ore appears important, follow it with a drift. Alternatively, it should be possible to gain an adequate idea of this ore by diamond drilling several holes upward and to the west from Level 300, near the foot of Raise 3-550B (see composite plan of levels, Fig. 1).

5) The tactite should be sampled. If of ore grade, it should be explored by a short drift southwestward.

6) The extent of these pillars should be investigated and they should eventually be mined.

7) Generally speaking, the limestone lying southwest of the northwest trending part of the 200 Level haulage way has been insufficiently explored for possible further footwall projection of the main ore body. Although there are no positive ore indications (except the southwestward striking ore protruberances mentioned in 6), above (Fig. 2), it is advisable to diamond drill this footwall rather thoroughly.

8) Northeast of the 2d crosscut (spad 20A) the drift lies largely in dike rock. This intrusive mass is large and irregular in form, due partly to faulting, and has obscured the ore possibilities in this part of the level. Insofar as can be seen, the intrusive dips from 45 to 65 degrees to the southeast. It cuts off the ore extending upward from the corresponding section of the 300 Level, and it likewise cuts off the ore extending downward from the surface. (See Cross-sections IV, V, V and VII.) Because of this dike, there is no ore to speak of on this part of the 200 level, except at the end of it, in and near 1000 X cut north, where a small orebody has been partly mined in the footwall of the intrusion. Beneath the dike, however, there should be plenty of ore, judging from the powerful ore body exposed below in the 300 Level drift and stopes.

Above the 200 Level there are several stopes, but they are inaccessible and their size and ore content are unknown.

9) At the northeast end of the level, ore shows in the workings and in several of the diamond drill holes (see Fig. 2), and the bothersome dike seems to be diminishing in width.

300 Level: 10) Near spad 309, some tactite of ore grade was found in DD Holes 3-281A, 3-278A, 3-282A, and 3-283A, above the level, and bands of tactite were found in the adjacent holes 3-279-A and 3-280A. These intercepts probably are on the same small body as appears in the drift, between limestone walls, a few feet from the collar of the holes.

7) From the second crosscut (at spad 20A) drill four 150-foot holes: a) flat hole due south, b) flat hole S 25E, about parallel to haulage way, c) up 20 degrees, S15E, d) down 20°, S15E.

From the first crosscut (about 30 feet in from spad 15A, drill three 150-foot holes: 1) flat hole N25W, about parallel to haulage way, 2) up 20 degrees N15W, 3) down 20° N15W.

8) The exploration of the ore possibilities below the dike are described in the exploration recommendation for 300 level.

Above the 200 Level, it is first necessary to put the stopes in an accessible, safe condition, insofar as possible, so that they can be mapped and a definite idea formed of the ore possibilities in this locality. It would probably be a mistake to assume that all the profitable ore had already been mined. After mapping and sampling, an adequate diamond drilling program, or other exploratory program, could be laid out.

9) The drift should be continued at least 100 feet to the northeast, exploring further the ore found in the DD holes, and following the contact between granite and limestone.

10) An exploratory raise should be driven 80 feet, about 60 degrees above the horizontal, following the tactite body as indicated in the DD cores.

11) Near spad 309, four wildcat holes (3-274, 275, 276, 277) were bored southeast into the granite at angles of plus 10 to plus 30 degrees following the inspiration of the resident engineer, E. A. Hollingsworth, and an 18-foot section of ore, assaying 0.67% WO₃, was cut in No. 3-276, 67 feet from the granite-limestone contact.

Several additional holes must be drilled to ascertain the importance of this discovery, but nonetheless it brings clearly to light the possibility of the existence of ore bodies in the granite, rather far removed from the contact.

12) Near spad 311 (Fig. 3) DD Hole 3-11A was drilled in July 1951. A 17-foot section of ore was cut directly below the sill, and has not been further investigated. It might be part of the 3-260 - 3-550 ore body, isolated south of Fault D.

13) See Fig. 3. At the end of the short drift running northeast from a point near the foot of Raise 3-320 M, a segment of rich ore is visible in the back and walls, abutting against Fault G, which cuts it off. The ore directly above this drift has been stoped, reportedly, but the drift is blocked and the stope cannot be entered. The geology of this local area definitely suggests the possibility of finding more ore on this level, and this inference is sustained by the results of DD H 3-286A, drilled downward at 33° below 300 Level (see Fig. 3). Two ore sections were found in this hole; the first, from 63 to 73 feet may correspond to the ore mined in and above the 300 Level in the northeast part of Stope 3-390. The second ore section, extending from 88 to 96 feet in the drill hole, is believed to correspond to the faulted part, east of Fault G, of the ore exposed at the end of the aforementioned short drift. Both ore sections in the DD core are in granite. The possibilities of a large and valuable ore body on and above 300 Level (as well as below), to the east of Fault G and south-east of Stope 390 are thus very good.

14) An even further northeastward extension of this same possible ore body may be represented by the 10-foot ore section found (from 117 to 127 feet) in DD H 3-296A.

11) DD holes 100 feet long or more should be driven on either side, as well as above and below the ore intercept in DD H 3-276. If the results are promising a crosscut should be driven out on 300 Level (already begun - Jan./55) and the ore body further explored and then developed if warranted.

Beyond this particular occurrence, it is necessary to drill other holes into the granite hanging wall on 300, 400 and lower levels, in a systematic way.

12) A shallow winze could be sunk from the DD station on 300 Level, or several DD holes could be bored steeply upward from the 400 Level crosscut north of spad 408, in order to get a preliminary idea of the importance of this body.

13) Clean out the short drift. Advance the heading N45E about 80 feet, following ore after it is found. Raise on the ore.

14) After further exploratory drilling, the ore-bearing area could best be reached by a further northeastward extension of the new drift proposed under 13) above.

15) Tactite was intersected in DD H 3-168A a few yards southwest of Stope 560 W. It may be a continuation of the large body partly mined in that stope.

16) North of the wide 500 ore body on 300 Level, narrow tactite sections have been cut in DD Holes 3-95A, 3-64A, 3-177A and 3-174A (see Figure 3 and Section VI). The connection, if any, with the main ore body, is not known. The ore possibilities here are fairly good.

17) DD Hole 3-139A crossed Fault B below the northeast end of Stope 800 and ore sections aggregating 24 feet were found on the south side (see Fig. 3). This ore is a faulted segment of the ore in 800 and 900 stopes. Its extent is unknown but might be great. It may extend upward above the hanging wall of 800 and 900 stopes, as well as downward; and it may extend southwestward along Fault B, possibly connecting with the ore in the southeast corner of Stope 620 C, above 400 Level.

18) Narrow ore sections were found in DD Holes 3-270, 3-272 and 3-273, at the northeast end of 300 Level (see Fig. 3). These represent the upper edge of Ore Reserve Block No. 1 (see preceding description of ore reserves). Lateral and upward continuations may exist.

19) Many of the stopes on 300 Level are no longer accessible, so it is impossible to judge their possibilities of additional ore. There are many drift pillars along the level, between old stopes, that might contain in the aggregate a worthwhile tonnage of ore.

20) Between Section VI and Section VII (Figs. 13 and 14), immediately above and beneath 300 Level, is a wide body of tactite bounded on the south by Fault B (see Fig. 3). The hanging wall part of it, near the fault, has been partly mined on stopes 3-560 (above the level) and in 4-620B, below the level. Near the footwall, a small part of it was mined

15) Drift southwest 50 feet from the end of the level beneath Stope 560 W.

16) Crosscut to the ore, then follow it with a drift. Diamond drill this area from 300 Level both downward and upward.

17) The south side of Fault B on 300 and 400 levels should be intensively explored by diamond drilling and cross-cutting. The drill sites and direction of the holes can be selected by the resident engineer.

18) Drift at least 100 feet northeast on contact from the northeast end of the level near Spad 337 I. Raise on ore if good ore widths are found.

19) Where old stopes can easily be made accessible, this should be done, and they should be mapped and sampled. Further exploration or development could proceed, or not, upon the basis of these findings. The drift pillars on the level should be closely examined and a complete list made of them for reference during future pillar-robbing operations. Filled stopes must presumably remain inaccessible until it is decided to reopen them to mine residual ore, if any is supposed to exist.

20) This block may contain minable quantities of ore, and it should be investigated by two raises driven in the tactite on 300 Level.

Below the level, it could best be explored by a sublevel drift, with short crosscuts where necessary, running north-

in Stope 560E (Figs. 3 and 6). In the footwall drift extending east from Stope 560E toward spad 337D, the grade of the tactite appears to be very low.

Above the 300 Level, the following DD holes were bored with indicated results:

DDE 3-100A	Plus 45°	- grade submarginal
3- 99A	Plus 20°	- grade marginal
3-101A	Plus 20°	- grade marginal
3-102A	Plus 45°	- grade submarginal

Below the 300 Level, the following DD holes were bored with the indicated results:

3-103A	-60°	grade submarginal
3-104A	-56°	ore
3-64A	- 5°	ore?
3-69A	-24°	marginal

It will be seen from this data that part of the tactite below the level appears to be ore, and the rest is marginal or submarginal. This block has accordingly been left out of the ore reserve because of its apparent general low grade, and the uncertainty of how much ore it might contain. Ore that may possibly lie as a floor pillar in the back of the stope 620B has also been omitted from the ore reserve because the back is timbered and the ore cannot be seen.

On Section VI (Fig. 13) it will be noted that the ore appears to be divided by a limestone partition into an upper branch directly beneath Fault B and a lower branch. The lower branch might be low grade, corresponding to the low grade section in the footwall part of the body in the 300 Drift above.

21) The possibilities of ore additional to that estimated in ore reserve Blocks XI, XII, XIII, and XIV have already been alluded to in the description of the ore reserves.

westerly from the new raise 620, on the 11th floor of Stope 620B. Alternatively this drift could be driven from one of the upper floors of Stope 620C.

400 Level: 22) Near the main shaft, west of the short crosscut starting at spad 404, tactite was intersected in DD Holes 4-41A, 4-48A, and 4-49A. Most of it has a low WO₂ content. At this place the granite contact makes a pronounced curve (see Fig. 4) and the possibility of an important ore body is rather good, in spite of the low assays obtained so far. The mining of whatever ore exists would presumably be postponed until the end of the life of the mine, because of the proximity to the main shaft.

23) At the end of the short contact drift running east from spad 408, beneath Stope 340E, good ore, although narrow, is visible (see Fig. 4 and the sketch of the face thereon). This ore appears to be a part of the same body as was intersected in DD H 4-115A and in 3-285A (see Section VII), and its extension even farther northeastward is indicated by the log of DDE 3-286A.

The downward extension of the ore in the sill of Stope 3-390 is definitely indicated by DDE 3-284A, and 3-285A. It would appear that this body merges with the one lying immediately to the south at some place between 300 and 400 levels (see Section VII (Fig. 14) and Fig. 3).

There is here, therefore, the strong possibility of an ore body of great importance.

24) In this sill of 300 Level (see Fig. 3), several small ore bodies can be seen below Stope 3-550. This ore extends below 300 Level, as shown by ore sections in DD Holes 3-77A and in 3-290A and 3-293A. In 3-293A, the ore was found from 65 to 75 feet below the level. In DD Holes 4-106A, 4-107A, 4-108A, and 4-109A, what is apparently the same ore was intersected at reduced widths, on the 400 Level (see Fig. 4).

25) Ore is reported to be on 300 Level, directly beneath Stope 3-460, but the downward extent and direction of this ore are problematical (see Sections VII and VIII). DD Holes 3-72A, 3-75A, and 3-76A intersected tactite some of which was of ore grade. Judging from the DD H logs it seems likely that the ore body flattens somewhat below the sill,

22) Further diamond drilling, upward and downward from 400 Level is recommended.

23) On 400 Level, drift west 80 feet following the contact or the ore. Drive a raise on the ore to connect with the 300 Level drift proposed in 13) above, which presumably would follow the same ore body.

Additional diamond drilling should be done from the 400 drift between spads 410 and 411, in directions south and southeast, horizontally, as well as inclined upward and downward.

24) This ore can be explored by crosscutting 40 feet northeast from the end of the old 400 Level crosscut (spad 408A) to the ore as shown in DDE 4-107A, and by drifting on the ore a short distance, with a raise to 300 Level.

25) This possibility may be best explored by diamond drilling steeply downward along the line of Section VII on 300 Level, between spads 315 and 317 (see Fig. 3), and some of the holes should be inclined toward the east. If a worthwhile ore body is delineated, mining might conveniently proceed from Stope 4-500H, after it has been

and plunges at a moderate angle into Fault B, on the south side of Stope 4-620B (see Fig. 6, plan of 620B Stope, 11th floor above 400 Level). Possibly, also, the ore may terminate before it reaches Fault B. There is an excellent chance of a large mass of ore in this area directly beneath 300 Level sill, and abutting against Fault B.

26) Directly above ore reserve Block VIII which lies mainly in the back of Stope 4-580E (see earlier descriptions of Stope 4-580E and of Block VIII), as well as upward to the northeast and to the southwest, additional ore may very well lie along the hanging walls of Faults B and C (see Sections IV and V). There is the scant possibility that the ore visible in the northeast face of Stope 580E, on the 4th and 5th floors (Fig. 7) pitches gently upward, more or less following Faults C and B on their south sides to a union with the ore found south of Fault B on 300 Level, DDH 3-139A (see Fig. 3).

27) Northwest of Raise 4-620M (Fig. 4), in DD Holes 4-156A and 4-157A, good ore sections were cut, lying south of the projection of Fault B. This ore appears to lie directly beneath Stope 620B, although the position of this stope is not known exactly except on the upper floors. Presumably this ore abuts against Fault B on the northeast and continues some unknown distance toward the southwest (see Fig. 4). The ore mined in Stope 4-685 continues southwestward along the 400 Level drift, and runs into the northwest wall of the drift near the point where Fault B crosses the drift. A short distance northwest of the drift, the same ore was found in DD Holes 4-144A, 4-245A, and 4-247A. Apparently this ore continues southwestward until it is cut off by Fault B. Additionally, there may be even more ore to the north of this body.

The ore lying north of Fault B in this locality is the downward extension of the ore visible in the northwest part of Stope 620C, which in turn connects with the ore seen along the northeast face of Stope 620B (11th floor) and also with that visible in the crosscut to Raise 620, in the same stope (see Fig. 6 and Fig. 12, Section V). This mass of ore is probably large, but it has been little explored.

extended north to Fault B (see Section VI).

26) Stope 580E, as it is continued upward and outward, should eventually show what ore continuations are possible, as long as the stope is made to extend always to the walls of the ore and the geology is carefully observed and mapped.

Diamond drilling should be carried out from the 11th floor of Stope 620B with the holes pointed southeast along Section V, and south along Section IV, at vertical angles of minus 30, zero, and plus 30 degrees. These holes might possibly be substituted by some of those recommended under 17) above.

27) The ore lying both northeast and southwest of Fault B should be followed by a drift running 100 feet southwest from spad 415. It should also be crosscut and drifted on the 3rd and 6th floors of Stope 620C, and stoped from the 400 level if the grade warrants.

28) The ore showing in 1000 crosscut, 400 Level, below 1000 Stope, extends southwestward an unknown distance. It might possibly connect with the bulge of tactite that runs out into the limestone at the foot of Raise 745R.

29) The possibility of ore in some places south of Fault B in Stope 4-1050 has been mentioned (see description of Stope 4-1050).

30) The ore in the drift at the northeast end of the 400 level is very narrow, but further exploration of the contact in a northeastward direction should be done.

31) The possibility of additional ore, above and beyond that estimated in the ore reserve, has been mentioned under Blocks III, V, VII, VIII, and X. (See corresponding description of these ore reserve blocks, given in an earlier section of this report.)

Below 400 Level: 32) In the chapter on Geology, mention has been made of the possible structure of the ore deposit at greater depth, below the 400 level (see Sketch 1). The ore possibilities here are favorable. There has been little exploration in depth, except in the immediate vicinity of the 1000 shaft. Elsewhere only an occasional DD hole descends below the elevation of the 400 Level.

28) Drift southwest on ore from 1000 crosscut.

30) Continue drift northeast along contact at least 100 feet.

32) There are many possibilities for diamond drilling below 400 Level, because this deeper part of the deposit has remained almost unexplored. One scheme, that may give a great deal of information in a short time, is the following:

On 400 Level, crosscut 80 feet to the southeast from the drift at a point near spot 419R, to a point near coordinates:

10400 E
10600 E

Here a diamond drill station should be cut, and DD holes drilled as follows to intersect the downward extensions of the ore:

Vertical	
North	minus 30, 45, 60 degrees
Northwest	minus 30, 45, 60 degrees
West	minus 30, 45, 60 degrees
Southwest	minus 30, 45, 60 degrees

All holes should be drilled at least 200 feet or so. Once the ore has been roughly delineated by these holes, additional holes should be bored to complete the picture and

Lateral Extensions: 33) The granite-limestone contact to the northeast and to the southwest of the mine workings was examined only briefly at the surface. Diamond drilling southwest of the mine from the surface, in 1954, resulted disappointingly.

The probability is that by far the greater part of the more profitable ore is localized along and near the pre-granite, northwest fault, and that the exploration of the contact at distances of more than 400 or 500 feet to the northeast or southwest of this fault would not result in important discoveries. There remains, however, the possibility that another similar pre-granite fault might occur somewhere near the mine, and might make ore. The surface geology (Fig. 1) does not indicate the presence of another such fault, however.

Ore in Granite: 34) The existence of ore in the granite at some distance from the contact has been noted on earlier pages. Other ore deposits of the contact-metasomatic type have been known to include ore bodies in the intrusive rock rather far removed from the contact itself, so this occurrence is not unique. It requires additional study.

to extend the explored area. It may be possible, with close drilling, to block out a sizeable tonnage in this way.

The 1000 shaft, which has reached 500 Level, should be continued down to 600 Level as quickly as possible.

33) The possibilities of lateral extensions of the ore beyond the present limits of the mine should receive more extended consideration than it is possible to give on the basis of the present study. Nonetheless, drifting northeast on 200, 300 and 400 levels for short distances should proceed in accordance with the recommendations given earlier in this report.

34) The surface occurrences of ore in granite should be studied, mapped, and, if they seem important, their extensions should be explored by diamond drilling from the surface.

The desirability of underground diamond drilling outward into the granite at various levels has been noted in foregoing recommendations.

MAIN CONCLUSIONS AND RECOMMENDATIONS

1. The ore reserve, estimated in a preliminary way as of January 22, 1955, is 58,350 short tons with an average grade of 1.17% WO₃. Assuming 100% recovery in the mine and 83% recovery in the mill, this ore should yield concentrates containing a total of 56,725 short-ton units of WO₃ having a gross value, at the price of \$63.00 per unit, of about \$3,570,000.00. This ore reserve would be sufficient to feed the mill for about one year and four months at the rate of 125 tons per day.
2. The ore possibilities above the 400 Level, in addition to the reserve, are excellent. Specific localities have been listed in the foregoing chapter. The careful exploration of these localities might well block out an additional reserve of 25,000 to 100,000 tons.
3. No geological evidence was seen that indicated that the ore would cut off at the shallow depth below 400 Level. The possibilities in depth now seem favorable, but the reality will depend largely on the structural behaviour of the contact at depth, especially of the pre-granite fault.
4. Many recommendations for exploration and development have been given in the preceding chapter. In addition to these, more diamond drilling should be carried out in the ore reserve blocks themselves, in order to verify the conclusions about tonnage and grade given in this report.
5. The ore drilling in the future should be consciously divided into two classes:
 - a) Close drilling, to help establish ore reserves and to determine the size, shape and grade of each ore occurrence in advance of mining, thus permitting the planning of the most advantageous method of development and mining.
 - b) Wildcatting, to explore areas where ore might exist, but of which there is no definite indication.

6. Drifting, crosscutting and raising for purposes of exploration and development should likewise be carried out in places where diamond drilling has already delineated ore, and in other places where the diamond drilling method is somehow handicapped.
7. The exploration of working stopes by systematic geologic mapping is very important in this mine, in order that ore is not inadvertently left in the stopes when they are backfilled.
8. The geology of the mine is complicated enough to require the continuous services of a trained and experienced mining geologist, or of a mining engineer with ample experience in geological and exploratory work. It seems essential that such a man be hired. His duties would include:
 - a) The geological mapping of new workings
 - b) Review of the geology of old workings
 - c) The preparation of geological maps and sections in such a way that new information is always posted up to date, and a comprehensive view of the known geology of the mine can always be easily had
 - d) The logging of drill cores
 - e) Petrographic and mineralogical investigations
 - f) The preparation of ore reserve estimates every six months
 - g) The direction of the exploration and development program, under the general supervision of the management.
9. Every six months, an exploration and development program for the next six months' period should be prepared by consultation among the managers and technical staff. The program should be reduced to writing and should give a description of each project proposed as well as its immediate objective. Once determined, the program should be followed rather rigorously. Progress reports should be prepared monthly showing projects completed

and in progress, results achieved, and the percentage completion of the entire program. A final report also should be made. The chief objective of this continuing exploration program would be to discover and block out ore reserves sufficient to keep the mill operating at least two to three years into the future. A second objective is to promote more efficient mining through a greater knowledge of the geology, and a third objective is to increase the selling price of the mine in the event that it should be decided to sell it. Practical obstacles that may exist to the realization of the various necessary exploration projects should be analyzed and steps taken to solve them.

10. Diamond drill cores, at least those containing ore, should be saved, labelled and stored for future reference. This means that the tactite cores must be split before assaying. This precaution is necessary to be able to prove ore discoveries and reserve calculations to any future prospective purchaser of the mining property.
11. An additional diamond drill should be bought.
12. Detailed petrographic and mineralogical studies should be made of the ore and rocks. Chemical or spectrographic analyses of the ore should be made to determine whether other valuable constituents than tungsten are present.

W. C. Stoll

WALTER C. STOLL

Seattle, Washington

February 18, 1955

206

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REV. SCHMIDT, 1937

	3	5	8	•	+			
2	2	7	1	•	+			
4	5	2	1	•	+			
9	5	3	4	•	+			
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1	0	5	7	0	•	+		
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1	2	4	4	0	•	+		
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	8	8	4	4	•	+		
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2	8	6	7	4	6	•	◊	

1950

MEMORANDUM

THE GOLDFIELD CONSOLIDATED MINES COMPANY

SAN FRANCISCO, CALIFORNIA

6806
206
File 22

SUBJECT YANKEE TUNGSTEN MINE

DATE March 29, 1943

TO Mr. Wingfield

FROM Julian

M

Enclosed is map on which is shown the surface geology of the interesting portion of the claims, together with a sketch of the prospect work at "A". Also enclosed is a 20 scale sketch showing the veins from March 5th to 27th, the date of my last visit. As marked in the latter, two additional showings of ore have been encountered. While of good grade, they appear to be bunches only.

It will be noted also the heading lacks only a few feet of coming under the last lime area which showed good ore on surface. The work during this week should prove whether this last lime area is also a floating remnant. If so, the development will be discontinued and such ore as is available will be extracted and stockpiled at the mill.

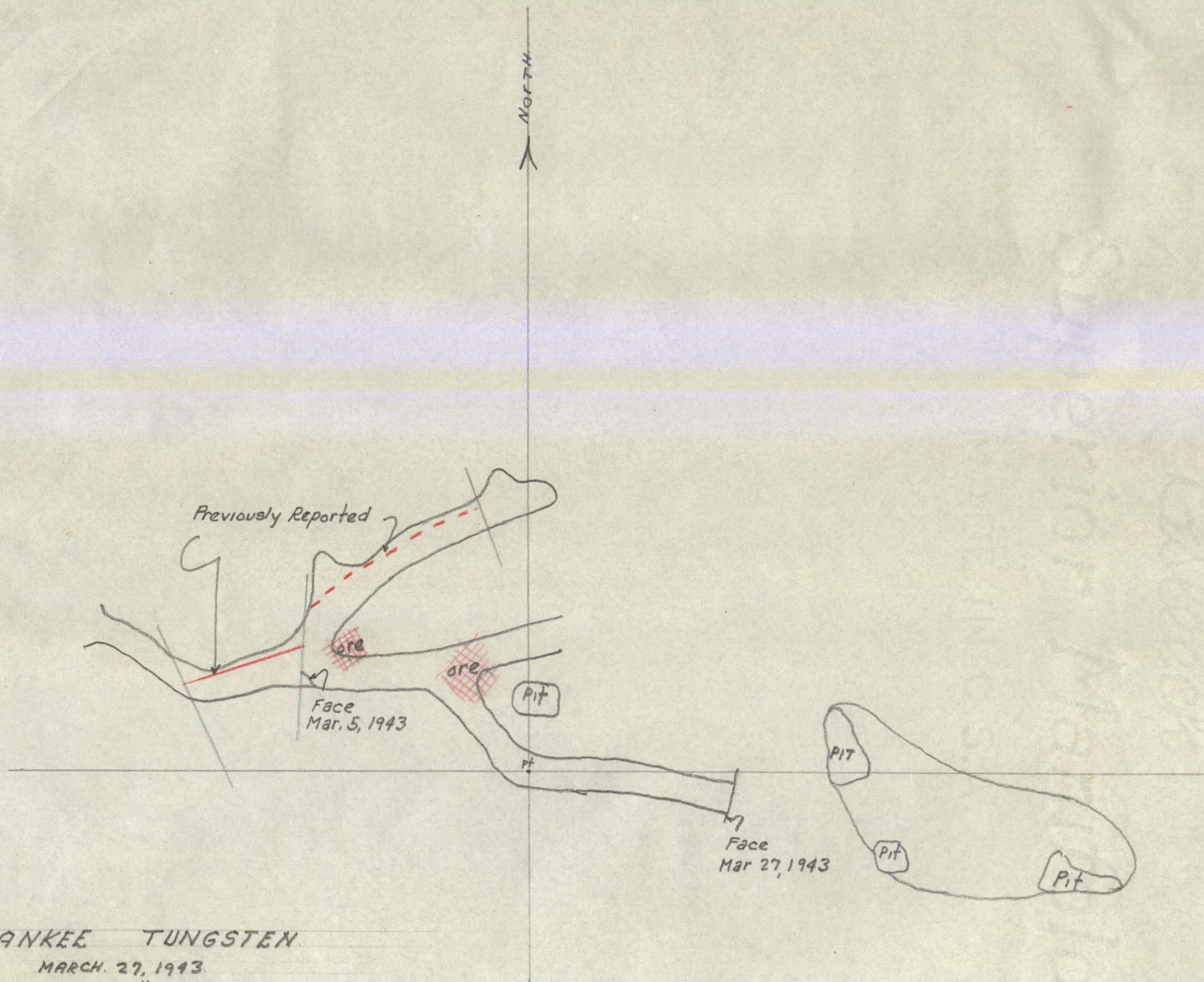
At point "B", a 3' streak of high grade ore was exposed at surface on the lime-granite contact. It was prospected by an open pit and shallow shaft in which the values disappeared suddenly at a 10' depth.

The chance for developing additional ore would lie in prospecting the contact between the granite and lime, which occurs at unknown depths under the black metamorphic rock, shown in green on the map. However, this is blind prospecting and the chance of success does not appear to justify the work.

Bureau of Mines engineers have recently examined the district and recommended that the Bureau undertake a development (diamond drilling) program on the Desert Scheelite property adjoining. They state that if this work is undertaken, they will include a hole or two on Yankee Claim to prospect the contact at depth.

Moore appears to have all the equipment necessary, and expects to get his little mill in operation April 5th.

Julian

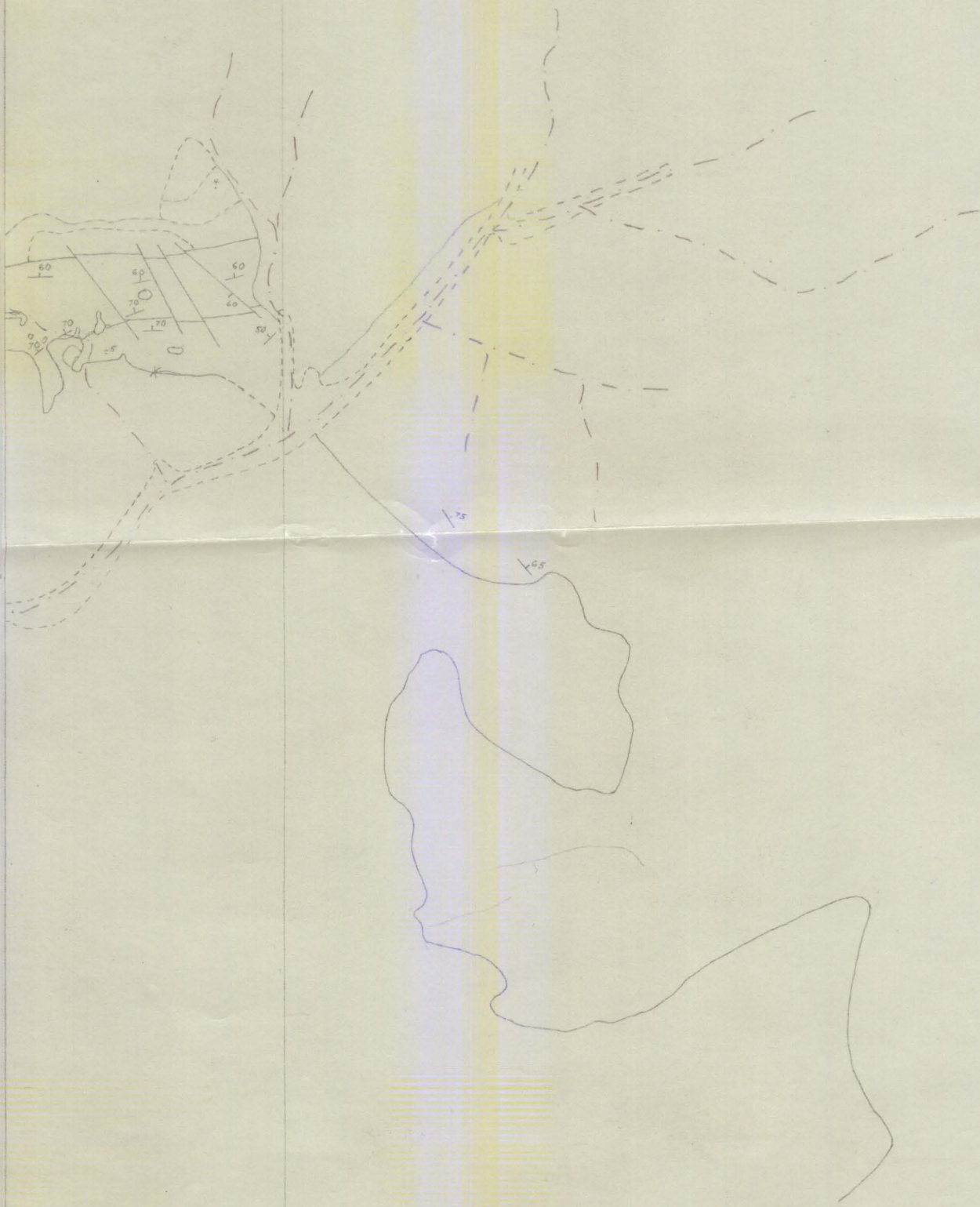


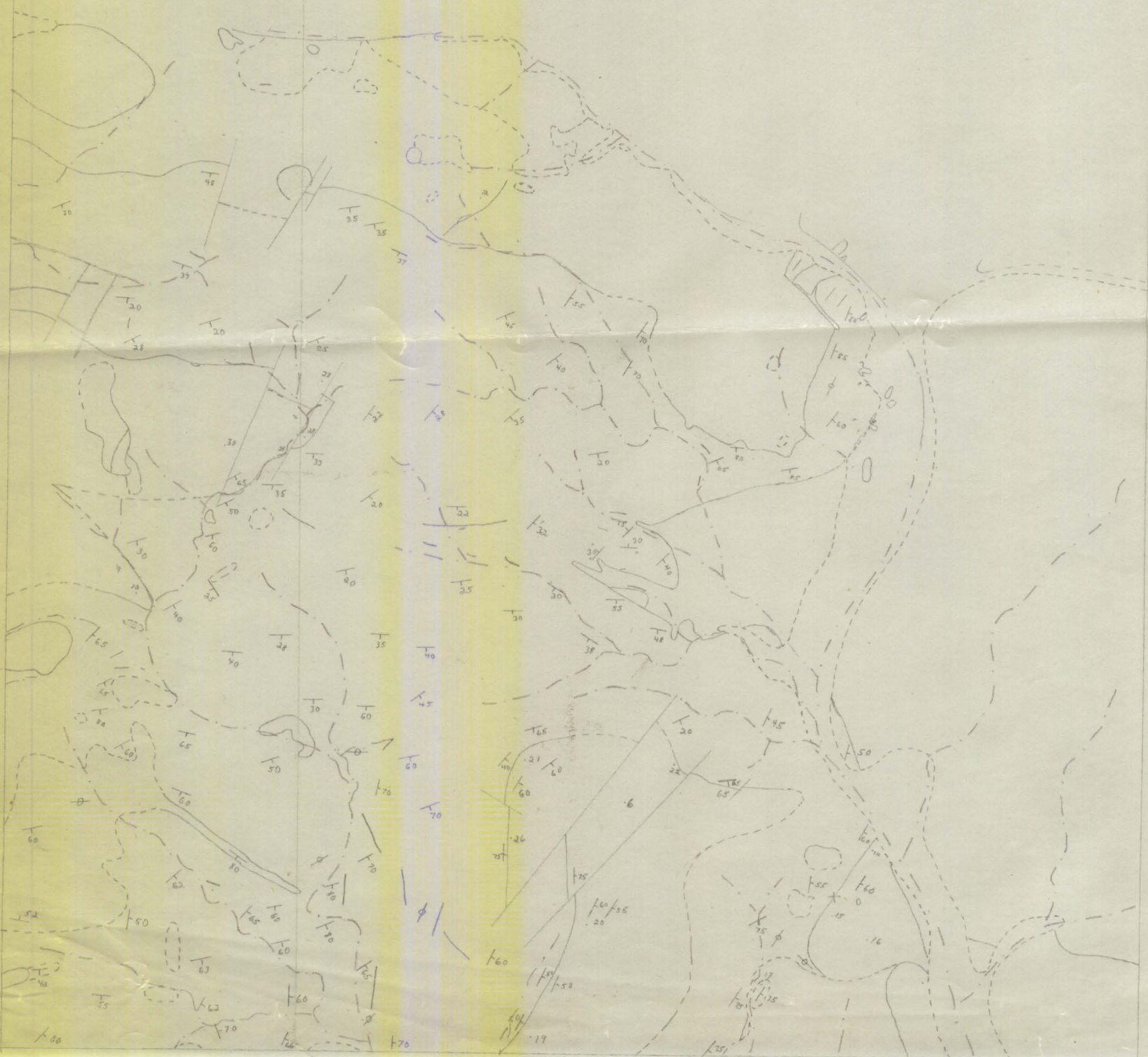
YANKEE TUNGSTEN.

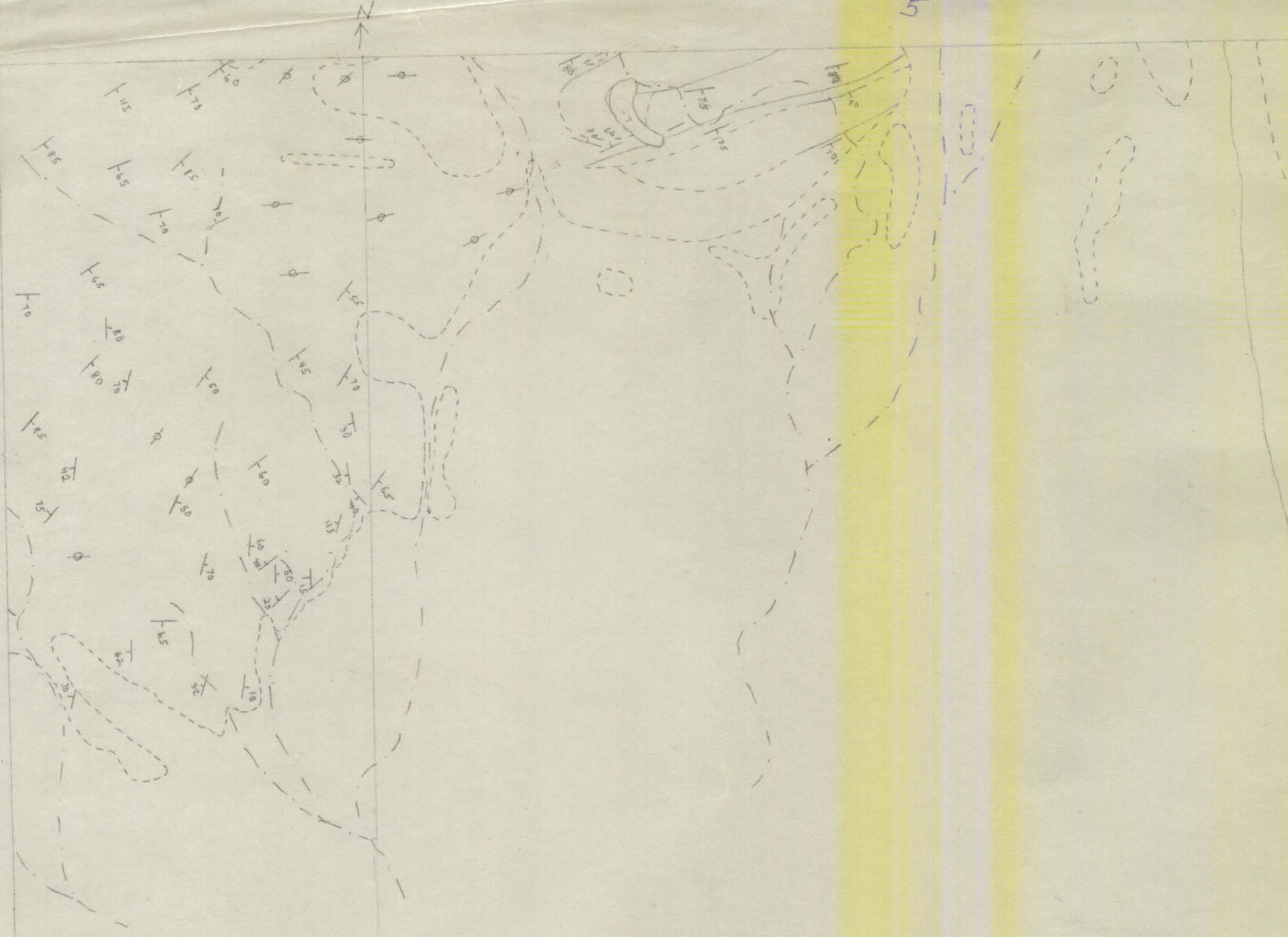
MARCH 27, 1943.

SCALE 1" = 20'

2







- 1- MV in tongue
- 2- MV on ridge NW of Mine.
- 3- Shale W Hooper No. 2
- 4- MV N. of Hooper OK
- 5- Hornfels "
- 6-
- 7- Diorite SW Hooper No. 2
- 8- tuff " " "
- 9- MV SW good LMR - ls etc.
- 10- MV " " " "
- 11- TV? dike on etc. south lead - brite mine
- 12- TV dike along Rockville road.
- 13- Dike SE of good LMR - ls etc.
- 14- Hornfels NE Hooper No. 2
- 15- " E " "
- 16- " SE " "
- 17- " S " "
- 18- " on good UMR - ls etc.
- 19- " " " "
- 20- " " " "
- 21- " " " "
- 22- " " " "
- 23- OK MV along road SE of gray shale
- 24- OK MV - on NW side of lead NW of Mine.
- 25- MV - intrusives NW of mine
- 26-
- 27- Marble just N of main fault.
- 28- OK Hornfels on good LMR - ls etc.
- 29- MV " " " "
- 30- " " " "

R-31-MV

39: *homfels - mostly fine grained fty.* - sim. to 5

40 " " " " " " " "

38 " " " " " "



Box 1110, Ely, Nevada

November 22, 1943

Mr. A. R. Kinkel, Jr.
U. S. Geological Survey
506 Federal Building
Salt Lake City, Utah

Nevada Scheelite Mine, Rawhide, Nevada

Dear Art:

I spent the afternoon and evening of November 19 and all day November 20 at the Nevada Scheelite mine, Rawhide district, with Bob Stopper reviewing the Bureau of Mines drill program.

As you know, Bureau of Mines hole 1, inclined at 73° along 10,030 N, did not intersect the contact between granite and limestone in the expected position; the hole was abandoned because of drilling difficulties at a point approximately 100 feet deeper than originally planned. In order to locate the contact and determine what could be expected from future surface drilling, Nevada Scheelite Co. drilled a hole from 10,060 N, 10,230 E on the 200 level of the mine, inclined 60° S. 77° E., and struck good ore. This hole showed a bench in the contact with a dip at least locally at a low angle to the west; so the Company is now drilling a vertical hole from the same station to see if the flat bench continues westward. Meanwhile, the Bureau has continued to drill other surface holes not affected by the information from hole 1. Holes have been completed beneath outcrops at 10,510 N, 10, 190 E, and at 9,535 N, 9,550 E.; one is just being started to strike about the 200 level beneath the outcrop at 9,700 N, 9,900 E. I have suggested that this last hole be drilled at -45° rather than steeper because of the uncertainties as to the dip of the contact.

Because of the unexpected difficulties encountered in hole 1, successfully solved by the Company's first underground hole, the Bureau's project engineer, John Price, in agreement with Stopper, is trying to have the drill contract changed to permit both surface and underground drilling. Sullivan, the contractor, has agreed to do underground drilling. Neither the Bureau's office in Salt Lake City nor the Mine's office in Los Angeles have yet given written consent.

My own opinion as to the general picture of the contact beneath the main orebody: the bottom of the main shaft, 85 feet beneath the 200 level, shows that the contact remains essentially vertical to that depth. Drill hole 1 and the underground hole show that the contact 250 feet northeast of the shaft has reversed its dip beneath the level; this reversal has not been proved to be more than local. I suspect that the vertical underground hole now being drilled will show that the contact steepens again downward, with a lobe of limestone about 80 feet wide being eliminated below the 200 level. The ultimate result of this benching will be the straightening of the contact with complete elimination of the bulge containing the big orebodies, but this result is not to be expected until a greater depth is reached.

Kinkel: Rawhide -2-

Inasmuch as the contacts cannot be projected downward with certainty, the areas to be explored are a long distance from the surface, and the granite is difficult to drill because of fracturing, it seems reasonable and economical to drill several holes downward beneath the 200 level to depths of 100 or 200 feet in order to test the structure. If the contact reverses its dip, then the orebodies can be tested further by underground drilling. If the contact continues to dip northeasterly in the area of proposed hole 2, then surface drilling may again be feasible. I have discussed with Bob the inadvisability of interpreting the entire underground picture on the basis of the holes drilled thus far.

Bob seems to have the situation well in hand. Inasmuch as most holes will depend on preceding ones, both he and you, as well as the project, would benefit by your visiting the mine as frequently as possible.

Sincerely yours,

Dwight M. Lemmon

cc Nolan
Stopper
Krauskopf

duplicate

Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad B. Krauskopf

June 1944

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*This is not the
correct pagination
for this report.
M.L.C.-7.25-58*

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Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad B. Krauskopf

June 1944

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Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad B. Krauskopf

June 1944

- - - - -

Abstract

Contact metamorphic tungsten deposits occur 4 miles east of Rawhide, Mineral County, Nevada, where a small granite stock, intrusive into Mesozoic limestone hornfels and metavolcanic rocks, is exposed in the midst of far more extensive Tertiary volcanic rocks. Scheelite, the tungsten-bearing mineral, is found in bodies of tactite, a dark-colored silicate rock composed essentially of garnet, epidote, calcite, quartz, and minor amounts of pyrite and magnetite. The tactite occurs at the contact between limestone and granite, and in lenses extending along bedding into limestone from the granite; it is present only along small portions of the contact but where present it ranges in thickness from 2 to 50 feet. Much of the tactite is scheelite-bearing, and large portions of it contain from 0.5 to 1.5 percent of WO_3 .

Production to May 1944 was approximately 57,000 units of WO_3 from 70,000 tons of ore, a yield of 0.81 units per ton from ore which probably contained about 1.5 percent of WO_3 . Over 90 percent of this yield was from the Nevada Scheelite mine, the only important deposit in the district. In April 1944, reserves at this property were estimated at 191,950 tons of indicated ore containing 175,413 units of WO_3 , and 116,300 tons of inferred ore containing 96,000 units of WO_3 ; the tailings pile at the mill, at Dead Horse Wells 9 miles south of the mine

comprises more than 50,000 tons of material containing 24,500 units of WO_3 (0.49%). Reserves from other properties in the district amount to only a few thousand tons.

Introduction

Contact metamorphic tungsten deposits occur at elevations of 5000 to 6000 feet in the southern part of the Sand Springs Range 4 miles east of the nearly deserted town of Rawhide, Nevada. The area is in the Regent Mining district in the extreme northern part of Mineral County, in secs. 1 and 12, T.13 N., R.32 E., Mt. Diablo Base and Meridian (fig 1). It is about 25 miles airline east of Schurz and about

Figure 1. Index map of Nevada, showing location of tungsten deposits near Rawhide.

40 miles airline southeast of Fallon. The region is shown near the south border of the Carson Sink quadrangle.

The best road to the district is a 22-mile dirt road which leaves U. S. Highway 50 about 35 miles east of Fallon. Nearly as good is a 30-mile dirt road connecting Rawhide with Schurz, the nearest railroad point. The area can be reached also by poor desert roads from Luning and Hawthorne.

Scheelite, the tungsten-bearing mineral, was first recognized in the district in 1930, when the deposit, later known as the Nevada Scheelite or Leonard mine, was discovered. No extensive development was undertaken until 1936 when Nevada Scheelite, Inc. (mining affiliate of Mills Alloys, Inc. of Los Angeles, California) acquired the property and built a small mill at Dead Horse Wells, 9 miles south of the deposit on a playa where water is available in wells. This mill was subsequently enlarged to 80 tons daily capacity, and was used to treat most of the ore mined in the district.

About 1940, Beverly Moore built a small mill about 7 miles south of the Nevada Scheelite mine. This mill treated ore from the Hooper No. 1 mine, as well as small amounts of custom ore. It was dismantled in 1944.

Production of the district to the end of April 1944 was about 57,000 units of WO_3 from 70,000 tons of ore. At least 90 percent of this yield was from the Nevada Scheelite mine, and the remainder from the Viking's Daughter, the Hooper No. 1, the Yankee Girl, and the Eed-a-how deposits.

This report is a compilation of work done for the Geological Survey by several geologists at different times. In the summer of 1942, the Stanford University field course in geology, known as the Stanford Geological Survey, directed by Malcolm B. Kildale and partly financed under a cooperative agreement with the U. S. Geological Survey, made topographic and reconnaissance geologic maps of the district. These maps and the accompanying report were made available to the U. S. Geological Survey. In three weeks of June 1943, Konrad B. Krauskopf and Robert Stopper mapped the principal deposits in detail. From October 1943 to February 1944, Stopper served as geological adviser for a Bureau of Mines exploratory program, revised mine maps, and prepared a geologic map covering an area of about 4 square miles in the vicinity of the Nevada Scheelite mine (fig. 2). Dwight M. Lemmon,

Figure 2. Geologic map of the vicinity of the tungsten deposits near Rawhide, Nevada.

of the Geological Survey, visited the area at numerous times while field work was under way, advised on exploration, and in August 1945 with S. W. Hobbs mapped about 200 feet of new workings on the 200 level of the Nevada Scheelite mine. Lemmon also revised this report for ^{publication} ~~release~~.

The Bureau of Mines, in cooperation with the Geological Survey, explored the Nevada Scheelite properties with diamond drills from October 1943 to February 1944. Eleven holes totalling 2,365 feet in length were drilled under the direction of George W. Holmes, John Price, and Robert W. Geehan, each of whom was in turn, engineer in charge of the project.

Geology

Rocks

The rocks exposed in the vicinity of the tungsten deposits consist of a metamorphosed series of interbedded volcanic and sedimentary rocks of Mesozoic age, which ^{are} intruded by granite and dikes of several varieties of Mesozoic age and Cenozoic volcanic rocks. Part of the limestone adjoining the granite has been altered by contact metamorphism to tactite, a portion of which contains scheelite in commercial amount. The tactite bodies are too small to be shown on the general map of the district (fig. 2), but are shown on the more detailed maps.

The metamorphosed rocks consist of the following five stratigraphic units, starting with the oldest: (1) lower metavolcanic rocks, (2) lower hornfels, (3) limestone, (4) upper hornfels, and (5) upper metavolcanic rocks. The thicknesses of the metavolcanic formations are unknown, but each appears to be hundreds or even thousands of feet. The limestone is about 750 feet thick in the southwestern part of the area mapped, (fig. 2), but may be only 400 feet thick north of the Nevada Scheelite mine. On the basis of lithology, these metamorphic rocks are tentatively referred to the Excelsior formation of Middle Triassic age described by Muller and Ferguson /

/ Muller, S. W., and Ferguson, H. G., Mesozoic Stratigraphy of the Hawthorne and Tonopah Quadrangles, Nevada, Geol. Soc. Am., Bull., vol. 50, pp. 1573-1624, 1939.

The lower metavolcanic rocks are altered andesite, dacite, and basalt flows, and interbedded lenticular agglomerate. A few small conglomerate lenses are interbedded with the meta-volcanic rocks. Epidote is abundant along joint planes. Bedding is not determinable.

The lower hornfels is composed mainly of quartz in distinct, equidimensional grains up to 0.2 mm. in diameter, enclosed in a ground-mass of finer quartz, feldspar, sericite, and chlorite. The rock is of uniform texture

and composition.

The limestone, where least metamorphosed, is a dark gray, finely crystalline rock composed almost entirely of calcite. In most of the area mapped, it has been recrystallized to a coarser-grained rock and has been bleached to a white or buff color for distances of half a mile or more from the granite. Adjoining granite contacts, it has been changed locally to dark-colored tactite which occurs in bodies up to 50 feet thick.

The upper hornfels is of variable composition and includes types in which quartz and garnet, quartz and sericite, andalusite, or andalusite and mica are prominent.

The upper metavolcanic rocks are mainly massive andesite flows with uniform texture and composition. Individual flows are not discernible. In thin section, the rock shows abundant, indistinct plagioclase phenocrysts, probably andesine up to 5 mm. long in a groundmass of the same mineral. Scattered through the groundmass-feldspar are small grains of magnetite, sericite, green mica, and hornblende. The mica and hornblende are concentrated, often with epidote, in spots whose shape suggests pseudomorphism after pyroxene.

The granite intrusive ranges from granite to granodiorite in composition. It is fine- to medium - grained with normal granitic texture. Biotite is the most abundant mafic mineral, often the only one, although hornblende predominates locally near contacts. Foliation is practically absent. The granite is probably a correlative of similar rocks in the Sierra Nevada, and hence of Upper Jurassic age.

The Cenozoic volcanic rocks are chiefly welded tuff and andesite, and are exposed only on the edges of the area mapped in figure 2. They are part of the volcanics that cover the southwest part of the Sand Springs range.

Locally irregular areas of the older rocks have been hydrothermally altered, a process accompanied by the introduction of pyrite. North of the Nevada Scheelite mine the alteration has produced several areas of a soft, conspicuously iron-stained material consisting chiefly of sericite, quartz, clay minerals, and pyrite. Sometimes original textures are sufficiently preserved to make possible identification of these rocks as schist, meta-volcanics, or granite, but more often the alteration is so complete that original textures are unrecognizable. About three-quarters of a mile southwest of the Nevada Scheelite mine, and half a mile away from the nearest exposed granite, irregular portions of the limestone are weathered reddish-brown by oxidation of fine-grained pyrite disseminated through the rock. Alteration of the noncalcareous rocks is probably related to Tertiary volcanism. Pyritization of the limestone may be similarly explained, although the distribution of the altered limestone areas at the outer limit of the bleached, recrystallized aureole surrounding the intrusive suggests a possible genetic relationship with the granite.

Structure

The metavolcanic rocks, limestone, and hornfels (Excelsior formation) were folded and faulted prior to introduction of granite. The limestone is well-bedded except where completely recrystallized, but the metavolcanic rocks are massive; so the details of the structure are gained only from the limestone. The beds in general dip steeply southeastward. If local crumpling be disregarded the rocks are found to be folded into an open anticline and complementary syncline, which are superimposed across the regional dip and and plunge in the same direction [~]southeast. The axis of the anticline is 500 feet southwest of the Nevada Scheelite shaft, and the axis of the syncline about half a mile southwest of the shaft. The folds have been disrupted by 2 sets of pre-granite normal faults that cause repetition of beds.

One set of faults strikes northwesterly and dips steeply to the northeast, the other strikes northeasterly and dips steeply to the northwest. Displacements, which range up to 1000 feet, are mostly down the dip.

Emplacement of the granite intrusive was controlled in part by the earlier faults, in part by the relative susceptibility of the rocks invaded. Formation of the embayment in the limestone between the Hooper No. 1 and Nevada Scheelite shafts was facilitated by fault intersections. Similarly, the position of the granite in the north part of the Nevada Scheelite mine was controlled by a pre-granite fault. Much of the granite stock now fills space formerly occupied by the upper metavolcanic rocks.

Post-granite faults are of minor importance, and are mainly restricted to contacts between granite and metamorphic rocks. They are rarely recognizable at the surface, but are present in the underground workings of the Nevada Scheelite mine where the contacts between tactite and granite are crushed by faults of small displacement.

Ore deposits

The tungsten deposits are of the contact metamorphic type and consist of the ore mineral scheelite (calcium tungstate) disseminated in tactite. The known tactite occurrences are at or near contacts between granite and limestone and were formed by alteration of the limestone by the granite. This tactite alteration is present along only a small proportion of the contact, and scheelite is present in only a part of the tactite. Much of the limestone is in direct contact with the granite without intervening tactite.

Other mineral deposits, distinct from the tungsten occurrences, were formerly worked in the district. The quartz veins in metavolcanic rocks at Sunnyside, three-quarters of a mile east of the Nevada Scheelite mine, were worked on a small scale for gold. Other veins yielded small amounts of barite, lead, silver, and copper. The quartz veins at Rawhide which occupy

fractures in Tertiary volcanic rocks west of the area mapped for this report. yielded about a million dollars in gold. They are connected with a later period of mineralization than that responsible for the other deposits, which are probably allied to the granite intrusive.

The Nevada Scheelite mine is the largest tungsten deposit known in the district. Four other productive deposits are within half a mile of the main one, and scattered occurrences of scheelite are known within a radius of several miles. The Nevada Scheelite and Hooper No. 1 deposits are on the west margin of the main granite stock, and the contacts at these localities dip beneath the granite. The Viking's Daughter (Glory Hole) is at the edge of a small offshoot from the main granite body. The Red-a-how mine is in a limestone pendant in the granite, and the Yankee Girl mine is between limy hornfels and granite. The Hooper No. 2 deposit replaces a limestone bed in hornfels several hundred feet from the nearest granite contact.

The ore bodies appear to be localized by a combination of the following: (1) a contact or close approach of granite to limestone; (2) bends in the contacts; (3) pre-granite faulting. The thickest known tactite masses (those at the Nevada Scheelite and Hooper No. 1 mines) are along granite-limestone contacts that cut across the bedding in the limestone and dip beneath the granite.

The tactite bodies range in thickness from a few inches up to 50 feet. The thick portions tend to form shoots with some vertical continuity, although each tactite body appears to be lenticular in plan.

The fresh tactite ore consists dominantly of andradite garnet in red to brown zoned crystals up to an inch or more in diameter. Accompanying the garnet are variable quantities of calcite, quartz, amphibole, epidote, pyroxene, wallastonite, pyrite, magnetite, scheelite, and chalcopyrite. Scheelite, the only ore mineral, occurs in fine grains and in euhedral crystals up to an inch in diameter. In ultraviolet light, the scheelite fluoresces light yellow, indicative of some contained molybdenum. Concentrates from the mill

average 0.5 percent of MoO_3 , presumably contained in the scheelite.

The ore bodies in the Nevada Scheelite mine are largely oxidized. On the 200-foot level, the deepest in the district, remnants of sulfides are found only in isolated zones. As the result of oxidation, the pyrite and other sulfides, and some of the garnet, were changed to limonite. Some of the ore is stained green by malachite formed by oxidation of chalcopyrite, but the ore in general contains less than 0.6 percent of Cu although some isolated samples from drill cores ran as much as 5.4 percent of Cu. It is expected that the percentage of unaltered sulfides will increase at depth, but it is not likely that all the unoxidized tactite contains high percentages of sulfides, for the sulfide content of samples from drill holes beneath the present mine ranges down to very small amounts.

The grade of the ore in bodies of commercial importance ranges from 0.5 percent of WO_3 to 2.0 percent or greater.

MINES

Nevada Scheelite, Inc.

Nevada Scheelite, Inc. owns the following 16 patented, adjoining claims covering the largest tungsten deposits known in the district:

Gussie L.	Blanco No. 1	Tungsten No. 1	Princess
Blue Bell	Blanco No. 2	Titan	Turtle
Lead Mountain	Don	Titan No. 1	Ma Parker
Blanco	Tungsten	Duke	Viking's Daughter

The Nevada Scheelite mine on the Don claim and the Glory Hole on the Viking's Daughter claim are the only deposits that have been worked.

Nevada Scheelite mine

The Nevada Scheelite mine (fig. 3) is opened by a ³/₄-compartment vertical

Fig. 3. Surface map, Nevada Scheelite mine.

shaft 270 feet deep with levels at 50, 100, and 200 feet. There are 3200

feet of drifts and 500 feet of raises in the mine, and a number of stopes (figs. 4 - 9).

- Figure 4. Geologic map of the 100 level, Nevada Scheelite mine.
Figure 5. Geologic map of the 200 level, Nevada Scheelite mine.
Figure 6. Sections A-A', B-B', C-C', Nevada Scheelite mine.
Figure 7. Sections D-D', E-E', F-F', Nevada Scheelite mine.
Figure 8. Sections G-G', H-H', I-I', Nevada Scheelite mine.
Figure 9. Vertical projections of the Nevada Scheelite mine showing ore reserves.
-

In the vicinity of the Nevada Scheelite mine, the metamorphic limestones are folded into an anticline that pitches steeply southeast. Southwest of the mine these rocks strike east and dip steeply south; in the vicinity of the mine itself, they strike northeast and dip from vertical to steeply southeast. (fig. 3) The limestone, 400 feet thick near the mine, was

Fig. 3. Surface map, Nevada Scheelite mine.

locally altered by the granite intrusive to tactite which occurs along the contact as an irregular zone about 1800 feet long and from 2 to 50 feet wide. Although much of the tactite is covered at the surface, it is shown to be remarkably persistent in the underground workings and drill holes and extends to a depth of at least 400 feet. Most of the tactite in the zone contains at least 0.5 percent of WO_3 and much of it contains 1.5 percent of WO_3 .

For a distance of 700 feet, from 600 feet south of the Nevada Scheelite shaft to 100 feet north, the contact between granite and limestone is nearly vertical, and is concordant with bedding in the limestone. The tactite zone on this portion of the contact is narrow, with widths of from 2 to 10 feet, except near the shaft where it is 20 feet wide in places. North of the shaft at distances of 100 feet on the surface, 170 feet on the 100 level, and 240 feet on the 200 level, the contact swings sharply westward across the beds in limestone, and flattens to dips of 30° to 40° NE. This change in attitude persists for 350 feet northwesterly where another change in direction of the

contact makes it once again concordant with the limestone.

The two beds and intermediate flattening in the contact result from the intrusion of the granite along a portion of a pre-granite fault which strikes northwest and dips 30° to 40° NE. The limestone beds north of the fault are displaced about 350 feet northwest. The largest ore bodies known in the district are between these two bends where the granite contact crosscuts the bedding of the limestone. Tactite extends down the flat dip of the contact, with granite above and limestone below. Although the contact of the granite and the tactite in this sector is fairly regular, the contact of the tactite and the limestone is quite irregular and prongs of tactite extend into the limestone for greater distances along some beds than others. In places, the tactite layers are as much as 50 feet thick, but taper out southward into limestone within 100 feet of the main contact. At the surface, isolated outcrops of tactite, some rich in scheelite, occur in limestone more than 100 feet from the main granite contact, most of them being associated with small faults and granite dikes. At depth, these isolated bodies of tactite may enlarge and coalesce with the larger replacement bodies that penetrate along the limestone beds.

North of the bends in the contact, the granite contact and the limestone are concordant and dip steeply northeast. For 600 feet northward, the tactite zone appears to be mostly 10 to 20 feet thick with only a few thinner portions. This part of the contact is poorly exposed at the surface, and is known underground only from 4 drill holes.

About 50,000 units of WO_3 had been recovered from about 60,000 tons of ore to the end of April 1944, a yield of 0.83 unit per ton ($0.83\% WO_3$). Detailed sampling by the Bureau of Mines of the tailings pile at the Nevada Scheelite mill showed an average content of 0.49 percent of WO_3 . Slimes, estimated to contain 0.2 percent of WO_3 , are not impounded in the tailings pile. From these figures, the average grade of ore is calculated

to be about 1.5 percent of WO_3 , a value which is consistent with the estimate based on an examination of the mine with ultraviolet light. The lower grade-limit of ore mined was about 0.7 percent of WO_3 ; the upper limit was 5 percent of WO_3 or more from occasional rich pockets. Drilling and sampling indicate that ore remaining in the mine probably will average less than 1.5 percent of WO_3 .

Estimates of reserves were prepared jointly by R. W. Geehan of the Bureau of Mines and Robert Stopper (fig. 9).

<u>Class of ore</u>	<u>Short tons</u>	<u>Percent of WO_3</u>	<u>Units</u>
Indicated	192,000	0.91	175,000
Inferred	<u>116,000</u>	0.65	<u>76,000</u>
	308,000		251,000

Ore two feet or less in width constitutes 10 percent of the above tonnages and probably won't be mined. Another 15 percent will probably be left as pillars in the mining operations. Further exploration might show the deposit to contain in addition about 300,000 tons of ore with a content of 0.5 percent or more of WO_3 .

Viking's Daughter Claim (Glory Hole)

The Viking's Daughter claim, one-third of a mile northwest of the Nevada Scheelite mine, was worked from 1937 to 1939 by Nevada Scheelite, Inc., the owners. Workings consist of an open pit, a short adit in one face of the pit, and several small open cuts (fig. 10).

Figure 10. Viking's Daughter claim and Yankee Girl mine

About 5000 tons of material was removed from the main pit, the adit, and adjacent pits. Of this about 3000 tons was ore with an average content of 1 to 2 percent of WO_3 .

The deposit is an irregular mass of tactite formed in limestone at the contact with a small body of granite. The contact between tactite and granite is a nearly vertical, post-mineral fault. Honeycombed, limonite-stained quartz is enclosed within the main tactite mass in the open pit and a similar body of quartz, with less limonite, is exposed in the adit and on the east rim of the pit. Both quartz bodies are barren of scheelite. The floor of the pit is concealed by debris, and the only exposures of scheelite-bearing tactite are on the walls in disconnected patches estimated to contain 1.0 percent of WO_3 . The operators report that an unknown volume of ore remains in the bottom of the pit, but that the workings were abandoned in favor of better-grade ore found in the Nevada Scheelite mine.

Small isolated outcrops of tactite occur in limestone southeast of the main pit and in a smaller pit 50 feet south of the large pit. None of these contain appreciable amounts of scheelite.

Hooper property (Primrose group)

The Primrose group of 8 unpatented claims (Primrose, Primrose extension, Suzanne Ellen, Homer, Ajax, Ajax No. 2, Ajax No. 3, and Ajax No. 4), owned by J. H. Hooper, adjoin the Nevada Scheelite holdings on the south. Except for prospect pits, the only exploration is in the Hooper No. 1 mine on the Ajax No. 3 claim, and in the Hooper No. 2 workings on the Ajax claim. The only production was from the Hooper No. 1 mine.

Hooper No. 1 Mine

The Hooper No. 1 mine, also known as the Moore lease shaft and the Primrose mine, is 1500 feet south of the Nevada Scheelite shaft. Workings consist of a 100-foot vertical shaft, a drift for 200 feet southeast of the shaft on the 100-foot level, and stopes between this level and the surface. An inclined winze 25 feet deep was dug below the 100-foot level near the south face. (fig. 11) Nevada Scheelite, Inc. leased the property

from 1937 to 1939 and mined 1500 tons of 2 percent ore from the upper part of the mine. Beverly Moore leased the property in 1940 and mined about 5000 tons of ore from which he recovered about 1800 units of WO_3 in his mill.

On the 50-foot level of the mine, the tactite exposed in stopes was 5 to 25 feet thick, whereas on the 100-foot level, the tactite in the drift was only 2 to 10 feet thick. At the shaft, the contact is steep; southeast of the shaft, however, the contact is inclined about 45° NE. , with the granite lying on top of the tactite and limestone. The richest ore, estimated at 2 percent of WO_3 , was mined from the upper stope just south of the shaft. According to Mr. Moore, fairly good ore was taken from the stope farthest to the south, from the 100-foot level up to about the 25-foot level, although the ore was of poorer grade near the bottom. The single small stope north of the shaft was in a thick body of tactite averaging less than 0.5 percent of WO_3 . The best ore exposed in the mine in 1944 was a small strip on the south wall of the southermost stope, probably cut off by marble a short distance south, and a thin layer of tactite exposed in the winze below the 100-foot level. Reserves of indicated ore are estimated at 120 tons containing 2 percent of WO_3 and 800 tons containing 0.5 percent of WO_3 .

Other ore bodies may occur northwest of the shaft, where the contact is covered by alluvium. The curvature of the granite contact, coupled with the presence of several pre-granite faults, suggest that the contact for 500 feet northwest of the Hooper No. 1 shaft, is worth exploration in search of new ore bodies. South of the shaft, neither the surface exposures nor those on the 100-foot level show much tactite or ore.

Hooper No. 2 Mine

The Hooper No. 2 shaft, located on the Ajax claim about 1000 feet south of the Hooper No. 1 shaft, is 110 feet deep on the incline. From the bottom, 140 feet of drift extend northeastward. A winze sunk 16 feet below this drift leads to another 20 feet of drift on a slightly lower level. (Fig. 11)

The workings follow a tactite layer in a somewhat foliated andalusite-biotite hornfels. This layer is about 20 feet stratigraphically above the main limestone, which is exposed northwest of the shaft. Scattered tiny outcrops of granite appear in the hornfels about 100 feet east of the shaft, but the nearest observable contact with the main granite mass is 400 feet east. The tactite which ranges from 1 to 10 feet in thickness is coarsely crystalline and contains large epidote and quartz crystals. Clear, transparent, euhedral scheelite crystals up to half an inch in diameter have been found in small vugs. Most of the tactite in the shaft contains a little scheelite, somewhat concentrated toward the footwall; two rich spots contain 3 or 4 percent of WO_3 , but short drifts cut through them into barren material. The best ore found is in the drift, in a pillar 60 feet north of the shaft where a block of about 15 tons contains 4 percent of WO_3 . The workings show that the only ore to be expected is in small, isolated pockets.

Eed-a-how claim

The Eed-a-how claim adjoins the Nevada Scheelite property on the east, and the workings are about 1700 feet northeast of the Nevada Scheelite shaft. The claim is owned by W. A. Adams, and was leased in 1942-43 by J. A. Madison, who shipped 300 tons of 1.5 percent WO_3 ore to Metals Reserve Co. The shaft is 85 feet deep on a 70° incline to the south. At the 50-foot level, a drift extends 100 feet east; several small stopes have been dug above the drift.

The shaft follows a tactite layer on the south side of an east-west trending sliver of limestone 15 or more feet thick. The hanging wall of the shaft is granite, the footwall is limestone, and the tactite between ranges from 5 feet in thickness down to nothing. At the surface, the ground is covered by large granite boulders which obscure bedrock. Small outcrops of tactite and limestone appear 100 feet west and 35 feet east of the shaft. The limestone thus has a proved extent of 100 feet on each side of

the shaft; whether it is a pendant or connected with the limestone exposed 600 feet of the shaft is unknown. Tactite and limestone extend beneath the bottom of the shaft.

Scheelite is unevenly distributed through the tactite. Portions of the tactite contain 1.5 percent of WO_3 , although the average grade is probably 0.5 percent of WO_3 . Reserves were estimated in 1944 at 1000 tons of indicated ore and 1500 tons of inferred ore, all with an average grade of 1.0 percent of WO_3 .

Yankee Girl Mine

The Yankee Girl mine is half a mile northeast of the Nevada Scheelite mine on the north border of the granite stock. It is owned by Leo and Eugene Grutt, and was leased in 1943 to Goldfield Consolidated Mining Co. The owners produced 50 tons of 1.0 percent ore, and Goldfield Consolidated mined 150 tons of 1.5 percent ore. Fifty tons of the latter was shipped to the Metals Reserve Co. stockpile in Salt Lake City, and 100 tons was concentrated in the district at the Moore mill.

The mine is opened by an adit with 200 feet of workings in two branches (fig. 10). A winze extends 25 feet below the adit, and a raise connects the east face of the adit with the surface. Another exploratory raise 18 feet high was dug in a north branch of the adit.

The mine is on a contact between granite and hornfels. At the surface, tactite is exposed discontinuously in pits for a distance of 140 feet. In the adit, the tactite exposed has no continuity, and consists of thin layers bordering small, xenolith-like masses of limestone enclosed in granite. These discontinuous limestone lenses probably represent a formerly continuous limy layer in the clastic sediments from which the hornfels was formed. Scheelite is distributed erratically through the tactite, and at places along the walls of the drift forms ore containing 0.5 percent of WO_3 . In 1944 the best ore exposed was confined to a face in the winze showing 1.0

percent of WO_3 over area 6 by 8 feet. Indicated ore outlined by the workings at that time was estimated at 20 tons of 1.0 percent WO_3 and 150 tons of 0.5 percent WO_3 .

Other properties

A small amount of ore has been produced from three of four small properties outside the area mapped for this report. The "Strand Upper property", 4 unpatented claims held by William Strand and R. H. Sheeby, is 2 miles northwest of the Nevada Scheelite mine. Small bodies of tactite, several feet in diameter, formed by the alteration of limestone by a nearby granite intrusive, occur in an area of about half a square mile. Forty pounds of scheelite ^{was} ~~were~~ produced from a single pocket mined in one of several small open cuts. Most of the tactite contains only occasional crystals of scheelite.

The Big Kassok claim, $1\frac{1}{2}$ miles northeast of the Nevada Scheelite mine, is held by Eugene Grutt, Eugene Grutt, Jr., and Leo Grutt. A 30-foot adit and two small open cuts were dug on a tactite body in metavolcanic rocks. The tactite is 150 feet long and as much as 35 feet wide. It strikes N. 70° E. and dips vertically. A small amount of scheelite is erratically distributed in the tactite, the largest concentrations containing an average of 0.1 percent of WO_3 .

The Crystal No. 1 and No. 2 claims (the "Tom Kenyon property", held by the estate of Tom Kenyon), are 8 miles east of Rawhide. The property was leased in 1939 to Beverly Moore who produced 30 tons of ore containing 0.25 percent of WO_3 and in 1940 to Forest J. Sur, who produced 36 tons of ore containing 0.62 percent of WO_3 . The deposit comprises two small bodies of tactite which occur in a granodiorite stock surrounded by metavolcanic rocks. The tactite bodies are regular in outline and 20 and 8 feet respectively in diameter. A 15-foot shaft has been sunk in each. Scheelite is erratically distributed in the tactite; probably half the tactite exposed averages 0.5

percent of WO_3 content. Reserves are estimated at 900 tons of indicated ore containing 0.5 percent of WO_3 .

The "Strand Lower property", 12 claims held by William Strand and R. H. Sheehy, is 10 miles east of Rawhide. The property was leased to Nevada Scheelite, Inc., in 1940 and to Beverly Moore in 1943. Nevada Scheelite produced 10 tons of ore containing 0.5 percent of WO_3 , and Moore produced 20 tons containing 0.5 percent of WO_3 . A limestone lens in metavolcanic rocks has been partly altered to tactite that contains powellite and erratically distributed scheelite. Small granite dikes crop out in the vicinity. Reserves are estimated at 50 tons of indicated ore containing 0.5 percent of WO_3 .

* * * *

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON

Rawhide, Nev.
Dec. 10, 1943

Dear Dwight;

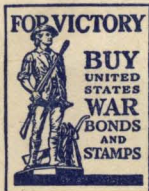
Hole B-1, the hole parallel to and 1' west of B, was completed this morning. Following is a log: 0'-137.5' marble, 137.5'-154' tactite, 154'-170' marble with thin layers of tactite, 170'-176.5' tactite, 176.5'-189' granite. The two points now located on the contact show it to be dipping 60° - 65° westerly in this area. The tactite is good ore. The drill is now being moved about 150' north to test the structure in that area.

I have received the dope you sent on the Lucky Four property and the Sand Springs District.

I am looking forward to your visit just before Christmas.

Sincerely Yours

Bob



May 1, 1951



UNITED STATES
DEPARTMENT OF THE INTERIOR
OSCAR L. CHAPMAN, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

DOCKET DMA-474

RAWHIDE TUNGSTEN DEPOSIT
Mineral County, Nev.

Rms

By E. J. Matson, D. E. White, and R. G. Reeves

May 1, 1951

DOCKET DMA-474

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

RAWHIDE TUNGSTEN DEPOSIT
Mineral County, Nev.

SUMMARY

The Rawhide tungsten deposit was examined on April 3 and 4, 1951 by a joint Bureau of Mines^{1/} and U. S. Geological Survey^{2/} team in regard to an exploration loan with limited Governmental participation.

The property is located in the Sunnyside Mining District, Mineral County, Nev., about five miles northeast of the town of Rawhide.

The property is developed by an adit about 400 feet long and several small open cuts. No shipments of ore have been made from the property.

Rocks in the area comprise metamorphosed limestones intruded by masses of meta-andesite and a granitic stock. Scheelite occurs sparsely in the limestone near contacts with meta-andesite and closely related to shears and fractures.

INTRODUCTION

This report is in regard to the application for an exploration loan by the Rawhide Tungsten Co. in the amount of \$50,000. The Docket number of the application is DMA-474, and the commodity is tungsten.

1/ E. J. Matson, Mine Examination & Exploration Engineer, Bureau of Mines, Region III.

2/ D. E. White and R. G. Reeves, geologists, U. S. Geological Survey.

One day and one night were spent at the property making a geologic sketch and sampling the deposit.

HISTORY

The Rawhide district, from 1909 to 1920, was noted for its gold, silver, lead and zinc production. After 1920 the district has been on the decline. However, during and after World War II, the district again took on new stimulus and became an important tungsten producer.

The Rawhide tungsten property, comprising five claims known as the Elizabeth, Crescent, Nugget, Oscar and Last Hope, were located by William H. Strand during the latter part of 1947. A millsite called the Rawhide Tungsten for the above was also located in May 1949 by the afore-mentioned locator.

On the 10th of July 1949, a partnership was formed between William H. Strand, 690 Wildes Street, Fallon, Nev. and R. H. Sheehy, P. O. Box 607, Carson City, Nev. The firm name of the partnership was called Rawhide Tungsten Co.

PHYSICAL FEATURES

The claims are in an area of moderately rugged relief at a mean altitude of about 5,500 feet. The climate is typical of the desert country, consisting of dry, hot summers and moderately cold winters. Precipitation occurs chiefly as snow during the winter months. Vegetation is scarce, consisting of sagebrush and grass of the desert varieties.

No water is available on the property. However, about five miles distant at the millsite location, water is obtainable in the flats

from relatively short well holes. Water for mining and domestic purposes would have to be hauled from the well.

No transmitted electric power is available at the property. Diesel engines would have to be installed for electric power facilities.

GEOLOGY

The bedrocks of the area consist of intricately folded and contorted blue and white limestone and impure schistose limestone intruded by irregular masses of meta-andesite, which in turn are intruded by a granitic stock (see fig. 1).

The geology of the sedimentary rocks is very complex. The sketch map of figure 1 shows some of the general relations, based on a five-hour reconnaissance of the area. A careful study, probably of at least several weeks duration, would be necessary to be confident of many of the detailed relations.

The white limestone appears to be a bleached or recrystallized phase of the blue limestone. Both are intricately folded; in places a prominent fracture cleavage has been superposed on the bedding; where bedding is inconspicuous the cleavage is easily mistaken for bedding.

A "schistose" phase of the sedimentary rocks is exposed on the north side of the portal of the Oscar adit, and on the surface at intervals for 300 feet ENE of the portal adjacent to meta-andesite. Although the schistose limestone has some characteristics of a distinct stratigraphic unit, this phase appears to cut across the bedding in the Oscar adit, and was identified on the surface only on the ENE-

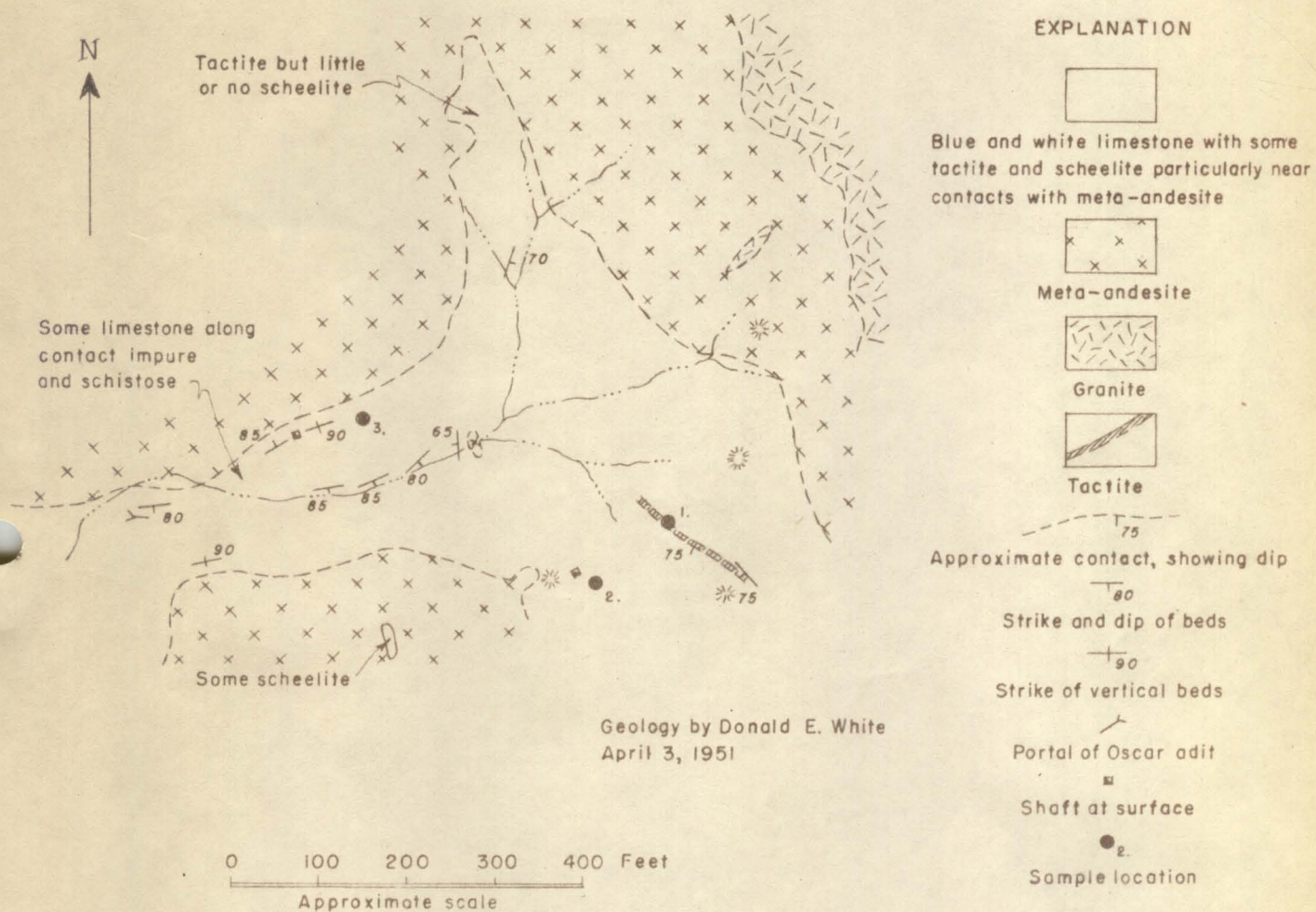


Figure 1. Geologic sketch map of the Crescent claim, Rawhide Tungsten Company, Mineral County, Nevada

striking portion of the meta-andesite. It may therefore be a metamorphic facies of the limestone, perhaps originating from selective solution of carbonate from limestone adjacent to the meta-andesite, and from structural movement localized along the contact.

The sedimentary rocks are intruded by irregular masses of a porphyritic rock that is probably andesitic in composition. Low-grade metamorphism has destroyed the texture in part, particularly near the contacts and in the smaller masses. Small, unmapped intrusions of dacite or a related rock were found in the southeastern part of figure 1; these rocks are probably comparable in age to the meta-andesite.

Biotite granite (perhaps granodiorite or quartz monzonite) crops out in the northeastern part of the mapped area. This rock is the northwestern part of a small stock perhaps three-fourths of a mile long and nearly one-half mile wide, with the long dimension oriented WNW. Erosion has probably exposed only the uppermost part of a larger intrusion existing at depth, because the granite is generally mildly altered and iron-stained, and contains numerous veins and irregular masses of quartz. The presence of granite dikes in meta-andesite, and of inclusions of meta-andesite in granite is clear evidence that the granite is younger in age.

Ore deposits

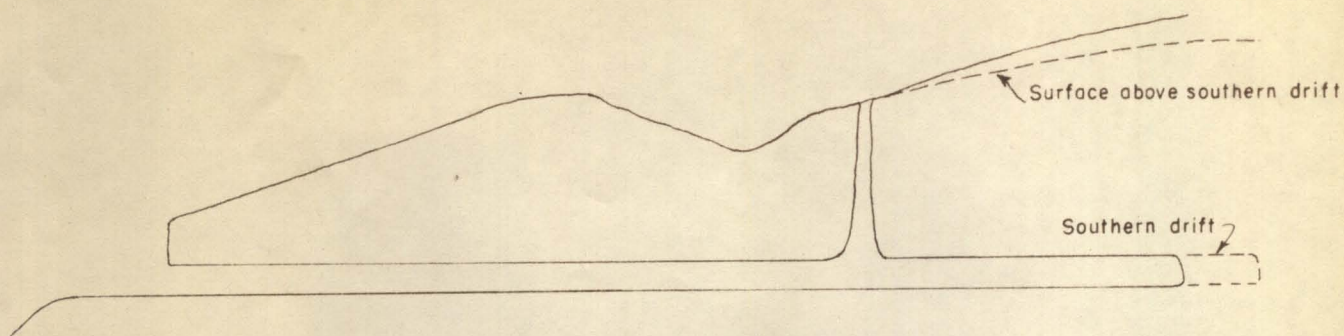
In a number of places the limestone has been converted to a garnet-epidote-calcite rock, or "tactite". Commonly the tactite also includes some scheelite. The principal exception is the northern ex-

tension of the sedimentary rocks (see fig. 1), where the limestone has been extensively converted to tactite but scheelite is rare or absent. Scheelite is apparently more abundant where narrow stringers and small masses of quartz have also been introduced.

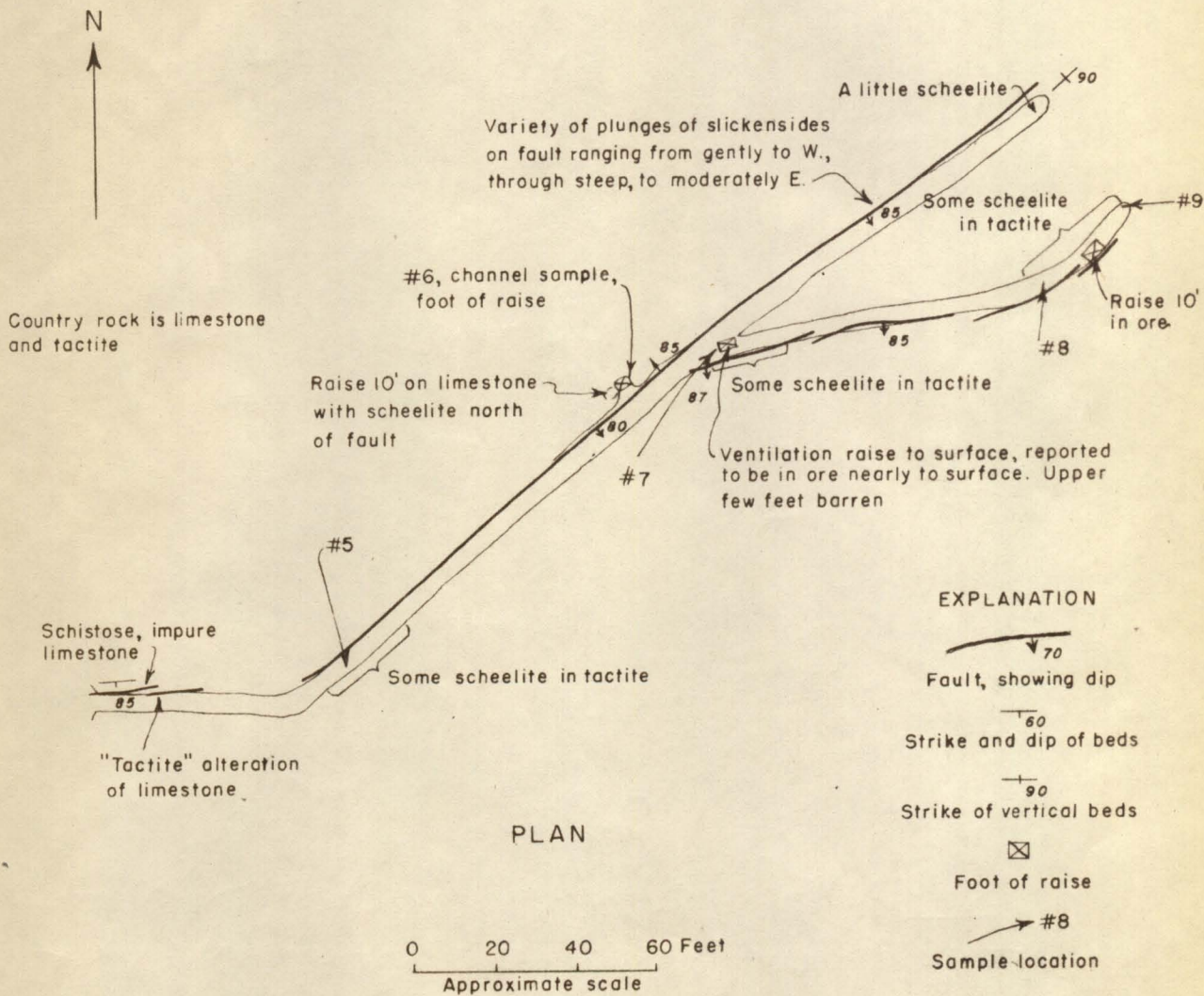
Most of the scheelite and tactite is localized near the contacts with meta-andesite, although in the northwestern part of the area, impure schistose limestone separates the scheelite-bearing rock from the meta-andesite. In addition, in the southeastern part of the mapped area, a limestone bed not closely associated with meta-andesite has been converted to tactite containing a little scheelite.

The distribution of tactite and scheelite appears to be more closely related to pre-mineral shears and fractures in limestone than to selective mineralization of specific limestone beds. This relation appears to be particularly clear in the Oscar adit ^{Fig. 2} where two sets of faults diverge, but both sets are associated with scheelite. Although bedding cannot everywhere be distinguished from fracture cleavage, the southern set of faults probably crosscut the bedding. Elsewhere in the adit the faults are either parallel to the bedding or crosscut the bedding at low angles.

Several prospect pits have been dug on the Oscar claim about 750 feet WSW of the portal of the Oscar adit. (This adit, despite its name, is entirely within the Crescent claim). The prospect pits are in limestone and tactite adjacent to meta-andesite. The sedimentary rocks strike approximately N. 40° W. and dip 80° SW, under the adjacent andesite. Sample No. 4 was taken from the southeastern pit, near the road to the Oscar adit.



LONGITUDINAL SECTION



Outline of workings from
Rawhide Tungsten Company

Geology by
Donald E. White and Robert G. Reeves

Figure 2. Geology of the Oscar adit, Crescent claim, Rawhide Tungsten Company, Mineral County, Nevada

Although tautite and scheelite are generally closely associated with meta-andesite, this association is probably structural rather than genetic. In common with many other scheelite deposits, the mineralization is probably genetically related to the granitic rocks.

Ore Reserves

The assays indicate that no ore bodies of appreciable size and mineable grade have yet been revealed on the property.

HOUSING

Five large size trailer houses are installed at the mine location. Each trailer can accommodate at least two men.

MINE EQUIPMENT

A small blacksmith shop is installed near the tunnel portal equipped with sundry tools. The company also has one Ford dump truck and one pick-up truck, one 105-cu.ft. air compressor, compression drills, mine cars, pipe, rail and accessory tools.

MINE DEVELOPMENT

The property is developed by some shallow cuts scattered over the surface and an adit, 400 feet in length, driven into the hillside along a limestone meta-andesite contact. The adit is equipped with track and air line. A raise connects through to surface about 200 feet back from the portal.

SAMPLING

The mineralization in underground workings was observed under an ultra violet lamp and samples were taken in the mineralized sections without the use of the light. A moil and hammer were used for sampling

purposes. Samples were taken normal to and crosscutting the strike length of the mineralization. Four samples were taken from surface and five from the adit. One large grab sample was also taken from the 300 tons of sorted material at the portal.

A tabulation of the sampling is as follows:

<u>Sample No.</u>	<u>Width</u>	<u>% WO₃</u>	<u>Place</u>
1	5.0	0.06	Outcrop
2	5.0	.08	"
3	2.3	.06	"
4	3.3	.41	"
5	3.0	.03	Underground
6	2.0	.04	"
7	3.5	.04	"
8	3.0	.06	"
9	4.0	.01	"
10	Grab	.03	Sorted rock at portal

CONCLUSIONS

No reserves of mineable ore were observed on the property. The 400-foot adit, which was a sincere effort on the part of the owners to uncover tungsten ore below surface, exposed only weak mineralization that with the aid of an ultra violet lamp, showed sparse scheelite.

Only one small pit excavated at an outcrop about 1,000 feet southeast from the Oscar adit exposed scheelite (sample No. 4) of mineable quality. This exposure was too small from which to estimate any mineable ore.

To date, the development and grade of tungsten mineralization do not warrant granting of the loan application at this time, however, further exploration by the owners may reveal mineralization of importance to justify further consideration.

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**SUMMARY REPORT ON THE TUNGSTEN DEPOSITS
IN THE VICINITY OF THE NEVADA SCHEELITE COMPANY MINE**

**Regent Mining District
Mineral County, Nevada**

M. B. Kildale

March, 1943

INTRODUCTION

This report is based upon geological work done by the Stanford Geological Survey during the period between July 24 and August 22, 1942. This work was carried on as part of the regular curriculum of the department of geology at Stanford in cooperation with and with the aid of the United States Geological Survey, arrangements being made with Mr. Hewitt, Mr. Nolan and Mr. Lemmon of that organization. The field work was carried on by a group of three instructors and eighteen students in geology under the direction of the writer. During this period the geology of an area of about five square miles was studied in detail, the geology was plotted on Airplane photographs, a topographic and geologic map on a scale of 200 feet to the inch (with a contour interval of 20 feet) was completed and the underground geology of the Nevada Scheelite mine was mapped on a scale of 1 inch = 50 feet.

The accompanying geologic and topographic map shows the surface geology of the portion of this area in the immediate vicinity of the principal mine and includes the area most promising for the immediate development of other tungsten deposits. The accompanying 50-scale plan maps show the underground geology of the principal mine workings.

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LOCATION

The Regent, or Rawhide mining district is situated at the southwest end of the Sand Springs Mountain range, in the extreme northern part of Mineral County, Nevada, about five miles south of the Churchill County Line. It lies about 40 miles in an air-line southeast of the town of Fallon and about 20 miles east of Schurz, the nearest railroad point. The area is shown on the extreme southern edge of the Carson Sink Quadrangle map.

The principal known tungsten deposits are found at, or in the vicinity of, the Nevada Scheelite Company mine which is situated on the southern flank of the mountains about five miles east of the nearly deserted mining camp of Rawhide. The mine lies about nine miles north of Dead Horse Wells, where the company's mill is located. The elevation at the mine shaft is approximately 5100 feet above sea level.

The area here discussed is most readily reached by driving easterly from Fallon over highway 50 for a distance of 33 miles, thence southerly over a dirt road for a distance of 23 miles. It can also be reached from Fallon by driving southerly over highway 95 for a distance of about 24 miles, thence easterly over a dirt road to Rawhide. The total distance from Fallon is approximately the same as by the first route. From the south the area can be reached by a dirt road from Luning, east of Hawthorne.

HISTORY AND PRODUCTION

Scheelite-bearing deposits are reported to have been first discovered in this area in 1930, small scale development work being carried on over a period of several years by the discoverer and by the Mills Alloys Company of Los Angeles who built the first small concentrating mill at Dead Horse Wells in 1936. More active development work was started late in 1939 by the Nevada

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Scheelite Company of Los Angeles, Mr. Oscar Mills, President. Between that time and August, 1942 this company had equipped and developed the mine to the 200 foot level, and had constructed a larger (50-ton) mill at Dead Horse Wells. Up to the present time (January 1, 1942) the company has produced about 33,000 units of scheelite from approximately 40,000 tons of ore. The recoverable grade has averaged between $3/4$ and 1% WO_3 . A uniformly high-grade concentrate (approximately 75% WO_3) is now made at the mill. At the time when the area was mapped by the Stanford Geological Survey, the mine was reported to be producing between 40 and 50 tons per day.

No sampling, except for "lamping", was done on the exposed faces in the mine, hence no accurate estimation of the grade or tungsten content of the ore reserves could be made. It was estimated, however, by the writer that in August, 1942 there were about 10,000 tons of material of probably average grade "in sight" in the mine. This estimate included the ore partially blocked out between the 200 and 100 levels and short extensions of the known ore shoots below the levels opened at that time.

GENERAL GEOLOGY

The geologic legend on the accompanying 200-scale map shows the various formational and lithologic units mapped in this area and the map shows the areal distribution of these units within a small portion of the total area studied. These formations or mapable units will be described very briefly in the following paragraphs.

Limestone and Metamorphosed Limestone

The oldest rocks exposed are composed of a thick series of limestone beds which underlies a considerable percentage of the area mapped and which in large part has been partially or completely metamorphosed. The metamorphism in general consists largely of simple recrystallization and change in color, resulting in a change from bluish-grey, well-bedded limestone to light grey

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fine-crystalline limestone or to coarse-grained white "marble". There is only local development of (such) metamorphic silicates such as tremolite. There are many local and erratic gradations between relatively fresh bluish limestone and metamorphosed limestone or marble. Along the granite contacts the re-crystallized limestone has locally been replaced by tactite (See later).

Bedding can in places still be discerned in the recrystallized limestone; in other places "flowage" has taken place during crystallization, giving banded structures which may or may not represent original bedding; in still other places the bedding has been obliterated by complete recrystallization to massive "marble".

The distribution of the recrystallized limestone indicates that the metamorphism is due both to regional dynamic stresses and to the later intrusions of granite.

The limestone sequence is best exposed in the area about one mile southwest of the Nevada Scheelite mine where the structure can be well seen and where some fossils were found which indicate a lower Jurassic age for this series of beds. The paleontologic evidence is not yet sufficient, however, to enable correlation with any of the formations previously established in this part of Nevada and no formational name has been assigned to all or any part of these rocks.

The largest exposed mass of limestone extends from the area just mentioned above northeasterly to the Nevada Scheelite mine where the rocks are extensively recrystallized. Another belt of limestone extends in an east-west direction along the north edge of the large granite area (See map). These metamorphosed limestones are important in connection with the tungsten mineralization in that nearly all of the ~~scheelite-bearing~~ tactites occur along contacts between them and later granitic intrusives.

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Dioritic Rocks

Also underlying a large percentage of the area mapped are large masses of dark-colored, fine-grained to porphyritic igneous rocks to which the field names diorite, dolerite or andesite-porphyry were applied. The largest mass of these dioritic rocks makes up the bulk of Big Kasock Mountain, just north of the area mapped by the Stanford survey. Within the area they occur as stocks and sills intruding the limestone and may even in part represent old volcanic flows. Their occurrence and texture indicate that for the most part they are shallow intrusives.

Where fresh these rocks are notably hard and compact and resistant to erosion. The characteristic texture is finely porphyritic with lath-like plagioclase phenocrysts. Breccia structures were found in one mass near the mine.

The ground-mass is usually finely crystalline. The most abundant minerals are plagioclase, biotite and hornblende or pyroxene, with, in some cases, quartz. Epidote veinlets are common, particularly on Big Kasock Mountain.

These dioritic rocks are cut by later dikes of granite, and along fissures or sheared zones they often show the effects of hydrothermal alteration, becoming softer and lighter colored. North and west of the Nevada Scheelite mine are large areas of highly altered rocks, which have been so much affected by processes of hydrothermal alteration that field identification was impossible but which because of occasional transitional zones are believed to be largely altered dioritic rocks. More petrographic work is needed to accurately classify all of the rocks, both altered and unaltered.

The contacts between diorite and limestone in some places show the development of schistosity in one or both rocks and rarely a little sulphide

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mineralization. Tactite is occasionally found along these contacts but always close to the later granite.

Granite

The third widespread and important rock type occurring in this area is granite, which is intrusive into both the limestone and the dioritic rocks, but which does not cut the Tertiary volcanic rocks.

The granite outcrops cover two large areas, one near the northern border of the area mapped, south of Big Kasock Mountain, the other to the east and south of the Nevada Scheelite mine (See map). Several smaller exposures or "outliers" occur around these larger masses.

In mineral composition most of this rock is true granite or ranges within narrow limits from a granite to a granodiorite. The northern mass of granite contains pegmatitic areas and is cut by pegmatite dikes as well as quartz veins. The mass east and south of the mine contains many quartz veins. Many of these are small and discontinuous and localized along joint fractures; a few, as those at the Sunnyside mine, are strong and are mineralized.

A few small intrusive bodies of intermediate (monzonitic) composition are also probably related to the granite. In the western part of the area a plug of quartz-porphyry occurs and may either represent a phase of the granitic intrusion or be related to the later Rawhide volcanics.

Tertiary Volcanic Rocks

The only other rocks which outcrop over wide areas comprise a series of later (Tertiary?) volcanic flows which overlie all of the above mentioned rocks. These flows have been grouped under the name of Rawhide volcanics. They outcrop extensively along the west border of the mapped area, dipping off of the older formations and extending ~~westwardly~~ to the old camp of Rawhide.

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They also form one large hill north of the Nevada Scheelite property, the southern edge of which is shown on the accompanying surface map, and occur as small patches in other places.

In the Nevada Scheelite area these volcanics include several different flows of rhyolitic and dacitic composition and some tuffaceous rocks.

Tactite

Because of their economic importance in connection with the tungsten mineralization the tactite zones and bodies were mapped as a separate unit by this survey. The term tactite is used here to designate those bodies of "contact-metamorphic" silicates which occur characteristically on, or close to, contacts between granite and re-crystallized limestone, and which have been formed largely by replacement of the limestone.

The predominant minerals in the tactite bodies in this area are garnet and epidote, usually accompanied by diopside, calcite, and (or) quartz, and where mineralized by scheelite and sulphides such as pyrite and chalcopyrite. The textures of the tactite range from dense finely crystalline to very coarsely crystalline and vuggy.

The greatest number of tactite bodies exposed on the surface are found in the vicinity of the Nevada Scheelite mine and their distribution is shown on the accompanying map. It will be noted that these occur along the northern and western edges of the large granite stock, particularly along, or close to the westward "prong" of the granite from the vicinity of the Nevada Scheelite shaft southwesterly and then southeasterly around the granite to the Moore Lease shaft.

Although most of the tactite occurs directly on the granite-limestone contacts, it is occasionally found along diorite-limestone contacts close to

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the granite or as replacements of small blocks of limestone "included" in the granite.

The tactite bodies along the granite-limestone contacts are apparently irregularly distributed but in some cases at least are localized by definite structural features which will be discussed below in the section on Occurrence of Tungsten Ores.

General Structure

As shown on the geologic map of the entire area, the general strike of the limestone beds throughout this area is easterly-westerly and the distribution of the limestone as well as the visible structure suggests that these rocks have been folded into a series of east-west folds. Most of the mapable faults also have east-west to northeast strikes, although another series striking west of north was also found. The presence of these easterly-westerly structures in the older rocks at the south end of the north-south trending Sand Springs range may be significant in explaining the localization of the granite intrusives and associated mineralization in this district.

Due to the many intrusions of diorite and granite and due to the metamorphism of the limestone much of the structure in the limestone is not clear. However, in the southwest area, 1 to $1\frac{1}{2}$ miles southwest of the Nevada Scheelite mine, one east-west fold is well exposed. A reversal of dips in the area west of the mine also indicates an east-west trending anticline in that area and to the north the distribution of the limestone beds in two steeply-dipping east-west belts indicates the possibility of a parallel steep syncline.

The best exposed of the northeast fault zones is that found in the workings of the Nevada Scheelite mine. Here a zone of steep northeast faults occurs, the various strands of which often coincide with the granite-limestone contacts but which also in several places leave the contacts and pass off into

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either the granite or the marbleized limestone. To the southwest of the mine part of this faulting at least swings to the west along the same granite-limestone contact and extends westerly beyond the granite tongue and into the limestone. Still farther west other east-west faults and fissures were mapped in the limestone and diorite. The strong quartz veins in the granite at the Sunnyside mine also have east-west trends.

Of the faults which strike west of north, two may be mentioned here. One of these is the fault which is easily visible on the airplane photo of the area a mile southwest of the mine. Here it can be seen to offset the limestone ^{and antiferline} beds along the line of the canyon where the Lambert prospect tunnel is located. Another such fault zone is that exposed along the granite-limestone contact in the workings of the Moore Lease shaft. This east-dipping fault may extend northerly through the granite under the canyon at the base of the steep ridge east of the Nevada Scheelite mine.

ORE DEPOSITS

Types of Mineralization

Three types of mineralization were found within the area mapped in this district:

- (1) Quartz veins often carrying sulphides with gold or gold and silver values. These are most abundant in the granite, next most abundant in the diorite. The chief sulphides are pyrite, chalcopyrite and tetrahedrite, with lesser amounts of galena and sphalerite. The ores mined in the past were from the oxidized portions of such veins which locally carried high values in silver or gold. The most productive of such veins were those found at the Sunnyside mine about one-half mile east of the Nevada Scheelite shaft.
- (2) Fissures carrying jasperoid, pyrite and its oxidation products, some barite and galena or its oxidation products. The east-west vein in limestone at the Lambert Lead Mine prospect in the southwestern part of the area represents this type. These deposits have not been important economically.

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- (3) Tactite or contact-metamorphic ores carrying scheelite, often accompanied by minor quartz, pyrite and chalcopyrite.

The general mode of occurrence of all of these types of ores indicates that they are probably related to the granitic intrusions. Hence the gold-silver veins in the Tertiary (?) volcanics at Rawhide probably represent a different and later period of mineralization. Only the tungsten ores will be described in greater detail here.

Occurrence of Tungsten Ores

As mentioned above, the tungsten mineralization in this district is characteristically associated with the bodies of tactite which in nearly every case occur on or close to the granite-limestone contacts. Also as mentioned above, the most numerous surface exposures of tactite are found along the northern and western edge of the large mass of granite which lies east of the Nevada Scheelite shaft. These outcrops extend from the area northeast of the shaft southwesterly through the mine and westerly along the contact to the end of the westward granite "prong", thence easterly and southeasterly to the Moore Lease shaft. The surface exposures are irregular, although usually elongated parallel to the contact and are up to 100 feet in length. One other strong exposure of tactite occurs at the Taylor Glory hole at the eastern tip of a long east-west striking tongue or dike of granite.

As judged by inspection with the fluorescent lamp, the surface outcrops of these tactite bodies vary greatly in tungsten content, most of the undeveloped outcrops showing little or no scheelite. The exposures, however, at the Glory Hole and at the Moore Lease shaft locally show strong scheelite mineralization and some good ore is reported to have been mined at both of these places.

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Mapping of these various occurrences of tactite, particularly those that well exposed in the main mine, shows the larger and more strongly mineralized bodies of tactite have been influenced by the presence of other structures in addition to the simple granite-limestone contacts. They are found to be localized along the contacts by such structures as post-granite faulting and fissuring, either parallel to or intersecting the contact, by sharp bends in the contact or by fingers or small tongues of granite extending outward from the main mass of granite. In the Nevada Scheelite mine area there is a strong system of northeast-striking faults which in places probably parallel the original contact but which also in places leave the contact and pass off into the granite or into the limestone. Here also the largest tactite body - and the one richest in tungsten - occurs along a fault contact between granite and marble where the contact makes a sharp bend from northeast to northwest. Where the contact is faulted but is steep and straight the tactite zone is narrower but may be well mineralized.

Thus the presence of faulting and fissuring along the contacts appears to be a favorable factor in the formation of scheelite-bearing tactite. However, there doubtless have been several periods of fracturing or faulting - the presence of post-granite fracturing seems to have been favorable for the formation of the larger or more continuous bodies of tactite; also, after the formation of the tactite silicates later fracturing occurred which permitted the entrance of late-stage solutions which deposited more quartz, scheelite and sulphides; also the presence of gouge planes which cut the mineralized tactite shows that there have been post-mineral movements in these same areas.

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Distribution of Scheelite

Study of the ore shoots in the Nevada Scheelite mine and of other occurrences shows that although the scheelite wherever observed was closely associated with the tactite, it was distributed in several different ways in or along the tactite masses. The various modes of occurrence are listed below:

- (1) Scattered through the garnet, epidote and other tactite silicates.
- (2) In seams cutting the older silicates or around the silicate grains.
- (3) In quartz veinlets cutting the main mass of tactite, these veinlets also carrying pyrite and chalcopyrite.
- (4) As crystals and associated with quartz crystals in vugs in tactite zones.
- (5) Disseminated in altered pyritized granite along the borders of tactite.
- (6) Disseminated in marble close to the contact between tactite and marble.

The scheelite in the more highly mineralized tactites is often associated with quartz and with sulphides, particularly pyrite or chalcopyrite. In the oxidized zones the scheelite is thus often found in ~~an~~ areas showing abundant limonite and scattered stains or spots of copper carbonates. Manganese oxides are also often abundant. However, the strength of the scheelite mineralization is often not proportional to the amount of sulphides and local abundance of sulphides does not prove strong tungsten mineralization.

Geology of the Nevada Scheelite Mine

The accompanying 50-scale maps show the underground geology on the 100 and 200 levels of this mine and are largely self-explanatory. Used in conjunction with the surface geological map they will show the geology of the productive area as thus far developed.

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It will be noted from these maps that the largest and most productive stope lies 100 to 250 feet northeast of the shaft. In the area the granite contact shows a sharp change in strike from northeast to northwest or north-south and where the contact is intersected by several northeast-striking and easterly-dipping fissures in the limestone. Here the tactite zone shows widths up to 40 feet and the scheelite is well distributed throughout the zone. Due to the northeast dip of the fault contact and the northeast strike of the fissures, the ore shoot rakes east-northeast.

To the southwest of this wide tactite body the ore extends along the steeper northeast-striking contact to a point 50 to 75 feet northeast of the shaft but the minable tactite zone is narrower. Another narrow ore shoot has been mined along this fault zone and contact just southwest of the shaft.

On the 100 level, about 200 feet north of the large stope, another ore shoot of good grade (up to 2% WO_3) has been developed and mined above this level. As shown by the geological map this ore shoot occurs where the contact again shows a northeast strike and steep dip and is paralleled by a zone of strong northeast faults or fissures. The ore zone on this level is about 170 feet long, it pinches at the south end at the sharp bend in the granite contact; at the north end the ore is cut off where the diorite has replaced the limestone and come into contact with the granite. The northeast faulting, however, continues beyond the present face of the heading in granite. On the surface this fault contact between granite and limestone is exposed and can be traced to the northeastward for some distance.

As shown by the stope cross sections, the granite contact north of the shaft nearly everywhere dips easterly, as do the associated faults. The dips however show a wide variation, ranging from 35° to 85° and the thickness of the tactite zone likewise varies considerably. The altered limestone beds appear

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to have a general northeasterly strike and steep dip, as they have where exposed on the surface farther to the northeast.

In view of these rather abrupt variations in dip and strike of the contact and the associated fault zone, and in view of the mineralized tactite, it is unsafe to project the present ore shoots for any great distance. However, it should be pointed out that the main ore shoot, although not quite so long on the 200 level as on the 100 level, is wider just above the 200 level than anywhere above; hence it should extend for a probable comparable distance below. The north ore shoot has not been developed below the 100 level, but as the structure here is quite regular along the strike, it should likewise persist to greater depths. As the dip of the limestone beds along the contact zone is probably steep, at least in the northern part of the mine, conditions favorable for replacement by tactite should persist to greater depths.

FUTURE POSSIBILITIES AND DEVELOPMENT RECOMMENDATIONS

In view of the past and present production from the Nevada Scheelite mine and in view of the presence of many other undeveloped tactite zones in this vicinity it seems probable that other ore shoots besides those known at present can be found and that the tungsten production of the district can be increased both by deeper development of the present ore bodies and by the discovery of new ones. It must be mentioned, however, that the present mine workings are situated in the local area which, of all those examined, seems most favorable structurally for the formation of ore shoots and where the surface indications of tungsten mineralization are the strongest. It must also be admitted that the other exposed tactite outcrops are widely scattered and that both the size of the tactite bodies and the distribution of tungsten within them are prone to be erratic. Hence the amount of development work per ton of ore may be high.

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The development of the present ore shoots of the Nevada Scheelite mine below the present mine level can easily be carried on by drifting on the present 200 level and by sinking the shaft to the 300 or to lower levels. Such underground development on the projection of the present ore shoots will give far more conclusive results than diamond drilling and the cost of underground development here should not be high. Such exploration can be carried on at vertical intervals of 100 feet and the geological data from each level used in projecting the structures and ore shoots to the next level below. It must be pointed out that even in this area of strong and more-or-less continuous structures the strikes and dips of the contact and the faults may change suddenly, thus the size and rake of the ore shoots may change within short distances.

The same reasoning applies to future exploration in the Moore Lease area where a shaft has been sunk to the 85 foot level where some drifting has been done to the south along a very irregular and highly faulted contact, under the ore shoots mined above. The area north of the shaft along the fault zone, where the contact swings westward across the canyon, seems worthy of prospecting by underground drifting. Other lenses of ore may also be found south of the shaft below the present workings. The east-dipping fault zone and contact could here be explored by crosscutting and then diamond drilling from the 85 foot level.

In exploring for other scheelite ore bodies in this vicinity preliminary information could be obtained by diamond drilling from the surface in the neighborhood of the exposed tactite bodies. Both northeast and southwest of the mine the granite-marble contacts as exposed on the surface show steep dips and diamond drill holes could be drilled at various angles to penetrate the contact and projected tactite zones at various depths below the surface. After

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such a general drilling program the development of any ore bearing zones thus discovered could be carried on by underground methods.

The most promising development and exploration projects for the prospecting of extensions of the known ore shoots or for the discovery of new ore shoots in the area covered by the accompanying map are listed below:

- 1 - Development of the Central ore body below the 200 level by sinking the shaft to the 300 level, drifting northeasterly along the contact, and raising to the 200 level. As noted above the contact and the ore shoot will probably continue to show an east-northeast rake.
- 2 - Development of the North ore body on the 200 level by drifting northwest from the present most northerly heading.
- 3 - Development of the South ore shoot near the shaft by drifting southwesterly along the contact on the 300 level.
- 4 - Exploration of the granite contact northeast of the present workings by drifting northeasterly beyond the North ore body projection on the 200 level. Preliminary information as to the possibilities in this area can be obtained by diamond drilling from the surface near the exposed tactite zones. As the contact appears to dip steeply in this area holes can be drilled from the surface at various angles to cut the contact at various elevations.
- 5 - Exploration of the granite-marble contact southwest and west of the mine also by diamond drilling from the surface in the vicinity of the exposed tactite zones. Here also the contact dips steeply at the surface and inclined drill holes will cut the downward projection of the contact zone at satisfactory angles.
- 6 - Explore the granite-limestone contact in the vicinity of the Moore Lease shaft by drifting northerly from the 85 level and by drilling below this level as outlined above.
- 7 - Explore the Taylor Glory-hole tactite area by drilling or sinking below the present glory-hole at the end of the granite "nose" where both northeast and east-west faulting is present.

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MBK:P

Respectfully submitted,

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Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad B. Krauskopf

June 1944

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Tungsten Deposits near Rawhide, Mineral County, Nevada

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Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad B. Krauskopf

June 1944

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Abstract

Contact metamorphic tungsten deposits occur 4 miles east of Rawhide, Mineral County, Nevada, where a small granite stock, intrusive into Mesozoic limestone and metavolcanic rocks, is exposed in the midst of far more extensive Tertiary volcanic rocks. Scheelite, the tungsten-bearing mineral, is found in bodies of tactite, a dark-colored silicate rock composed essentially of garnet, epidote, calcite, quartz, and minor amounts of pyrite, magnetite, and scheelite. The tactite occurs at the contact between limestone and granite, and in lenses extending along bedding into limestone from the granite; it ranges in thickness from 2 to 50 feet, and is present only along small portions of the contact. Much of the tactite is scheelite-bearing, and large bodies contain from 0.5 to 1.5% of WO_3 .

Production to May 1944 was approximately 57,000 units of WO_3 from 70,000 tons of ore, a yield of 0.81 units per ton from ore which probably contained about 1.5% of WO_3 . Over 90 percent of this yield was from the Nevada Scheelite mine, the only important deposit in the district. In April 1944, reserves at this property were estimated at 191,950 tons of indicated ore containing 175,413 units of WO_3 , and 116,300 tons of inferred ore containing 96,000 units of WO_3 ; the tailings pile at the mill, at Dead Horse Wells 9 miles south of the mine, contains more than 50,000 tons of 0.49% WO_3 . In comparison, reserves from other properties in the district are negligible, and amount to only a few thousand tons.

Introduction

Contact metamorphic tungsten deposits occur at elevations of 5000 to 6000 feet in the southern part of the Sand Springs Range 4 miles east of the nearly deserted town of Rawhide, Nevada. The area is in the Regent Mining district in the extreme northern part of Mineral County, in secs. 1 and 12, T.13 N, R.32 E, Mt. Diablo Base and Meridian (fig. 1). It is about 25 miles airline east of

Figure 1. Index map of Nevada showing location of tungsten deposits near Rawhide.

Schurz and about 40 miles airline southeast of Fallon. The region is shown near the south border of the Carson Sink quadrangle.

The best road to the district is a 22-mile dirt road which leaves U. S. Highway 50 about 35 miles east of Fallon. Nearly as good is a 30-mile dirt road connecting Rawhide with Schurz, the nearest railroad point. The area can also be reached by poor desert roads from Luning and Hawthorne.

Scheelite, the tungsten-bearing mineral, was first recognized in the district in 1930, when the deposit, later known as the Nevada Scheelite or Leonard mine, was discovered. No extensive development was undertaken until 1936 when Nevada Scheelite, Inc. (mining affiliate of Mills Alloys, Inc. of Los Angeles, California) acquired the property and built a small mill at Dead Horse Wells, nine miles south of the deposit on a playa where water is available in wells. This mill was subsequently enlarged to 80 tons daily capacity, and was used to treat most of the ore mined in the district. About 1940, Beverly Moore built another small mill about 7 miles south of the Nevada Scheelite mine. This mill treated ore from the Hooper No. 1

mine, as well as small amounts of custom ore. It was dismantled in 1944.

Production of the district to the end of April 1944 was about 57,000 units of WO_3 from 70,000 tons of ore. At least 90 per cent of this yield was from the Nevada Scheelite mine, and the remainder from the Viking's Daughter, the Hooper No. 1, the Yankee Girl, and the Eed-a-how deposits.

This report is a compilation of work done for the Geological Survey by several geologists at different times. In the summer of 1942, the Stanford University field course in geology, known as the Stanford Geological Survey, directed by Malcolm B. Kildale, and partly financed under a cooperative agreement with the U. S. Geological Survey, made topographic and reconnaissance geologic maps of the district. These maps and the accompanying report were made available to the U. S. Geological Survey. In three weeks of June 1943, Konrad B. Krauskopf and Robert Stopper mapped the principal deposits in detail. From October 1943 to February 1944, Stopper served as geological adviser for a Bureau of Mines exploration program, revised mine maps, and prepared a geologic map covering an area of about 4 square miles in the vicinity of the Nevada Scheelite mine (fig. 2). Dwight M. Lemmon,

Figure 2. Geologic map of the vicinity of the tungsten deposits near Rawhide, Nevada.

of the Geological Survey, visited the area at numerous times while field work was under way, advised on exploration, and, in August 1945, with S. W. Hobbs, mapped about 200 feet of new workings on the 200 level of the Nevada Scheelite mine. Lemmon also revised this report for release.

The Bureau of Mines, in cooperation with the Geological Survey, explored the Nevada Scheelite properties with diamond drills from October 1943 to February 1944. Eleven holes totalling 2,365 feet in length were drilled under the direction of George W. Holmes, John Price, and Robert W. Geehan, each of whom was, in turn, engineer in charge of the project.

Geology

Rocks

The rocks exposed in the vicinity of the tungsten deposits consist of a metamorphosed series of interbedded volcanic and sedimentary rocks of Mesozoic age, Mesozoic granite which intrudes them, Mesozoic dikes of several varieties, and Cenozoic volcanic rocks. Adjoining the granite, part of the limestone has been altered by contact metamorphism to tactite containing scheelite ore bodies. The tactite bodies are too small to be shown on the general map of the district (fig. 2), but are shown on the more detailed maps.

The metamorphosed rocks consist of the following five stratigraphic units, starting with the oldest:-(1) lower metavolcanic rocks, (2) lower hornfels, (3) limestone, (4) upper hornfels, and (5) upper metavolcanic rocks. The thickness of the metavolcanic formations is unknown, but appears to be hundreds or even thousands of feet. The limestone appears to be about 750 feet thick in the southwestern part of the area mapped, (fig. 2), but may be only 400 feet thick north of the Nevada Scheelite mine. On the basis of lithology, these metamorphic rocks are tentatively referred to the Excelsior formation of Middle Triassic age described by Muller and Ferguson—

Muller, Siemon Wm., and Ferguson, Henry G., Mesozoic Stratigraphy of the Hawthorne and Tonopah, Quadrangles, Nevada, Geol. Soc. Am., Bull., vol. 50, pp. 1573-1624, 1939.

The lower metavolcanic rocks are altered andesite, dacite, and basalt flows, and interbedded, lenticular, agglomerate and conglomerate. Epidote is abundant along joint planes. Bedding is not determinable.

The lower hornfels is composed mainly of quartz in distinct, equidimensional grains up to 0.2 mm. in diameter, enclosed in a ground-mass of finer quartz, feldspar, sericite, and chlorite. The rock is of uniform texture and composition.

The limestone, where least metamorphosed, is a dark gray, finely crystalline rock composed almost entirely of calcite. In most of the area mapped, it has been recrystallized to a coarser-grained rock and has been bleached to a white or buff color for distances of a half mile or more from the granite. Adjoining granite contacts, it has been changed locally to dark-colored tactite in bodies up to 50 feet thick. About three quarters of a mile southwest of the Nevada Scheelite mine, and a half mile away from the nearest exposed granite, irregular portions of the limestone are weathered reddish-brown by oxidation of fine-grained pyrite disseminated through the rock. The distribution of these altered areas that cut across stratification is suggestive of a genetic relationship to the granite, for they lie roughly at the outer limit of the bleached, recrystallized aureole surrounding the intrusive. The pyritization might, however, be derived equally well from hydrothermal solutions accompanying Tertiary volcanic activity.

The upper hornfels is of variable composition and includes types in which quartz and garnet, quartz and sericite, andalusite, or andalusite and mica are prominent.

The upper metavolcanic rocks are mainly massive andesite flows with uniform texture and composition. Individual flows are not discernible. In thin section, the rock shows abundant, indistinct

plagioclase phenocrysts, probably andesine, up to 5 mm. long in a groundmass of the same mineral. Scattered through the groundmass-feldspar are small grains of magnetite, sericite, green mica, and hornblende. The mica and hornblende are concentrated, often with epidote, in spots whose shape suggests pseudomorphism after pyroxene.

The granite ranges from granite to granodiorite in composition. It is fine- to medium-grained with normal granitic texture. Biotite is the most abundant mafic mineral, often the only one, although hornblende predominates locally near contacts. Foliation is practically absent. The granite is probably a correlative of similar rocks in the Sierra Nevada, and hence of Upper Jurassic age.

The Cenozoic volcanic rocks are chiefly welded tuff and andesite, and are exposed only on the edges of the area mapped in figure 2. They are part of the Rawhide volcanics that cover the southwest part of the Sand Springs range.

Locally, north of the Nevada Scheelite mine, the older rocks have been hydrothermally altered to soft, conspicuously iron-stained material consisting chiefly of sericite, quartz, clay minerals, and pyrite. Sometimes original textures are sufficiently preserved to make possible identification of these rocks as schist, metavolcanics, or granite, but more often the alteration is so complete that original textures are unrecognizable. The alteration is probably associated with Tertiary volcanism.

Structure

The metavolcanic rocks, limestone, and hornfels (Excelsior formation) were folded and faulted prior to introduction of granite. The

limestone is well-bedded except where completely recrystallized, but the metavolcanic rocks are massive; so the details of the structure are gained from the limestone. The rocks in general dip steeply southeasterly, and, if local crumpling be disregarded, are folded into an anticline and a complementary syncline. The axis of the anticline, which pitches steeply southeast, is 500 feet southwest of the Nevada Scheelite shaft, and the axis of the syncline is about half a mile southwest of the shaft. These folds have been disrupted by a number of pre-granite normal faults that cause repetition of beds. The faults dip steeply northerly, and displacements, which range up to 1000 feet, are mostly down the dip.

Emplacement of the granite intrusive was controlled in part by the earlier faults, in part by the relative susceptibility of the rocks invaded. The embayment in the limestone between the Hooper No. 1 and Nevada Scheelite shafts was facilitated by fault intersections. Similarly, the position of the granite in the north part of the Nevada Scheelite mine was controlled by a pre-granite fault. Much of the granite stock now fills space formerly occupied by the upper meta-volcanic rocks.

Post-granite faults are of minor importance, and are mainly restricted to contacts between granite and metamorphic rocks. They are rarely recognizable at the surface, but are present in the underground workings of the Nevada Scheelite mine where the contacts between tactite and granite are crushed by faults of small displacement.

Ore Deposits

The tungsten deposits are of the contact metamorphic type and consist of scheelite (calcium tungstate) disseminated in tactite. The known occurrences are at or near contacts between granite and limestone where the limestone has been altered to tactite. This tactite alteration is present along only a small proportion of the contact, and all the tactite does not contain scheelite. Much of the limestone is in direct contact with the granite without intervening tactite.

Other mineral deposits, distinct from the tungsten occurrences, were formerly worked in the district. The quartz veins in metavolcanic rocks at Sunnyside, three quarters of a mile east of the Nevada Scheelite mine, were worked on a small scale for gold. Other veins yielded small amounts of barite, lead, silver, and copper. The quartz veins at Rawhide, west of the area mapped for this report, occupy fractures in Tertiary volcanic rocks, and yielded about a million dollars in gold. They are connected with a later period of mineralization than that responsible for the other deposits, which are probably allied to the granite intrusive.

The Nevada Scheelite mine is the largest tungsten deposit known in the district. Four other productive deposits are within a half mile of the main deposit, and scattered occurrences of scheelite are known within a radius of several miles. The Nevada Scheelite and Hooper No. 1 deposits are on the west side of the main granite stock, and the contacts dip beneath the granite. The Viking's Daughter (Glory Hole) is at the edge of a small offshoot from the main granite body. Eed-a-how is in a limestone pendant in the granite, and Yankee

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The ore bodies appear to be localized by a combination of the following: (1) a contact of limestone with granite or with hornfels or metavolcanic rocks; (2) bends in the contacts; (3) pre-granite faulting. The thickest known tactite masses (those at the Nevada Scheelite and Hooper No. 1 mines) are along contacts that cut across the limestone beds where the contacts dip beneath the granite.

The tactite bodies range in thickness from a few inches up to 50 feet. The thick portions tend to form shoots with some vertical continuity, although the tactite appears to be lenticular in plan.

The primary tactite ore consists dominantly of andradite garnet in red to brown zoned crystals up to an inch or more in diameter. Accompanying the garnet are variable quantities of calcite, quartz, amphibole, epidote, pyroxene, wollastonite, pyrite, magnetite, scheelite, and chalcopyrite. Scheelite, the only ore mineral, occurs in fine grains and in euhedral crystals up to an inch in diameter. In ultraviolet light, the scheelite fluoresces light yellow, indicative of molybdenum. Concentrates from the mill average 0.5% of Mo, presumably contained in the scheelite.

The ore bodies in the Nevada Scheelite mine are largely oxidized to the 200-foot level, the deepest in the district, and on this level, remnants of sulfides are found only in isolated zones. As the result of oxidation, the pyrite and other sulfides, and some of the garnet, were changed to limonite. Some of the ore is stained green by malachite formed by oxidation of chalcopyrite, but the ore in general

contains less than 0.6% of Cu although some isolated samples from drill cores ran as much as 5.4% of Cu. It is expected that the percentage of unaltered sulfides will increase at depth, but it is not likely that all the primary tactite contains high percentages of sulfides, for the sulfide content of samples from drill holes beneath the present mine ranges down to very small amounts.

The grade of the ore ranges from 0.5% of WO_3 to 2.0% or greater in bodies of commercial importance.

MINES

Nevada Scheelite, Inc.

Nevada Scheelite, Inc. owns the following 16 patented, adjoining claims covering the largest tungsten deposits known in the district:-

Gussie L.	Blanco No. 1	Tungsten No. 1	Princess
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The Nevada Scheelite mine on the Don claim and the Glory Hole on the Viking's Daughter claim are the only deposits that have been worked.

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The Nevada Scheelite mine is opened by a 3-compartment vertical shaft 270 feet deep with levels at 50, 100, and 200 feet. There are 3200 feet of drifts and 500 feet of raises in the mine, and a number of stopes (figs. 4 - 9).

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In the vicinity of the Nevada Scheelite mine, the metamorphic rocks are folded into an anticline that pitches steeply southeast. Southwest of the mine these rocks strike east and dip steeply south; in the vicinity of the mine itself, they strike northeast and dip from vertical to steeply southeast. The limestone, 400 feet thick near the mine, was locally altered to tactite by the granite intrusive in a zone about 1800 feet long and from 2 to 50 feet wide. Although much of the tactite is covered at the surface, it is shown to be remarkably persistent in underground workings and drill holes and extends to a depth of at least 400 feet. Most of the tactite in the zone contains at least 0.5% of WO_3 and much of it contains 1.5% of WO_3 .

For a distance of 700 feet, from 600 feet south of the Nevada Scheelite shaft to 100 feet north, the contact between granite and limestone is nearly vertical, and is concordant with bedding in the limestone. The tactite zone on the contact, is narrow, with widths of from 2 to 10 feet, except in the vicinity of the shaft where it is 20 feet wide in places. North of the shaft, at distances of 100 feet on the surface, 150 feet on the 100 level, and 200 feet on the 200 level, the contact swings sharply westward across the beds in the limestone, and flattens to dips of 30° to 40° northeast. This change in attitude persists for 350 feet northwesterly where another change in direction of the contact makes it once again concordant with the limestone.

The two bends and intermediate flattening in the contact were caused by a pre-granite fault which strikes northwest and dips 30° to 40° northeast. The limestone beds north of the fault are displaced about 350 feet northwest. This fault helped control the emplacement of the granite, which was later intruded along it. The largest ore

bodies known in the district are between these two bends. Tactite extends down the flat dip of the contact, with granite above and limestone below, and also follows south along beds in the limestone. In places, the tactite layers are as much as 50 feet thick, but taper southward into limestone within 100 feet of the main contact. At the surface, isolated outcrops of tactite, some rich in scheelite, occur in limestone more than 100 feet from the main granite contact, most of them associated with small faults and granite dikes. At depth, these isolated bodies of tactite may enlarge and coalesce with the larger replacement bodies that penetrate along the limestone beds.

North of the bends in the contact, the granite and limestone are concordant and dip steeply northeast. For 600 feet northward, the tactite zone appears to be mostly 10 to 20 feet thick with only a few thinner portions. This part of the contact is poorly exposed at the surface, and is known underground only from 4 drill holes.

About 50,000 units of WO_3 had been recovered from about 60,000 tons of ore to the end of April 1944, a yield of 0.83 units per ton. Detailed sampling by the Bureau of Mines of the tailings pile at the Nevada Scheelite mill showed an average content of 0.49% of WO_3 . Slimes, estimated to contain 0.2% of WO_3 , are not impounded by the tailings pile. From these figures, the average grade of ore appears to be about 1.5% of WO_3 , a value which is consistent with the estimate based on an examination of the mine with ultraviolet light. Little ore containing less than 0.7% of WO_3 was mined and occasional rich pockets contained 5% of WO_3 or more. Drilling and sampling appear to indicate that ore remaining in the mine will average less than 1.5% of WO_3 .

Estimates of reserves were prepared jointly by R. W. Geehan of the Bureau of Mines and Robert Stopper (fig. 9).

<u>Class of ore</u>	<u>Short tons</u>	<u>% of WO_3</u>	<u>Units</u>
Indicated	192,000	0.91	175,000
Inferred	<u>116,000</u>	0.65	<u>76,000</u>
	308,000		251,000

Ore two feet or less in width constitutes 10 percent of the above tonnages, and another 15 percent will probably be left as pillars in mining operations. Further exploration might show the deposit to contain in addition about 300,000 tons of ore with a content of 0.5% or more of WO_3 .

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Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad E. Krauskopf

June 1944

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- Figure 2. Geologic map of the vicinity of the tungsten deposits near Rawhide, Nevada.
- Figure 3. Surface map, Nevada Scheelite mine.
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- Figure 9. Vertical projections of the Nevada Scheelite mine showing ore reserves.
- Figure 10. Maps and section of workings on Viking's Daughter claim and map of Yankee Girl Mine.
- Figure 11. Maps, section, and projection of Hooper No. 1 mine and map and section of Hooper No. 2 mine.

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Tungsten Deposits near Rawhide, Mineral County, Nevada

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Robert Stopper and Konrad B. Krauskopf

June 1944

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Abstract

Contact metamorphic tungsten deposits occur 4 miles east of Rawhide, Mineral County, Nevada, where a small granite stock, intrusive into Mesozoic limestone and metavolcanic rocks, is exposed in the midst of far more extensive Tertiary volcanic rocks. Scheelite, the tungsten-bearing mineral, is found in bodies of tactite, a dark-colored silicate rock composed essentially of garnet, epidote, calcite, quartz, and minor amounts of pyrite, magnetite, and scheelite. The tactite occurs at the contact between limestone and granite, and in lenses extending along bedding into limestone from the granite; it ranges in thickness from 2 to 50 feet, and is present only along small portions of the contact. Much of the tactite is scheelite-bearing, and large bodies contain from 0.5 to 1.5 % of WO_3 .

Production to May 1944 was approximately 57,000 units of WO_3 from 70,000 tons of ore, a yield of 0.81 units per ton from ore which probably contained about 1.5 % of WO_3 . Over 90 percent of this yield was from the Nevada Scheelite mine, the only important deposit in the district. In April 1944, reserves at this property were estimated at 191,950 tons of indicated ore containing 175,413 units of WO_3 , and 116,300 tons of inferred ore containing 96,000 units of WO_3 ; the tailings pile at the mill, at Dead Horse Wells 9 miles south of the mine, contains more than 50,000 tons of 0.49 % WO_3 . In comparison, reserves from other properties in the district are negligible, and amount to only a few thousand tons.

Introduction

Contact metamorphic tungsten deposits occur at elevations of 5000 to 6000 feet in the southern part of the Sand Springs Range 4 miles east of the nearly deserted town of Rawhide, Nevada. The area is in the Regent Mining district in the extreme northern part of Mineral County, in secs. 1 and 12, T.13 N., R.32 E., Mt. Diablo Base and Meridian (fig. 1). It is about 25 miles airline east of

Figure 1. Index map of Nevada showing location of tungsten deposits near Rawhide.

Schurz and about 40 miles airline southeast of Fallon. The region is shown near the south border of the Carson Sink quadrangle.

The best road to the district is a 22-mile dirt road which leaves U. S. Highway 50 about 35 miles east of Fallon. Nearly as good is a 30-mile dirt road connecting Rawhide with Schurz, the nearest railroad point. The area can also be reached by poor desert roads from Luning and Hawthorne.

Scheelite, the tungsten-bearing mineral, was first recognized in the district in 1930, when the deposit, later known as the Nevada Scheelite or Leonard mine, was discovered. No extensive development was undertaken until 1936 when Nevada Scheelite, Inc. (mining affiliate of Mills Alloys, Inc. of Los Angeles, California) acquired the property and built a small mill at Dead Horse Wells, nine miles south of the deposit on a playa where water is available in wells. This mill was subsequently enlarged to 80 tons daily capacity, and was used to treat most of the ore mined in the district. About 1940, Beverly Moore built another small mill about 7 miles south of the Nevada Scheelite mine. This mill treated ore from the Hooper No. 1

mine, as well as small amounts of custom ore. It was dismantled in 1944.

Production of the district to the end of April 1944 was about 57,000 units of WO_3 from 70,000 tons of ore. At least 90 percent of this yield was from the Nevada Scheelite mine, and the remainder from the Viking's Daughter, the Hooper No. 1, the Yankee Girl, and the Bed-a-how deposits.

This report is a compilation of work done for the Geological Survey by several geologists at different times. In the summer of 1942, the Stanford University field course in geology, known as the Stanford Geological Survey, directed by Malcolm B. Kildale, and partly financed under a cooperative agreement with the U. S. Geological Survey, made topographic and reconnaissance geologic maps of the district. These maps and the accompanying report were made available to the U. S. Geological Survey. In three weeks of June 1943, Konrad B. Krauskopf and Robert Stopper mapped the principal deposits in detail. From October 1943 to February 1944, Stopper served as geological adviser for a Bureau of Mines exploration program, revised mine maps, and prepared a geologic map covering an area of about 4 square miles in the vicinity of the Nevada Scheelite mine (fig. 2). Dwight M. Lemmon,

Figure 2. Geologic map of the vicinity of the tungsten deposits near Rawhide, Nevada.

of the Geological Survey, visited the area at numerous times while field work was under way, advised on exploration, and, in August 1945, with S. W. Hobbs, mapped about 200 feet of new workings on the 200 level of the Nevada Scheelite mine. Lemmon also revised this report for release.

The Bureau of Mines, in cooperation with the Geological Survey, explored the Nevada Scheelite properties with diamond drills from October 1943 to February 1944. Eleven holes totalling 2,365 feet in length were drilled under the direction of George W. Holmes, John Price, and Robert W. Geehan, each of whom was, in turn, engineer in charge of the project.

Geology

Rocks

The rocks exposed in the vicinity of the tungsten deposits consist of a metamorphosed series of interbedded volcanic and sedimentary rocks of Mesozoic age, Mesozoic granite which intrudes them, Mesozoic dikes of several varieties, and Cenozoic volcanic rocks. Adjoining the granite, part of the limestone has been altered by contact metamorphism to tectite containing scheelite ore bodies. The tectite bodies are too small to be shown on the general map of the district (fig. 2), but are shown on the more detailed maps.

The metamorphosed rocks consist of the following five stratigraphic units, starting with the oldest:- (1) lower metavolcanic rocks, (2) lower hornfels, (3) limestone, (4) upper hornfels, and (5) upper metamolcanic rocks. The thickness of the metavolcanic formations is unknown, but appears to be hundreds or even thousands of feet. The limestone appears to be about 750 feet thick in the southwestern part of the area mapped, (fig. 2), but may be only 400 feet thick north of the Nevada Scheelite mine. On the basis of lithology, these metamorphic rocks are tentatively referred to the Excelsior formation of Middle Triassic age described by Muller and Ferguson

/ Muller, Simon Wm., and Ferguson, Henry C., Mesozoic Stratigraphy of the Hawthorne and Tonopah Quadrangles, Nevada, Geol. Soc. Am., Bull., vol. 50, pp. 1573-1624, 1939.

The lower metavolcanic rocks are altered andesite, dacite, and basalt flows, and interbedded, lenticular, agglomerate and conglomerate. Epidote is abundant along joint planes. Bedding is not determinable.

The lower hornfels is composed mainly of quartz in distinct, equidimensional grains up to 0.2 mm. in diameter, enclosed in a ground-mass of finer quartz, feldspar, sericite, and chlorite. The rock is of uniform texture and composition.

The limestone, where least metamorphosed, is a dark gray, finely crystalline rock composed almost entirely of calcite. In most of the area mapped, it has been recrystallized to a coarser-grained rock and has been bleached to a white or buff color for distances of a half mile or more from the granite. Adjoining granite contacts, it has been changed locally to dark-colored tactite in bodies up to 50 feet thick. About three quarters of a mile southwest of the Nevada Scheelite mine, and a half mile away from the nearest exposed granite, irregular portions of the limestone are weathered reddish-brown by oxidation of fine-grained pyrite disseminated through the rock. The distribution of these altered areas that cut across stratification is suggestive of a genetic relationship to the granite, for they lie roughly at the outer limit of the bleached, recrystallized aureole surrounding the intrusive. The pyritization might, however, be derived equally well from hydrothermal solutions accompanying Tertiary volcanic activity.

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For a distance of 700 feet, from 600 feet south of the Nevada Scheelite shaft to 100 feet north, the contact between granite and limestone is nearly vertical, and is concordant with bedding in the limestone. The tactite zone on the contact, is narrow, with widths of from 2 to 10 feet, except in the vicinity of the shaft where it is 20 feet wide in places. North of the shaft, at distances of 100 feet on the surface, 150 feet on the 100 level, and 200 feet on the 200 level, the contact swings sharply westward across the beds in the limestone, and flattens to dips of 30° to 40° northeast. This change in attitude persists for 350 feet northwesterly where another change in direction of the contact makes it once again concordant with the limestone.

The two bends and intermediate flattening in the contact were caused by ^apre-granite fault which strikes northwest and dips 30° to 40° northeast. The limestone beds north of the fault are displaced about 350 feet northwest. This fault helped control the emplacement of the granite, which was later intruded along it. The largest ore

bodies known in the district are between these two bends. Tactite extends down the flat dip of the contact, with granite above and limestone below, and also follows south along beds in the limestone. In places, the tactite layers are as much as 50 feet thick, but taper southward into limestone within 100 feet of the main contact. At the surface, isolated outcrops of tactite, some rich in scheelite, occur in limestone more than 100 feet from the main granite contact, most of them associated with small faults and granite dikes. At depth, these isolated bodies of tactite may enlarge and coalesce with the larger replacement bodies that penetrate along the limestone beds.

North of the bends in the contact, the granite and limestone are concordant and dip steeply northeast. For 600 feet northward, the tactite zone appears to be mostly 10 to 20 feet thick with only a few thinner portions. This part of the contact is poorly exposed at the surface, and is known underground only from 4 drill holes.

About 50,000 units of WO_3 had been recovered from about 60,000 tons of ore to the end of April 1944, a yield of 0.83 units per ton. Detailed sampling by the Bureau of Mines of the tailings pile at the Nevada Scheelite mill showed an average content of 0.49 % of WO_3 . Slimes, estimated to contain 0.2 % of WO_3 , are not impounded by the tailings pile. From these figures, the average grade of ore appears to be about 1.5 % of WO_3 , a value which is consistent with the estimate based on an examination of the mine with ultraviolet light. Little ore containing less than 0.7 % of WO_3 was mined and occasional rich pockets contained 5 % of WO_3 or more. Drilling and sampling appear to indicate that ore remaining in the mine will average less than 1.5 % of WO_3 .

Estimates of reserves were prepared jointly by R. W. Geehan of the Bureau of Mines and Robert Stopper (fig. 9).

<u>Class of ore</u>	<u>Short tons</u>	<u>% of WO_3</u>	<u>Units</u>
Indicated	192,000	0.91	175,000
Inferred	116,000	0.65	76,000
	308,000		251,000

Ore two feet or less in width constitutes 10 percent of the above tonnages, and another 15 percent will probably be left as pillars in mining operations. Further exploration might show the deposit to contain in addition about 300,000 tons of ore with a content of 0.5 % or more of WO_3 .

Viking's Daughter Claim (Glory Hole)

The Viking's Daughter claim, one-third of a mile northwest of the Nevada Scheelite mine, was worked from 1937 to 1939 by Nevada Scheelite, Inc., the owners. Workings consist of an open pit, a short adit in one face of the pit, and several small open cuts (fig. 10).

Figure 10. Maps and section of workings on Viking's Daughter claim and map of Yankee Girl mine.

About 3000 tons of ore with an average content of 1 to 2 % of WO_3 was mined from the property. A total of about 5000 tons of material was removed from the main pit, the adit, and adjacent small pits.

The deposit is an irregular mass of tactite formed in limestone at the contact with a small body of granite. The contact between tactite and granite is a nearly vertical, post-mineral fault. Honey-combed, limonite-stained quartz is enclosed within the main tactite mass in the open pit and a similar body of quartz, with less limonite, is exposed in the adit and on the east rim of the pit. Both quartz

bodies are barren of scheelite. The floor of the pit is concealed by debris, and the only exposures of scheelite-bearing tactite are on the walls in disconnected patches estimated to contain 1.0 % of WO_3 . It is reported that ore was left in the bottom of the pit, and that the workings were abandoned because of better-grade ore found in the Nevada Scheelite mine.

Small isolated outcrops of tactite occur in limestone southeast of the main pit and in a smaller pit 50 feet south of the large pit. None of these contain appreciable amounts of scheelite.

Hooper property (Primrose group)

The Primrose group of 8 unpatented claims (Primrose, Primrose extension, Suzanne Ellen, Homer, Ajax, Ajax No. 2, Ajax No. 3, and Ajax No. 4), owned by J. H. Hooper, adjoin the Nevada Scheelite holdings on the south. Except for prospect pits, the only exploration is in the Hooper No. 1 mine on the Ajax No. 3 claim, and in the Hooper No. 2 workings on the Ajax claim. The only production was from the Hooper No. 1 mine.

Hooper No. 1 Mine

The Hooper No. 1 mine, also known as the Moore lease shaft and the Primrose mine, is 1500 feet south of the Nevada Scheelite shaft. Workings consist of a 100-foot vertical shaft, a drift for 200 feet southeast of the shaft on the 100-foot level, and stopes between this level and the surface. An inclined winze 25 feet deep was dug below the 100-foot level near the south face. Nevada Scheelite, Inc. leased the property from 1937 to 1939 and mined 1500 tons of 2 percent ore from the upper part of the mine. Beverly Moore leased the property in 1940 and mined about 5000 tons of ore from which he recovered about 1800 units of WO_3 in his mill.

On the 50-foot level of the mine, the tactite exposed in stopes was 5 to 25 feet thick, whereas on the 100-foot level, the tactite in the drift was only 2 to 10 feet thick. At the shaft, the contact is steep; southeast of the shaft, however, the contact is inclined about 45° northeast, with the granite lying on top of the tactite and limestone. The richest ore, estimated at 2 % of WO_3 , was mined from the upper stope just south of the shaft. According to Mr. Moore, fairly good ore was taken from the stope farthest to the south, from the 100-level up to about the 25-foot level, although the ore was of poorer grade near the bottom. The single small stope north of the shaft was in a thick body of tactite averaging less than 0.5 % of WO_3 . The best ore exposed in the mine in 1944 was a small strip on the south wall of the southernmost stope, probably cut off by a marble a short distance south, and a thin layer of tactite exposed in the winze below the 100-level. Reserves of indicated ore are estimated at 120 tons containing 2 % of WO_3 and 800 tons containing 0.5 % of WO_3 .

Northwest of the shaft, the contact is covered by alluvium which may conceal ore bodies. The curvature of the granite contact, coupled with the presence of several pre-granite faults, suggest that this portion of the contact, for 500 feet northwest of the Hooper No. 1 shaft, is worth exploration in search of new ore bodies. South of the shaft, neither the surface exposures nor those on the 100-foot level show much tactite or ore.

Hooper No. 2 Mine

The Hooper No. 2 shaft, located on the Ajax claim about 1000 feet south of the Hooper No. 1 shaft, is 110 feet deep on the incline. From the bottom, 140 feet of drift extend northeastward. A winze

sunk 16 feet below this drift leads to another 20 feet of drift on a slightly lower level.

The workings follow a tactite layer in a somewhat foliated andalusite-biotite hornfels. This layer is about 20 feet stratigraphically above the main limestone, which is exposed northwest of the shaft. Scattered tiny outcrops of granite appear in the hornfels about 100 feet east of the shaft, but the nearest contact with the main granite mass is 400 feet east. The tactite ranges from 1 to 10 feet thick. Much of it is coarsely crystalline, with large epidote and quartz crystals. Clear, transparent, euhedral scheelite crystals up to half an inch in diameter have been found in vugs. Distribution of scheelite is erratic. Most of the tactite in the shaft contains a little scheelite, somewhat concentrated toward the footwall; two rich spots contain 3 or 4 % of WO_3 , but short drifts cut through them into barren material. The best ore found is in the drift, in a pillar 60 feet north of the shaft where a block of about 15 tons contains 4 % of WO_3 . The workings show that the only ore to be expected is in small, isolated pockets.

Eed-a-how claim

The Eed-a-how claim adjoins the Nevada Scheelite property on the east, and the workings are about 1700 feet northeast of the Nevada Scheelite shaft. The claim is owned by W. A. Adams, and was leased in 1942-43 by J. A. Madison, who shipped 300 tons of 1.5 % WO_3 ore to Metals Reserve Co. The shaft is 85 feet deep on a 70° incline to the south. At the 50-foot level, a drift extends 100 feet east; several small stopes have been dug above.

The shaft follows a tactite layer on the south side of an east-trending sliver of limestone 15 or more feet thick. The hanging wall of the shaft is granite, the footwall is limestone, and the tactite between ranges from 5 feet in thickness down to nothing. At the surface, the ground is covered by large granite boulders which obscure bedrock. Small outcrops of tactite and limestone appear 100 feet west and 35 feet east of the shaft. The limestone thus has a proved extent of 100 feet on each side of the shaft; whether it is a pendant or connected with the limestone exposed 600 feet west of the shaft is unknown. Tactite and limestone extend beneath the bottom of the shaft.

Scheelite is unevenly distributed through the tactite. The average grade of all the tactite is probably 0.5 % of WO_3 . Portions of it contain 1.5 % of WO_3 . Reserves were estimated in 1944 at 1000 tons of indicated ore and 1500 tons of inferred ore, all with an average grade of 1.0 % of WO_3 .

Yankee Girl Mine

The Yankee Girl mine is half a mile northeast of the Nevada Scheelite mine on the north border of the granite stock. It is owned by Leo and Eugene Grutt, and was leased in 1943 to Goldfield Consolidated Mining Co. The owners produced 50 tons of 1.0 percent ore, and Goldfield Consolidated mined 150 tons of 1.5 percent ore. Fifty tons of the latter was shipped to the Metals Reserve Co. stockpile in Salt Lake City, and 100 tons was concentrated in the district at the Moore mill.

The mine is opened by an adit with 200 feet of workings in two branches (fig. 10). A winze extends 25 feet below the adit, and a

raise connects the east face of the adit with the surface. Another exploratory raise 18 feet high was dug in a north branch of the adit.

The mine is on a contact between granite and hornfels. At the surface, tactite is exposed discontinuously in pits for a distance of 140 feet. In the adit, the tactite exposed has no continuity, and consists of thin layers bordering small, xenolith-like masses of limestone enclosed in granite. These discontinuous limestone lenses probably represent a formerly continuous limey layer in the clastic sediments which formed the hornfels. Scheelite is distributed erratically through the tactite, with ore containing 0.5 % of WO_3 appearing at places along the walls of the drift. In 1944 the best ore exposed consisted of a face in the winze showing 1.0 % of WO_3 over an area 6 by 8 feet. Indicated ore exposed by the workings at that time was estimated at 20 tons of 1.0 % WO_3 and 150 tons of 0.5 % WO_3 .

Other properties

A small amount of ore has been produced from three of four small properties outside the area mapped for this report. The "Strand Upper property", 4 unpatented claims held by William Strand and R. H. Sheehy, is 2 miles northwest of the Nevada Scheelite mine. Forty pounds of scheelite was produced from a single pocket mined in one of several small open cuts. Small bodies of tactite, several feet in diameter, formed by the alteration of limestone by a nearby granite intrusive, occur in an area of about half a square mile. The tactite contains only occasional crystals of scheelite.

The Big Kassok claim, $1\frac{1}{2}$ miles northeast of the Nevada Scheelite mine, is held by Eugene Grutt, Eugene Grutt, Jr., and Leo Grutt. A 30-foot adit and two small open cuts were dug on a tactite body in

metavolcanic rocks. The tactite is 150 feet long and as much as 35 feet wide. It strikes N. 70 E. and dips vertically. A small amount of scheelite is erratically distributed in the tactite, the largest concentrations containing an average of 0.1 % of WO_3 .

The Crystal No. 1 and No. 2 claims (the "Tom Kenyon property", held by the estate of Tom Kenyon), are 8 miles east of Rawhide. The property was leased in 1939 to Beverly Moore who produced 30 tons of ore containing 0.25 % of WO_3 and, in 1940 to Forest J. Sur, who produced 36 tons of ore containing 0.62 % of WO_3 . Two small bodies of tactite occur in a granodiorite stock surrounded by metavolcanic rocks. The tactite bodies are regular in outline and 20 and 8 feet respectively in diameter. A 15-foot shaft has been sunk in each. Scheelite is erratically distributed in the tactite; probably half the tactite exposed averages 0.5 % of WO_3 content. Reserves are estimated at 900 tons of indicated ore containing 0.5 % of WO_3 .

The "Strand Lower property", 12 claims held by William Strand and R. E. Sheehy, is 10 miles east of Rawhide. The property was leased to Nevada Scheelite, Inc. in 1940 and to Beverly Moore in 1943. Nevada Scheelite produced 10 tons of ore containing 0.5 % of WO_3 and Moore, 20 tons containing 0.5 % of WO_3 . A limestone lens in metavolcanic rocks has been partly altered to tactite that contains powellite and erratically distributed scheelite. Small granite dikes crop out in the vicinity. Reserves are estimated at 50 tons of indicated ore containing 0.5 % of WO_3 .

* * * * *

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Rawhide - REGENT DIST.

Important deposits of tectite containing scheelite occur at elevations of 5,000 to 6,000 feet in the southern part of the Sand Springs Range 4 miles east of the nearly deserted town of Rawhide. The area is in the Rawhide mining district, also known as the Regent district, in the extreme northern part of Mineral County, in secs. 1 and 12, T. 18 N., R. 32 E., and is shown near the south border of the Carson Sink quadrangle. The best of several routes to the tungsten district is a 22-mile dirt road that joins U. S. Highway 50 east of Sand Springs and about 35 miles east of Fallon.

Scheelite was discovered in 1930 in the deposit later known as the Nevada Scheelite or Leonard mine. No extensive development was undertaken until 1936 when Nevada Scheelite, Inc. (mining affiliate of Mills Alloys, Inc. of Los Angeles) acquired the property and built a small mill at Dead Horse Wells, 9 miles south of the deposit on a playa where water is available in wells. This mill was subse-

quently enlarged to 80 tons daily capacity, and handled most of the tungsten ore mined in the district until it was destroyed by fire on June 10, 1946. A new mill, built at the mine, was completed in September 1947.

About 1940, Wm. Beverly Moore built a small mill 7 miles south of the Nevada Scheelite mine near the playa, and treated ore from the Hooper No. 1 mine and small amounts of custom ore. This mill was dismantled in 1944.

Production of the district to the end of 1947 was about 81,350 units of WO_3 from 106,000 tons of ore treated. The Nevada Scheelite mine produced most of this ore. Small outputs were made from the Viking's Daughter, the Hooper No. 1, the Yankee Girl, and the Eed-a-ho deposits.

The Nevada Scheelite deposit was explored by the U. S. Bureau of Mines ^{between} ~~in~~ October 1943 and February 1944. Eleven holes with a combined length of 2,365 feet were core-drilled under the supervision

of G. W. Holmes, Jr., John Price, and R. W. Geehan, successively in charge of the project.

Anonymous, Nevada Scheelite, Inc., Mineral County, Nevada: U. S. Bureau of Mines, War Minerals Report 362, 19 p., 1945.

Geology

The rocks exposed in the vicinity of the tungsten deposits consist of interbedded, metamorphosed volcanic and sedimentary rocks of Mesozoic age, which are invaded by granite and capped by Cenozoic volcanic rocks. Part of the limestone adjoining the granite has been altered to taectite, a portion of which contains scheelite in commercial amounts. The taectite bodies are too small to be shown on the general map of the district (fig. 129), but are shown on the more detailed maps.

Fig. 129. Geologic map and section of the tungsten district near Rawhide, Mineral County, Nevada.

The metamorphosed rocks consist of the following five stratigraphic

units, starting with the oldest: (1) lower metavolcanic rocks, (2) lower hornfels, (3) limestone, (4) upper hornfels, and (5) upper metavolcanic rocks. The thicknesses of the metavolcanic formations are unknown, but appear to be hundreds or even thousands of feet. The limestone is about 750 feet thick in the southwestern part of the area mapped, but may be only 400 feet thick north of the Nevada Scheelite mine. On the basis of lithology, these metamorphic rocks are tentatively referred to the Excelsior formation of Middle Triassic age described by Muller and Ferguson¹.

¹ Muller, S. W., and Ferguson, H. G., Mesozoic stratigraphy of the Hawthorne and Tonopah quadrangles, Nevada; Bull. Geol. Soc. Am., vol. 50, pp. 1573-1624, 1939.
no. 10,

The lower metavolcanic rocks are altered andesite, dacite, and basalt flows, and interbedded agglomerate. Epidote is abundant along joint planes. Bedding is not determinable.

The lower hornfels is composed mainly of quartz in distinct,

equidimensional grains up to 0.2 mm. in diameter, enclosed in a ground-mass of finer quartz, feldspar, sericite, and chlorite. The rock is of uniform texture and composition.

The limestone, where least metamorphosed, is a dark-gray, finely-crystalline rock composed almost entirely of calcite. In most of the area mapped, it has been recrystallized to a coarser-grained rock and has been bleached to a white or buff color for distances of half a mile or more from the granite. Adjoining granite contacts, it has been changed locally to dark-colored tectite which occurs in bodies up to 50 feet thick.

The upper hornfels is of variable composition and includes types in which quartz and garnet, quartz and sericite, andalusite, or andalusite and mica are prominent.

The upper metavolcanic rocks are mainly massive andesite flows with uniform texture and composition. Individual flows are not discernible.

The granitic intrusive ranges from granite to granodiorite. It is fine- to medium-grained with normal granitic texture and shows no foliation. Biotite is the most abundant mafic mineral, often the only one, although hornblende predominates locally near contacts. The granite is probably a correlative of similar rocks in the Sierra Nevada, and hence of Upper Jurassic age.

The Cenozoic volcanic rocks are chiefly welded tuff and andesite, and are exposed only on the edges of the area mapped in fig. 129.

Locally, irregular areas of the older rocks have been hydrothermally altered. North of the Nevada Scheelite mine the alteration has produced several areas of soft, conspicuously iron-stained material consisting chiefly of sericite, quartz, clay minerals, and pyrite. In places original textures are sufficiently preserved to make possible identification of these rocks as schist, metavolcanics, or granite, but generally the alteration is so complete that original textures are unrecognizable. About three-quarters of a mile south-

west of the Nevada Scheelite mine, and half a mile away from the nearest exposed granite, irregular portions of the limestone are weathered reddish-brown by oxidation of fine-grained pyrite disseminated through the rock. Alteration of the non-calcareous rocks is probably related to Tertiary volcanism. Pyritization of the limestone may be similarly explained, although the distribution of the altered limestone areas at the outer limit of the bleached, recrystallized aureole surrounding the intrusive suggests a possible genetic relationship with the granite.

The older rocks were folded and faulted before invasion by granite. The details of the structure in these rocks are obtainable only from the limestone, which is well-bedded except where completely recrystallized. The metavolcanic rocks are massive. The beds in general dip steeply southeastward and are folded into an open anticline and complementary syncline, both of which plunge steeply southeast. The axis of the anticline is 500 feet southwest of the Nevada Scheelite

shaft. The folds have been disrupted by 2 sets of pre-granite normal faults that cause repetition of beds. One set of faults strikes northwest and dips steeply northeast, the other strikes northeast and dips steeply northwest. The maximum displacement is about 1,000 feet, and movement was mostly dip-slip.

Emplacement of the granite was controlled in part by the earlier faults, in part by the relative susceptibility of the rocks invaded. Formation of the embayment in the limestone between the Hooper No. 1 and Nevada Scheelite shafts was facilitated by fault intersections. Similarly, the position of the granite in the north part of the Nevada Scheelite mine was controlled by a pre-granite fault. Much of the granite stock now fills space formerly occupied by the upper meta-volcanic rocks.

Post-granite faults are of minor importance, and are mainly restricted to contacts between granite and metamorphic rocks. They are rarely recognizable at the surface, but are present in the underground workings of the Nevada Scheelite mine where the contacts be-

tween tactite and granite are crushed by faults of small displacement.

Tactite occurs along only a small proportion of the contact between granite and limestone, and only part of the tactite contains scheelite. Much of the limestone is in direct contact with granite without intervening tactite. The tactite bodies range in thickness from a few inches to 50 feet. The thick portions tend to form shoots with some vertical continuity, although each tactite body appears to be lenticular in plan.

The fresh tactite ore consists dominantly of andradite garnet accompanied by variable quantities of calcite, quartz, amphibole, epidote, pyroxene, wollastonite, pyrite, magnetite, scheelite, and chalcopyrite. Most of the scheelite occurs in fine grains, although euhedral crystals up to an inch in diameter have been found. The content of WO_3 in ore bodies of commercial importance ranges from 0.5 to more than 2.0 percent. In ultraviolet light, the scheelite fluoresces light yellow, indicative of some contained molybdenum, and concentrates average 0.5 percent of MoO_3 .

The ore bodies in the Nevada Scheelite mine are largely oxidized to the 200-foot level, and remnants of sulfides are found only in isolated spots. As the result of oxidation, the pyrite and other sulfides, and some of the garnet, were changed to limonite. Some of the ore contains malachite formed from chalcopryite, but the content of copper is generally less than 0.6 percent although a few samples from drill cores contained a maximum of 5.4 percent. The sulfide content of samples from drill holes in unoxidized tactite below the 200-level is variable, and only small amounts are present in some of the cores.

The largest tungsten deposit known in the district is at the Nevada Scheelite mine. Four other productive deposits are within half a mile of the main one, and scattered occurrences of scheelite are known within a radius of several miles.

Mines

Nevada Scheelite

The Nevada Scheelite mine is on the west side of the granite stock at a sharp bend in the contact (fig. 130). The limestone beds

Fig. 130. Geologic map of the Nevada Scheelite mine and vicinity, Mineral County, Nevada.

at the mine strike northeast and dip from vertical to steeply southeast. Tactite 2 to 50 feet wide occurs along the contact as an irregular zone about 1,800 feet long. Although much of the tactite is covered at the surface, it is remarkably persistent in the underground workings and drill holes, and extends to a depth of at least 400 feet. Most of the tactite contains at least 0.5 percent of WO_3 , and much of it contains 1.5 percent.

For a distance of 700 feet, from 600 feet south of the Nevada Scheelite shaft to 100 feet north, the contact between granite and limestone is nearly vertical, and is concordant with bedding in the

limestone. The tactite along this portion of the contact is narrow, with widths of 2 to 10 feet, except near the shaft where it is 20 feet wide in places. North of the shaft at distances of 100 feet on the surface, 170 feet on the 100-level, and 240 feet on the 200-level, the contact swings sharply westward across the beds in limestone and flattens to dips of 30° to 40° NE. (figs. 131 and 132). This change in

Fig. 131. Geologic maps of the 50, 100, and 200 levels, Nevada
Scheelite mine, Mineral County, Nevada.

Fig. 132. Geologic sections of the Nevada Scheelite mine, Mineral
County, Nevada.

attitude persists for 350 feet northwesterly where another change in direction of the contact makes it once again concordant with the limestone.

The two bends and intermediate flattening in the granite contact result from the intrusion of the granite along a portion of a pre-granite fault which strikes northwest and dips 30° - 40° NE. The limestone beds north of the fault are displaced about 350 feet north-

west. The largest ore bodies are between these two bends where the granite contact cuts across the bedding of the limestone. Tactite extends down the flat dip of the contact, with granite above and limestone below. In this portion of the mine, the tactite makes a fairly regular contact with the granite, but extends irregularly into the limestone for greater distances along some beds than others. In places, the tactite layers are as much as 50 feet thick, but taper out southward into limestone within 100 feet of the granite. At the surface, isolated outcrops of tactite, some rich in scheelite, occur in limestone more than 100 feet from the main granite contact, most of them being associated with small faults and granite dikes. At depth, these isolated bodies of tactite may enlarge and coalesce with the larger replacement masses along limestone beds.

North of the bends in the contact, the limestone beds are concordant with the granite contact and dip steeply northeast. For 600 feet north, the tactite appears to be mostly 10 to 20 feet thick with

only a few thinner portions. This part of the contact is poorly exposed at the surface, and is known underground only from 4 drill holes.

In March 1944, reserves in the mine were estimated to be 192,000 tons of indicated ore averaging 0.91 percent of WO_3 and 116,000 tons of inferred ore averaging 0.65 percent. No deduction was made for material that might be left in pillars during mining, nor for ore two feet or less in width, which constituted about 10 percent of the estimate. The geologic setting is favorable for discovery of additional ore, and further exploration might uncover another 800,000 tons containing 0.5 percent of WO_3 . About 30,000 tons of ore were mined between the date of the estimate and the end of 1947.

In 1944, the tailings from the mill at Dead Horse Wells amounted to 50,000 tons that averaged 0.47 percent of WO_3 . Tests made by the Metallurgical Branch of the Bureau of Mines at the Salt Lake City laboratory failed to discover an economic method of re-treating this material. The ore treated to 1944 contained about 1.5 percent of WO_3 .

About 0.83 percent was recovered in concentrates, 0.47 percent was left in mill tailings, and 0.2 percent was lost in mill slimes.

Viking's Daughter

The Viking's Daughter claim, a third of a mile northwest of the Nevada Scheelite mine, was worked from 1937 to 1939 by Nevada Scheelite, Inc., the owner. Workings consist of an open pit roughly 50 feet in diameter and 10 to 45 feet deep, a short adit in one face of the pit, and several small cuts. Of the 5,000 tons of material removed from the workings, about 3,000 tons contained 1 to 2 percent of WO_3 .

The scheelite-bearing tactite is an irregular mass at the contact of limestone with a small intrusion of granite. Honeycombed, limonite-stained quartz without scheelite is enclosed by the tactite. The floor of the pit is concealed by debris, and the only exposures of scheelite-bearing tactite in place are on the walls of the pit in disconnected patches estimated to contain 1.0 percent of WO_3 . The operators report that ore remains in the bottom of the pit, but that

the workings were abandoned in favor of better-grade ore found in the Nevada Scheelite mine.

Primrose (Hooper)

The Primrose group of 8 unpatented claims, owned by J. E. Hooper, adjoins the Nevada Scheelite holdings on the south. Except for prospect pits, the only exploration is in the Hooper No. 1 workings on the Ajax No. 3 claim, and in the Hooper No. 2 workings on the Ajax claim (fig. 133).

✓ Fig. 133. Geologic maps and sections of the Hooper No. 1 and Hooper No. 2 workings, Rawhide district, Mineral County, Nevada.

The Hooper No. 1 mine, also known as the Moore lease shaft and the Primrose mine, is 1,500 feet south of the Nevada Scheelite shaft (fig. 129). Workings consist of a 100-foot vertical shaft, a drift for 200 feet southeast of the shaft on the 100-foot level, and stopes between this level and the surface. An inclined winze 25 feet deep

was dug below the 100-foot level near the south face. Nevada Scheelite, Inc. leased the property from 1937 to 1939 and mined 1,500 tons of ore containing an estimated 2.0 percent of WO_3 . Wm. Beverly Moore leased the property in 1940 and produced about 1,100 units of WO_3 from 1,650 tons of ore treated.

The tactite was 5 to 25 feet thick on the 50-foot level and 2 to 10 feet thick on the 100-foot level. The granite contact is steep at the shaft, but southeast of the shaft the contact is inclined about 45° NE., with granite lying on top of the tactite and limestone. Ore estimated to contain 2 percent of WO_3 was mined from the upper stope just south of the shaft, and fairly good ore was taken from the stope farthest to the south, from the 100-foot level up to about the 25-foot level. The single small stope north of the shaft was in thick tactite averaging less than 0.5 percent of WO_3 .

The contact northwest of the Hooper No. 1 shaft for a distance of 500 feet is worth exploration for ore beneath the alluvial cover.

The curvature of the granite contact and the presence of several pre-granite faults are favorable geologic features. South of the shaft, neither the surface exposures nor those on the 100-level show much tactite or ore.

The Hooper No. 2 shaft, about 1,000 feet south of the Hooper No. 1 shaft, is 110 feet deep on the incline. From the bottom, a drift extends 140 feet northeast. A winze 16 feet deep and a drift 20 feet long were dug below this level. The workings follow a tactite layer in andalusite-biotite hornfels about 20 feet stratigraphically above the principal limestone formation. Scattered tiny outcrops of granite appear in the hornfels about 100 feet east of the shaft, but the nearest observable contact with the main granite mass is 400 feet east. The tactite is 1 to 10 feet thick, is coarsely crystalline, and contains large crystals of epidote and quartz. Clear, transparent, euhedral scheelite crystals up to half an inch in diameter have been found in small vugs. Most of the tactite in the shaft contains a

little scheelite, somewhat concentrated toward the footwall; two rich spots contain 3 or 4 percent of WO_3 , but short drifts from the shaft cut through them into barren material. The best ore is in the drift, in a pillar 60 feet north of the shaft where a block of about 15 tons contains an estimated 4 percent of WO_3 . The ore occurs only in small, isolated pockets.

Eed-a-how

Workings on the Eed-a-how claim are about 1,700 feet northeast of the Nevada Scheelite shaft. From an 86-foot shaft inclined 70° S., a drift extends 100 feet east at the 50-foot level, and several small stopes have been dug above the drift. J. A. Madison leased the claim in 1942-43 from W. A. Adams, and shipped 331 tons of ore containing 478 units of WO_3 to Metals Reserve Co.

The shaft follows a tactite layer on the south side of a sliver of limestone at least 15 feet thick. The hanging wall of the shaft is granite, the footwall is limestone, and the tactite between is 5 feet or less in thickness. The surface is covered by large granite

boulders which obscure bedrock. Small outcrops of tactite and limestone appear 100 feet west and 35 feet east of the shaft. The limestone thus has a proved extent of 100 feet on each side of the shaft; whether it is a pendant or connected with the limestone exposed 600 feet west of the shaft is unknown. Tactite and limestone extend beneath the bottom of the shaft. Scheelite is unevenly distributed through the tactite, portions of which contain 1.5 percent of WO_3 although the average content is probably about 0.5 percent.

Yankee Girl

The Yankee Girl mine is half a mile northeast of the Nevada Scheelite mine on the north border of the granite stock. The Goldfield Consolidated Mines Co. leased the property in 1943 from Leo and Eugene Grutt and shipped 54 tons of ore containing 47 units of WO_3 to Metals Reserve Co. An additional 100 tons was concentrated at the Moore mill in the Rawhide district.

The mine is opened by an adit with 200 feet of workings, a winze, and a raise to the surface. The workings are along a contact between granite and hornfels. At the surface, tactite is exposed in a series of pits over a length of 140 feet. The adit contains thin layers of tactite bordering small masses of limestone in granite. The limestone lenses probably represent a formerly continuous limey layer in the clastic sediments from which the hornfels was formed. Scheelite is distributed erratically through the tactite. The richest mineralization exposed in 1944 was estimated to contain 1.0 percent of WO_3 over an area 6 by 8 feet exposed in the winze. A little material containing 0.5 percent was visible along the walls of the adit.

Other deposits

Four other tungsten occurrences in the Rawhide district are outside the mapped area shown in fig. 129. Two miles northwest of the Nevada Scheelite mine, William Strand and R. H. Sheehy hold four claims on which small pods of tactite several feet in diameter occur

in limestone in an area of about half a square mile. Most of the tactite contains only occasional crystals of scheelite. Strand and Sheehy also own a group of 12 claims 10 miles east of Rawhide where tactite occurs in a limestone lens in metavolcanic rocks. Nevada Scheelite, Inc. as lessee in 1940 mined 10 tons of ore averaging 0.5 percent of WO_3 , and in 1943 Wm. Beverly Moore mined 20 tons of similar ore.

The Big Kaseck claim, staked by Eugene Grutt, Eugene Grutt, Jr., and Leo Grutt, is 1.5 miles northeast of the Nevada Scheelite mine. A small amount of scheelite is distributed in tactite 150 feet long and 35 feet wide, bordered by metavolcanic rocks. The content of WO_3 is estimated to be about 0.1 percent.

The Crystal claims, also known as the Tom Keyon property, are 8 miles east of Rawhide. Scheelite occurs in 2 masses of tactite 20 and 8 feet in diameter in granodiorite. About half the tactite exposed contains an estimated 0.5 percent of WO_3 . Shafts 15 feet deep have been dug in each deposit. In 1939, Wm. Beverly Moore as lessee mined 30 tons of

ore averaging 0.25 percent of WO_3 . In 1940 Forest J. Sur mined 36

tons averaging 0.63 percent.

Tungsten Deposits near Rawhide, Mineral County, Nevada

by

Robert Stopper and Konrad B. Krauskopf

June 1944

Illustrations

Ms. Page

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* * * * *

Kennametal, Inc., Latrobe, Pennsylvania. 1957 Annual Report.

Fiscal year ending June 30, 1957.

Report dated August 3, 1957 for annual meeting September 9, 1957.

"The ending of Government stockpiling of domestic tungsten production during the year is a step of major importance to us, our industry and the nation. An industrial society is strengthened by wisely using and developing its natural resources, and not by sterilizing them in futile hoarding. Since 1940, a major part of all tungsten produced domestically, or imported, has been acquired by the Government, and (as stated in a recent Congressional report) an "excessive surplus" has been stockpiled. Now, as such purchases are stopped, industry can rely upon a greater share of the available tungsten, at a more reasonable price. Creative minds can now use it to increase production and improve product performance in many new fields. We are facing, I believe, a period in which tungsten, embodied in our present products and in new products which we intend to make, will be used in ever-increasing quantities."

"..... Net income before taxes was \$424,755 higher than in 1956, but this increase did not carry through to net because 1957 taxes increased \$451,869. As a result, net income for the year was very close to last year, and amounted to \$2,440,309, or \$4.07 per share, as against \$2,467,423, or \$4.12 per share.

"Major causes for this change in operating results and the failure to increase net income in proportion to sales were discontinuance of tungsten mining, and a decline in the market price of tungsten which necessitated an inventory write-down at the year end. In 1956, our tungsten mine contributed \$1.28 per share to net income, whereas there was a loss from this source this year. Also, the change in income source, from tungsten mining to other operations, increased the over-all impact of Federal taxes, as net income from the mine, under percentage depletion, was subject to a tax rate about half that applying to our non-mining operations."

"At our Nevada Scheelite tungsten mine, operations were suspended in November when the Government stopped buying for the stockpile. Clean-up operations were completed by early March, when the mine was put on a stand-by basis. Exploration work prior to the close-down revealed the presence of additional ore reserves and, if economic conditions at some future date warrant, the mine can be put back into production.

"We plan to make use of the Nevada Scheelite organization and some of the mill facilities to further our decentralization policy and to expand our basic production facilities. Accordingly, we are now installing equipment for further beneficiation of tungsten minerals to the stage of high-purity macrocrystalline tungsten carbide.

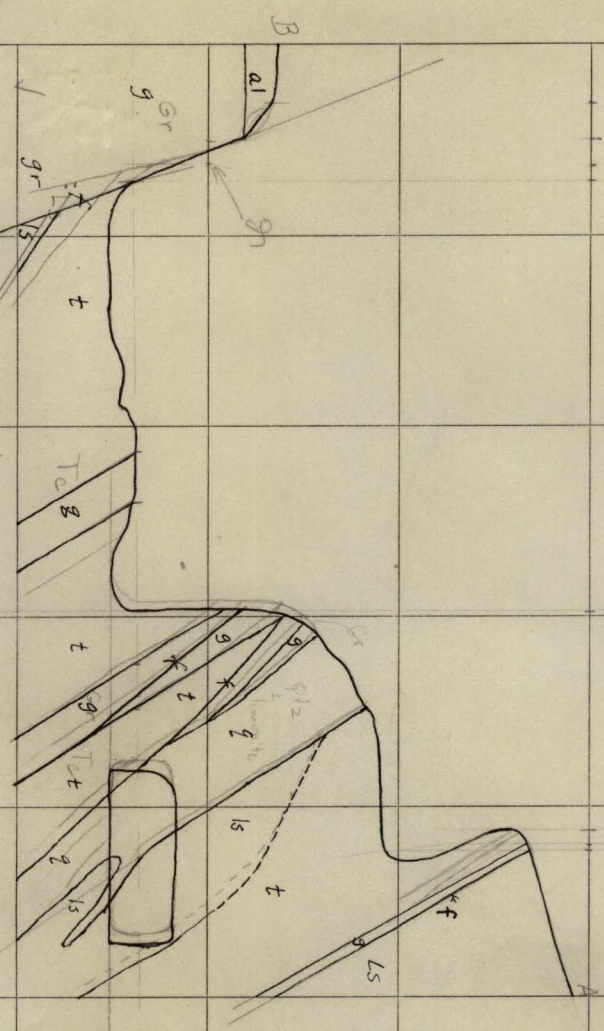
"Because of the above changes, it was considered advisable to liquidate Nevada Scheelite Corp., transfer its assets to the parent, and continue to operate it as a division. This reorganization was effected in April, 1957."

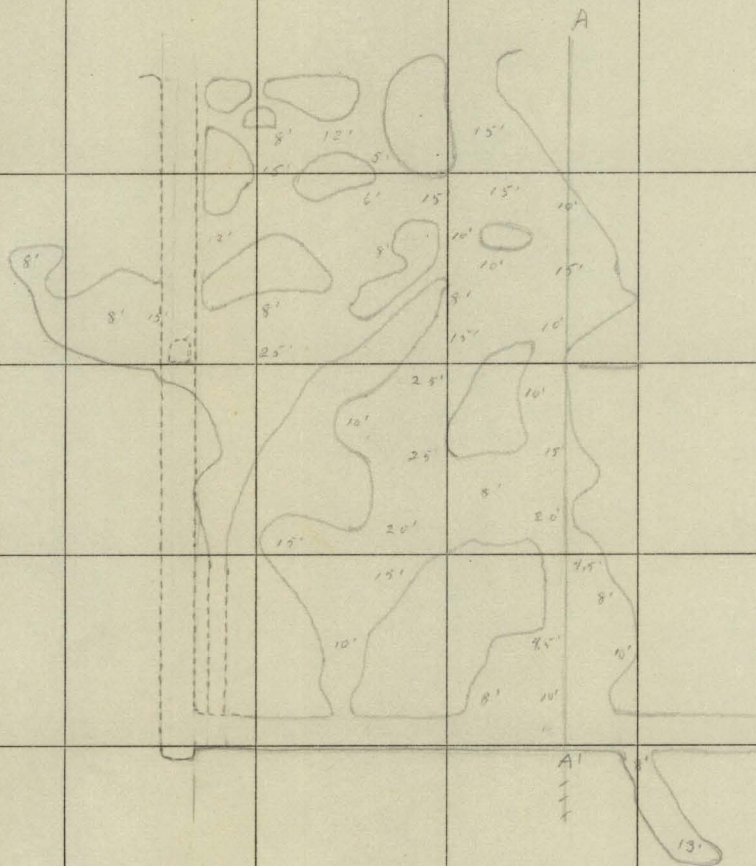
Kennametal Inc.
Annual report--1957

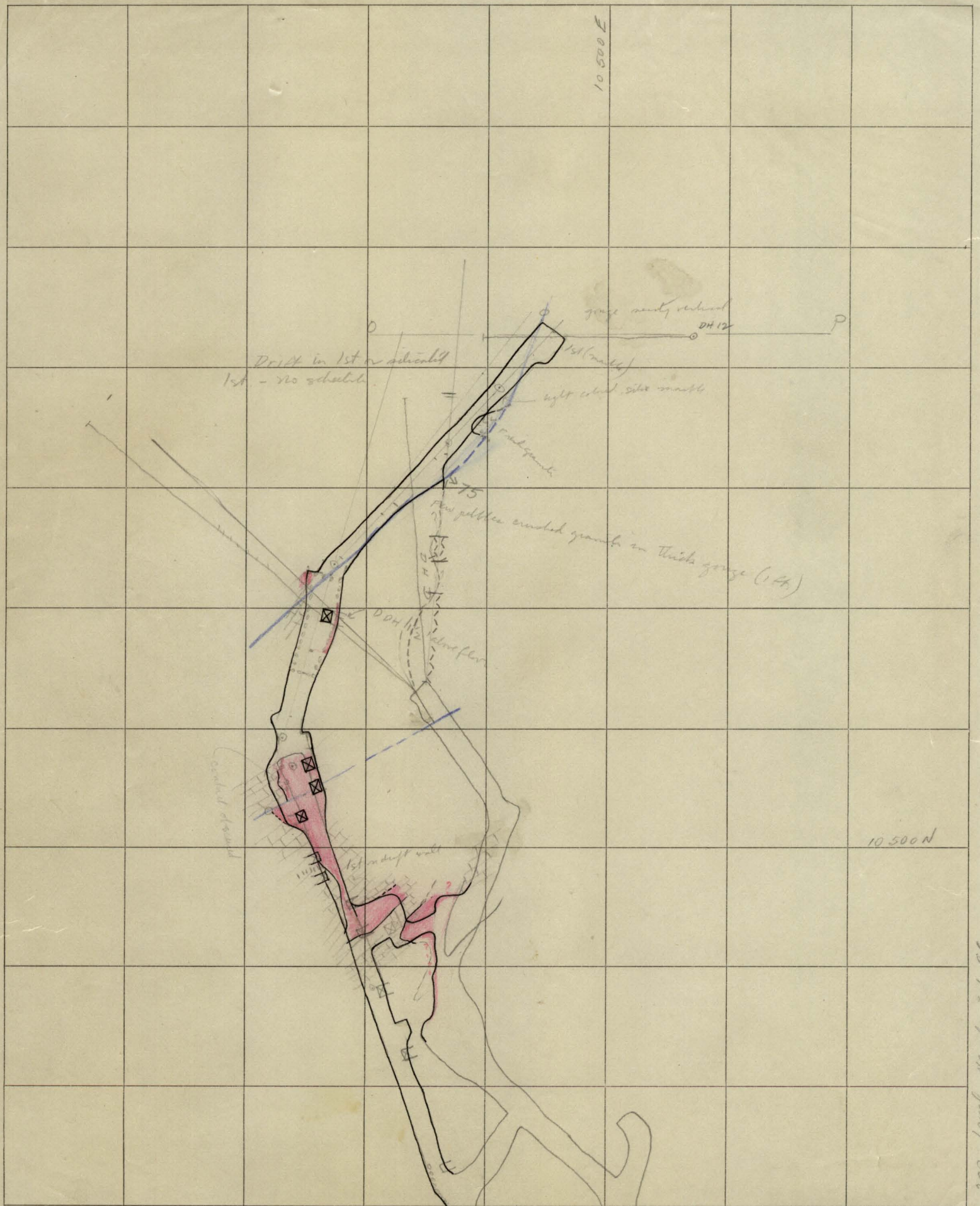
Chart shows tungsten sales (concentrates) 1952-1957 aggregate about \$11,000,000, with maximum in 1954 and 1955. Sales of HVAP shot to U.S. Government 1952-1955 aggregated about \$11,500,000, with maximum in 1954. (HVAP is high velocity armor piercing shell.)

Report does not give ore reserves, or production in units of WO_3 .

See
B-A Quarter
Plate
(12)







200 Level, Wanda Schale

CONCLUSIONS:

The unique history of this mine, the documented data on production and projections justify a modest exploration program (\$25,000). Verification of data would then easily justify the major acquisition, mining and milling costs which would total \$250,000 to \$500,000 depending on the size of the mill.

George M. Wilson
Consulting Geologist

Nevada Schulitz mine, Kennametal Inc.,

Mr. E. H. Colwell (Mgr)

347 Taylor Street, Fallon, Nevada

Mineral Co, Regent Mining Dist, sec 12-13N-32E

13.6 miles from surface geo of project shal.

from USBM report on structural survey of private
mining properties, Project Shal, final report

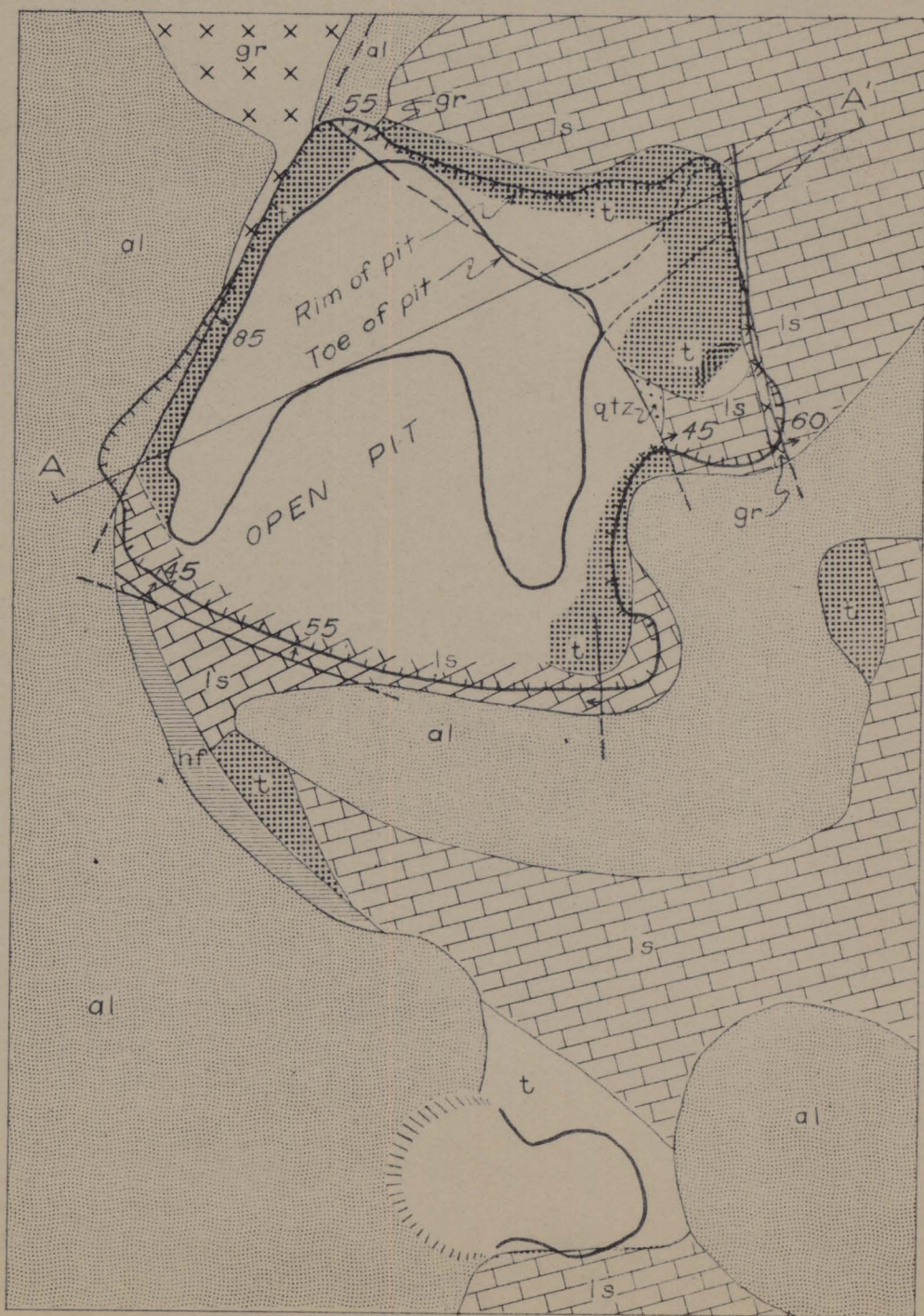
Dec 1963

Nev. Schulitz

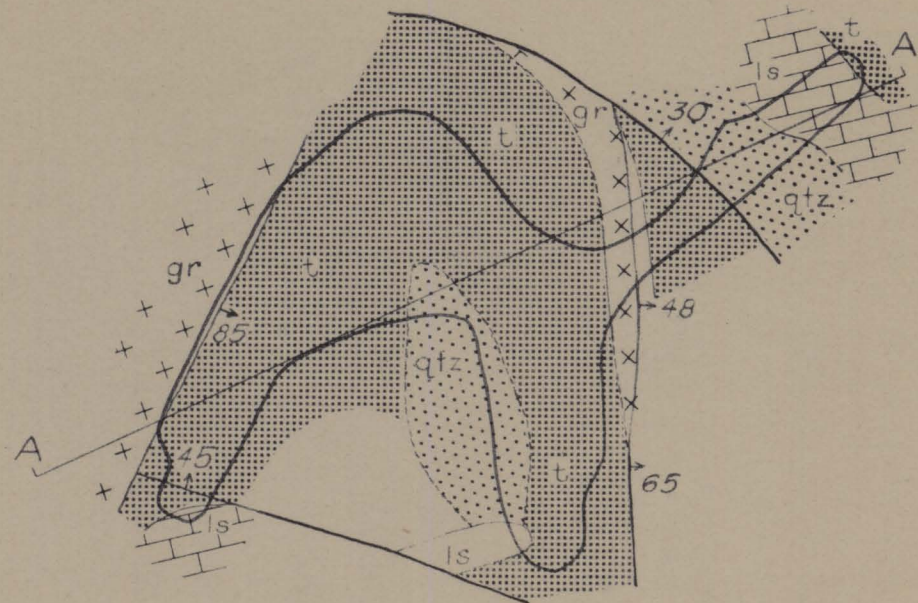
P. B. 24 output 1937-56 277,000 units w/3

mine idle Plant in standby condition. Active metallurgical
community 67 Bldgs, ca 80 people devoted to manufacture of

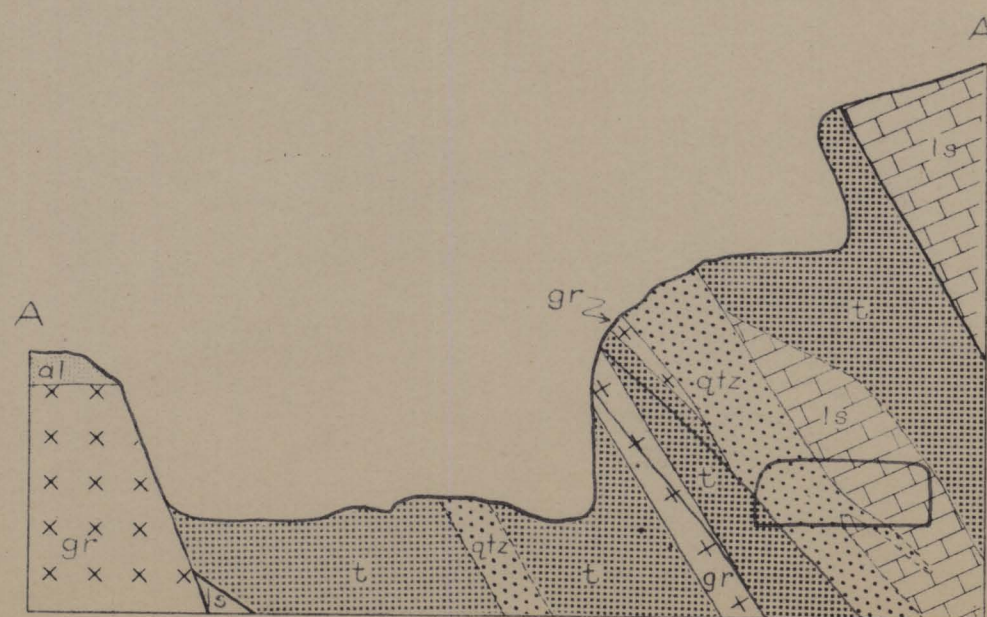
Tungsten Carbide. Mine developed on levels 100, 200, 300, 400, + 500
15 underground photos + surface



SURFACE MAP

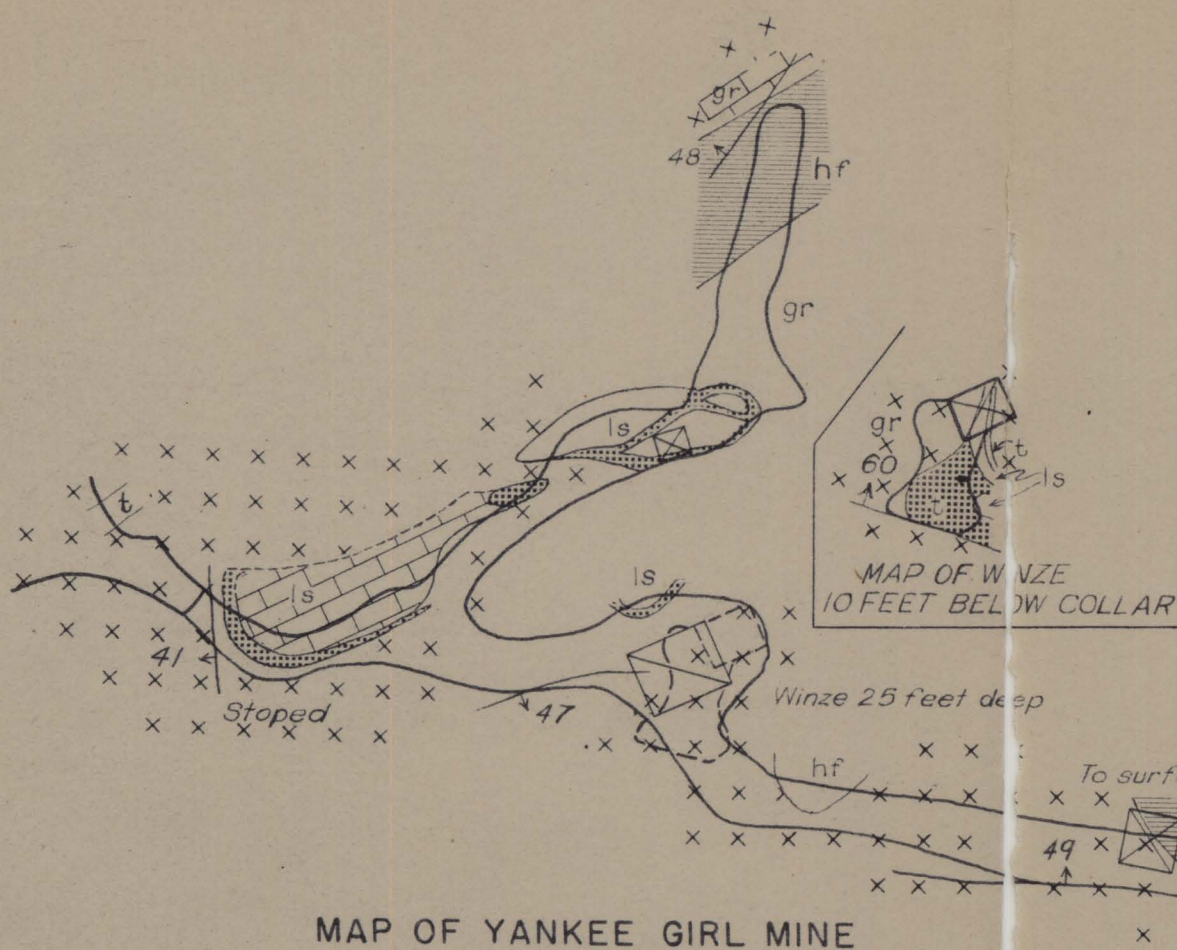


MAP 3 FEET ABOVE FLOOR OF MAIN PIT



SECTION A-A'

MAPS AND SECTION OF WORKINGS ON VIKING'S DAUGHTER CLAIM



MAP OF YANKEE GIRL MINE

EXPLANATION

- | | |
|----------|--|
| | |
| Alluvium | Limestone |
| | |
| Quartz | Hornfels |
| | ----- |
| Tactite | Contact, dashed where not accurately located |
| | |
| Granite | Fault, showing dip, dashed where concealed |

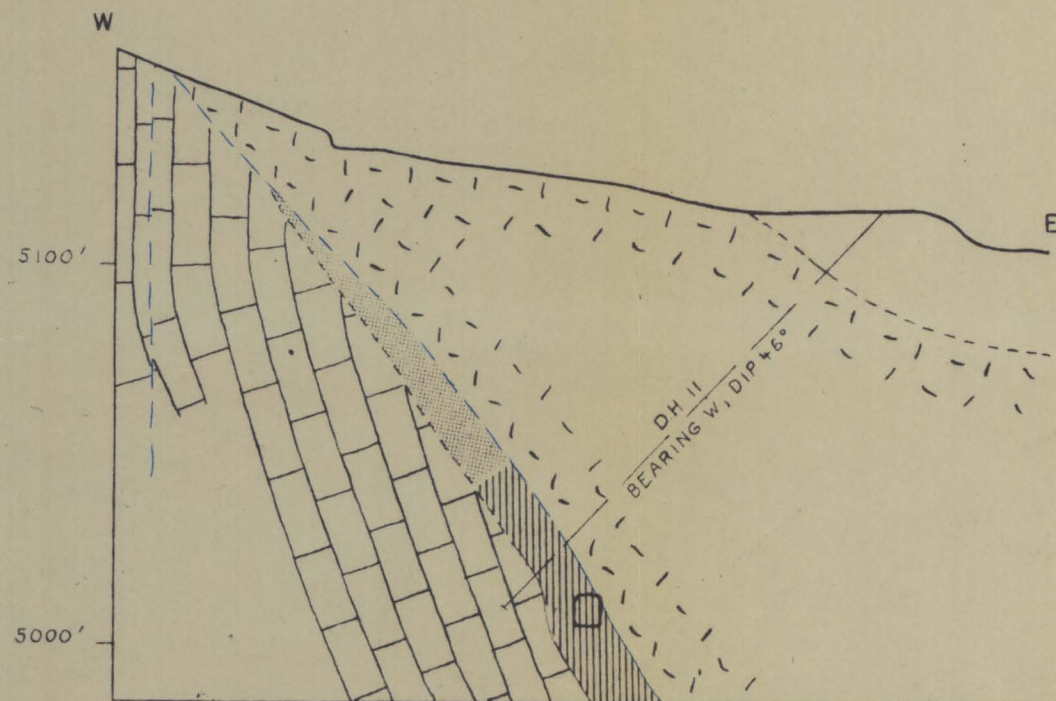
20 0 20 40 feet

Mapped by K.B. Krauskopf and R.F. Stopper, June 1943

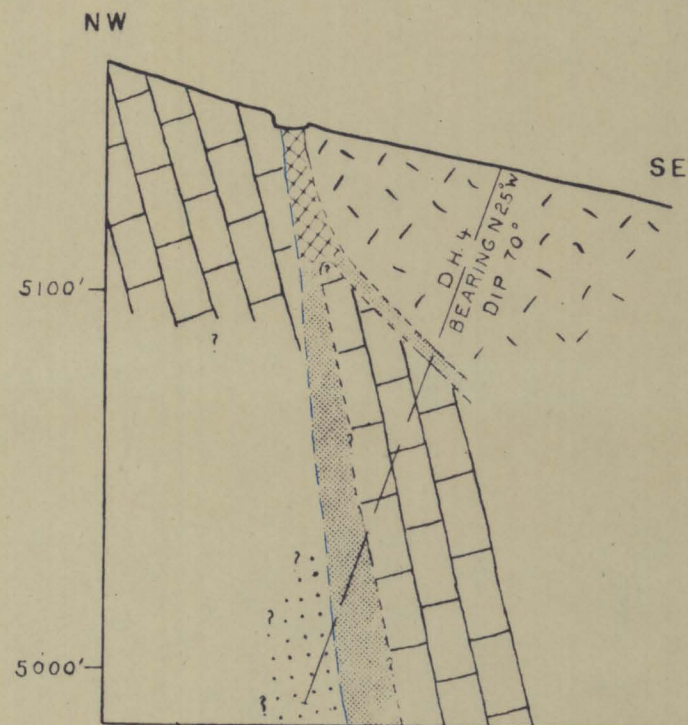
3820 0022

206
Item 22

SECTION THRU D.H. 11



SECTION THRU D.H. 4

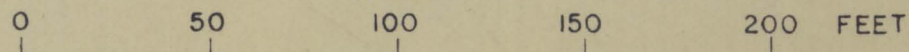


UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

VERTICAL SECTIONS THRU THE NEVADA SCHEELITE MINE

R. STOPPER MARCH 1944

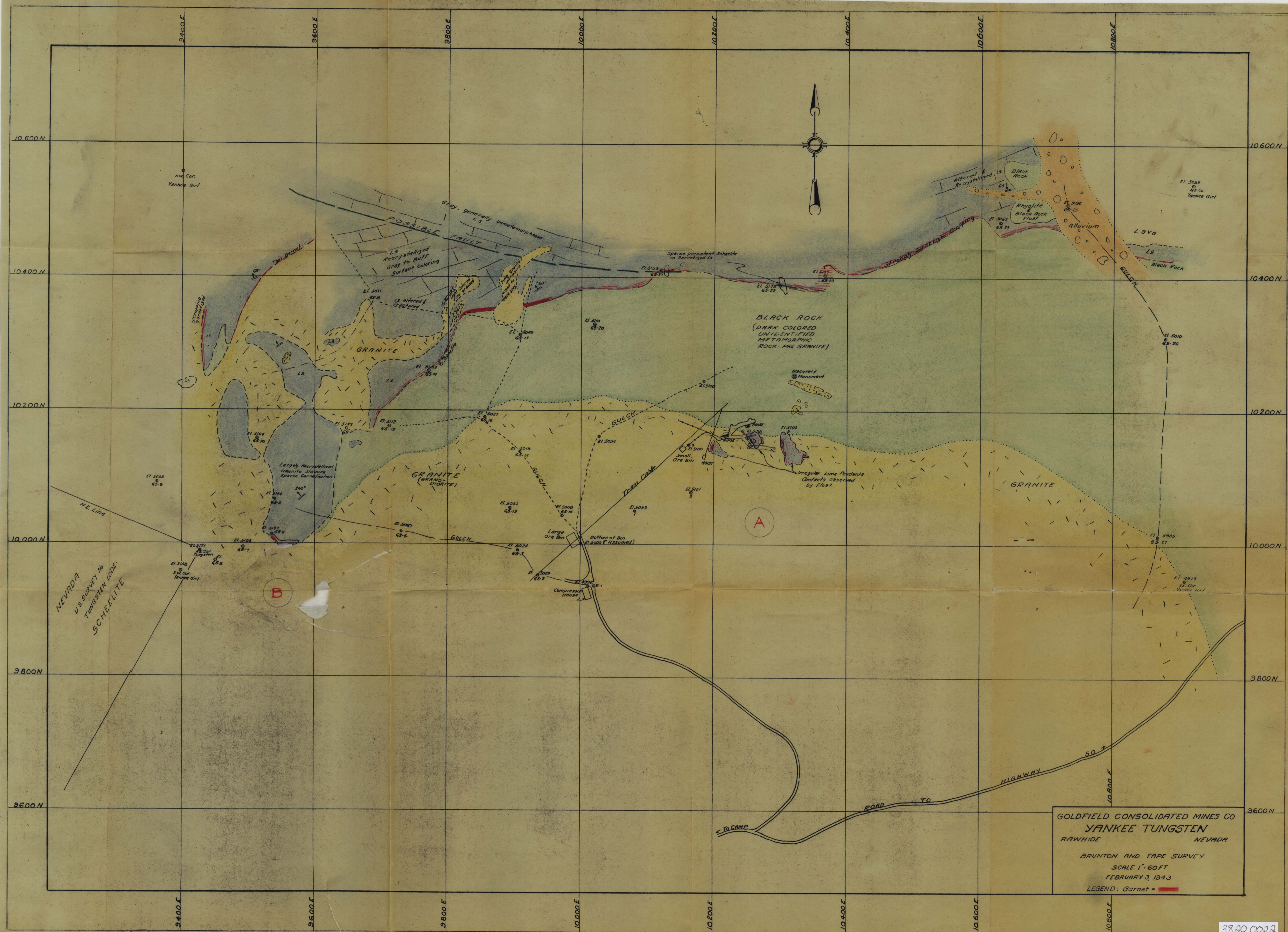
SCALE



3870 0022

FIG. 8

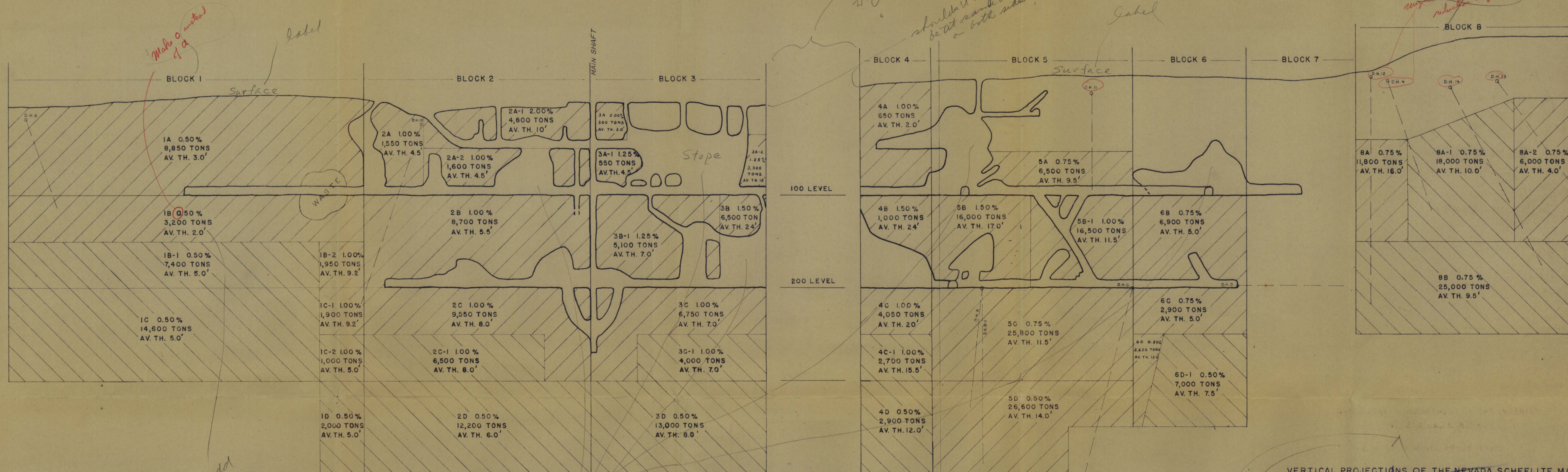
206 104



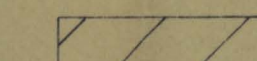
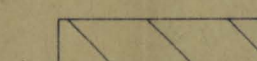
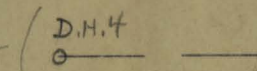
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PROJECTION PLANE N48°E

PROJECTION PLANE NS

VERTICAL PROJECTIONS OF THE NEVADA SCHEELITE MINE
SHOWING ORE RESERVES

EXPLANATION

 INDICATED ORE INFERRED ORE PROJECTION OF DRILL HOLE4D 0.50%
AV. TH. 10.0' BLOCK NUMBER AND CONTENT OF WO₃
AVERAGE THICKNESS OF ORE IN FEETSCALE
50 0 50 100 150 FEET

Ore estimates by R.W. Geahan, of Bureau of Mines and R.F. Stopper, of Geological Survey, March 1944

TUNGSTEN DEPOSITS NEAR RAWHIDE, MINERAL COUNTY, NEVADA

3380 0022 206 22 ENG





