

Memorandum on the

Humboldt-Springer Tungsten Mine and Notes on Current Operations of the Nevada Massachusetts Company, Inc., Mill City, Nevada

T. B. Nolan (4) S. G. Lasky D. M. Lemmon File

M. R. Klepper Assistant Geologist U. S. Geological Survey Mill City, Nevada February 14, 1943

# Memorandum on the Humboldt-Springer Tungsten Mine Abstract

The tungsten deposits in the Eugene Mountains, 8 miles west of Mill City, Nevada, are in limestone beds that have been partly altered to tactite. These narrow but persistant limestone beds are part of a dominantly argillaceous sedimentary sequence that has been metamorphosed to hornfels. The sediments have been intruded by two small stocks of granodiorite, and dikes of granodiorite, aplite, and andesite. Some of the limestone beds have been partly altered to tactite, and a worthwhile amount of scheelite was introduced into some of the tactite.

During the present investigation, the geology of the Humboldt-Springer mine workings was mapped. Three steeply-dipping, partly altical limestone beds, the Humboldt, the Springer, and the George, are explored in the mine. The Humboldt is explored for a maximum length of 1750 feet and to a depth of 1400 feet. Width of ore averages 6 feet. The bed is cut off by a stock of granodicrite to the north, and terminates in a silicated zone that may be a major fault to the south. These two cut-offs slope toward each other, shortening the Humboldt bed from 1700 feet in the upper levels of the mine to 700 feet in the 1575 level.(I). The percentage of marble and low-grade tactite is greater in the lower levels.

(I) Levels are designated according to footage along the incline of the Humboldt Shaft.

The Springer bed parallels the Humboldt. It is explored to a depth of I000 feet, and for a maximum length of I500 feet. Width of ore averages 3 feet. The southern limit of underground explorations is at a fault. The bed has never been recognized south of this fault. In the northern part of the workings the bed is too narrow to be mined.

The George bed, parallel to the other two, is explored for a short length on five levels. Mineralization of this bed is sporadic, and only a few small stopes of ore have been mined.

700,000 tons of 0.75% WOz ore have been taken from the Humboldt-Springer mine. Of this, the Humboldt bed has contributed more than 75%, the Springer 20%, and the George less than 5%. Measurable reserves (including broken ore) are estimated to total 23,500 tons of 0.75% WOz ore, indicated and inferred reserves: 20,000 tons of 0.75% WOz ore, and reserves of possible low-grade ore: 33,500 tons containing between 0.25% and 5% WOz.

In recent months, mining of ore has closely followed development work. Within a few months, all of the ore now developed will
be broken. Unless enough men to push necessary development drives
become available, the rate of production from the Humblodt-Springer
mine is likely to decline by the end of 1943. One hundred feet of
drifting along the bed no longer develops 75 feet of ore, as it did
in the early days of the mine.

# Location

The Humboldt-Springer is one of three tungsten mines in the Eugene Mountains that are operated by the Nevada Massachusetts Company, Inc. These mines, together with a few small and inactive mines and prospects, are situated in the low foothills along the east flank of

the range, 8 miles west of Mill City, Pershing County, Nevada. A surfaced road connects the mine area, including the mills and the camp, with U. S. Highway No. 40 at Mill City. Mill City is also a station on the Southern Pacific Railroad.

# History

The development of the Mill City tungsten district falls into two periods, I9I7-I9I8, and I924-present. Tungsten was discovered here in I9I7. During the period I9I7-I9I8, four mines produced tungsten ore: the Humboldt Corporation operated the Humboldt mine\*; the Pacific Tungsten Company operated the Stank\* and Springer mines; and the Mill City Tungsten Mining Company operated the Sutton No. I mine. More than half of the ore mined during this period was shipped to the Toulon custom mill. In I9I8, the Humboldt Corporation and the Pacific Tungsten Company each completed a mill near its mine. Both mills operated only a few months, closing in November when the price of tungsten dropped to \$150 a unit, following the armistice.

In 1924, C. W. Poole leased the Pacific Tungsten Company property. He operated until March, 1925, when the Nevada Massachusetts Company bought the Pacific Tungsten Company and the Mill City Tungsten Mining Company. In 1928, Nevada Massachusetts bought the Humboldt Corporation and enlarged the Pacific Mill to a capacity of 260 tons. Most of the equipment in the idle Humboldt mill was transferred to the enlarged mill. Except for a general shut-down of four months in 1933, one or more of the mines has been operated continuously since the Nevada Massachusetts Company acquired control.

<sup>\*</sup>The Friedman & Loring mines of Hess & Larsen, U. S. G. S. Bull. 725-D;pp.295-300, pl.XIV, I92I.

796,807

Grand Total

Production

Wr. O. F. Heizer, General Manager, Nevada Massachusetts Company, Inc., has kindly given the following information concerning production, as well as the historical facts in the preceding section.

Units WOZ	11,400	8,551	11,948	IO, II8	4,944	50,86I	688,343 739,204	57,603
Grade 8003	67%	814	67%	67%	70%(est)		75.6%	
Tons Conc.	170.671	120,443	178.343	151.088	70.628	691.173	9127 • 525 9818 • 698	1874.248
Tons Ore	7,032	5,554	7,905	15,220	2,85I	21,000 59,562	251,894 671,604 482 25,401 57,951 087,341	
Mill	Toulon	Toulon	Pacific	Humboldt	Toulon	acific Total.	Nevada Mass. Co.	Lant
Wine	Stank	دي	Stank	Humboldt	Sutton No. I	Stank F Springer Sub	Stank Humboldt- Springer Uncle Sam Sutton II Sutton Z	Tailings
Company	Pacific	1917-18 Humboldt Humbold	Pacific	Humboldt	Mill City Tungsten	C.W.Poole Lease	Mass. Co.	Meysda Mass. Co.
Feriod	1917-18	BI-416I	1918	1918	1918	1924-25	May I, 1925- Dec.3I, 1942	1941-2 N

# Current operations

General. At present, 240 tons of ore are milled daily (2). Half of the ore is obtained from the Stank mine, one quarter from the Humboldt-Springer, and one quarter from the Sutton #2. Current ore from the Stank averages I.0% WO3, from the Humboldt-Springer 0.8%, and from the Sutton 0.4%, giving a blended mill feed of 0.75%.

Three problems, other than geologic, confront the operator: shortage of labor, lack of development work, and limited hoisting capacity. All three are related, and the net effect is likely to become more serious during the year. Most of the available men and hoisting facilities are necessary to supply 240 tons of ore to the mill each day. Consequently, development headings are only a short distance ahead of stopes. In view of these facts, I predict that, unless the necessary development work can be done this year, production will decline during 1944.

Humboldt-Springer mine. The Humboldt and Springer mines were connected underground soon after acquisition by the Nevada Massachusetts Company. Since that time, they have been operated through the two-compartment Humboldt shaft. This shaft accommodates a one-ton skip, and could be improved to accommodate a two-ton skip.

Fifteen levels have been driven in the Humboldt bed, and the shaft is being sunk to the I6th (I700 foot level). The Springer bed, 200 feet west of the Humboldt, has been mined to the 975 foot level, and a crosscut is now being driven to it on the II00'level. The George bed, 250 feet west of the Springer, has been prospected on five levels.

<sup>(2).</sup> The tailings treatment plant, completed in I94I, is a separate operation. In it, 860 tons of current and accumulated taimlings are treated daily.

Only a few small stopes of ore have been mined from it. A sub level, 50 feet higher than the collar of the shaft, is now being driven along the bed.

Stank Mine. - My knowledge of the Stank mine is based on a brief examination and oral communication. The Stank is hampered by lack of adaquate hoisting facilities. Levels below the 700 are served by a sub-shaft. Trams are long and difficult; ore from some parts of the mine must be handled six times before it reaches the mill. In this mine, considerable driving has been done in waste, and on some levels there is little space for waste backfill. This condition has slowed down development work where it is necessary to crosscut through waste. Geology and reserves will be discussed in a subsequent memorandum.

Sutton No. 2 Mine. The Sutton No.2 has been stoped between the tung nel level and the surface. Drifting and stoping are now in progress on the I25 foot level, but the shaft has not been sunk below this level. This mine will be more fully discussed in a subsequent memorandum.

# Geology

The area in the vicinity of the mines is underlain by a steeply dipping sequence of hornfels. Thin but persistant strata of limestone are interbedded with the hornfels. The two small granodiorite stocks, associated granodiorite and aplite dikes, and younger hornblende-andesite dikes intrude the hornfels sequence. Near the granodiorite the limestone beds have been partly aftered to tactite and marble. Worthwhile amounts of scheelite have been introduced into some of the tactite.

Most of the hornfels is a soft brown aphanite. Some is pale gray and green. Beds of dense, fine-grained quartzite occur throughout the sequence. Most of the limestone is dark-colored and dense. The tactite is a heavy, coarsely crystalline rock containing varying amounts of

quartz, garnet, epidote, and calcite, with some pyrite and scheelite.

The beds are cut by faults of at least two generations. The first generation cuts only the sedimentary rocks. Fault zones belonging to this generation have been recrystallized to dense, hard, pale-colored silicat@rocks. Zones of similar silicate rock are common in the hornfels sequence, and some of them may represent unsolved faults. Ore beds are rarely cut off sharply at these zones, but commonly they are attenuated or dragged out for a few feet or tens of feet. Some of these faults are steeply dipping strike faults of small displacement; one is a low angle reverse fault with@ a horizontal component of displacement of at least IOOOfeet. Others that have not been solved probable exist.

# Scheelite Deposits

Scheelite ore deposits are confined to limestone beds that have been altered to tactite. Within these beds, economic amounts of scheelite occur in shoots of irregular size and shape. The factors that control localization of these shoots have not been recognized. Proximity of intrusive bodies does not directly influence their location. In many places along the beds, marble, and even limestone, contact intrusive bodies. Some ore shoots lie adjacent to major intrusive contacts; others are from IOOO feet to 2000 feet distant from recognized major contacts.

The ore is a medium to coarsely-crystalline aggregate of quartz, garnet, epidote, calcite, pyrite, scheelite, and locally molybdenite and pyrrhotite. Proportions of the different minerals vary markedly within a bed, and even within a single ore shoot. The ratiox of garnet to other minerals is higher in the Humboldt bed than in the Springer.

# Humboldt Bed

The Humboldt bed has yielded nearly half of the ore mined in this district. It can be traced on the surface from the Olsen granodiorite stock southward for I750 feet. It has never been identified south of this point.

On levels above the 725', the length of the bed averages I700 feet, and is one for about 75% of the entire length. Below the 725 foot level, the bed terminates at the southern end along a line that slopes about 40° north. The granodicrite cut-off at the north end dips steeply south. Consequently, the bed is shortened from I750 feet on the 725' level to a predicted 750 feet on the I700 level, and it may be eliminated within a few hundred feet of the present bottom of the mine. The ration of waste to one also increases markedly on lower levels. A good shoot of one occurs between I325 foot level and the I450 foot level, but only low-grade one has been found on the I575 foot level.

width of ore that can be stoped varies between 4 and I2 feet, averaging 6 feet. Grade of individual stopes (75xI00x6 feet) has varied between 0.25% and I0% WO3, averaging 0.75%. Transition between ore and almost barren bed is rapid; very little 0.25%-0.50% WO5 ore remains in the mine.

zones of very low-grade tactite and unreplaced limestone or marble occur along the bed at all elevations. The northern third of the outcrop is mostly unreplaced limestone and marble. Similarly the northern part of the lower levels of the mine is marble that contains only a few small shoots of ore.

problem of the Humboldt Bed. - The cut-off at the south end progressively shortens the most consistently mineralized part of

the Humboldt bed. No ore was found on the I575 foot level, and there is no reason to anticipate that mineralization of the bed will be better on the I700 foot level. Mining of the Humboldt bed cannot be continued for long unless a mineralized extension of the bed can be found beyond the cut-off at the south end, or unless a shoot of ore exists on the lower levels between the north headings and the granodicrite, a zone that has been poorly moneralized on higher levels.

The cause of the southern cut-off of the Humboldt bed is not known. The structural map suggests that two factors have been responsible. Between the surface and the 725 foot level the cut-off inclines steeply to the south, and the bed maintains a constant length. Below the 725 foot level, the cut-off inclines flatly to the north, and the length of the bed decreases rapidly. This cut-off might result from:

- (I). Lack of sedimentation,
- (2). Lack of sedimentation and faulting, possibly before consolidation, or
  - (3). Combination of two faults.
- (I). If the bed was deposited against an irregularly curving shoreline or in a basin with an irregular bottom, such a termination might occur. The lenses of ore that are often found beyond the termination of the bed might have been deposited in shallow pools along a shoreline or in depressions in the bottom of a basin.

In support of this hypothesis is the fact that I have never seen the full width of the bed abruptly truncated. Rather it either pinches out gradually or passes out into a discontinuous train of ore lenses. Mr. W. G. Emminger, Mine Superintendant, reports, however, that is some inaccessible stopes that cut-off has been abrupt.

- (2). Lack of sedimentation and faulting. Either the upper or lower cut-off, both of which are similar in appearance but differ in inclination, may be due to lack of sedimentation; the other may be faulted off. Faulting while the beds were semi-consolidated is believed to be a possibility.
- (3). Combination of faults.— Lenses and small streaks of ore that occur in silicated rock beyond the termination of the bed, as as well as from 20 to 50 feet in the hanging and footwall of the bed, are considered by some people to be "dragged" ore. No proponent of this theory has clearly explained why such ore lenses are found at different distances in both the hanging and footwall of the bed on a single level. An alternative suggestion is that they were deposited as discontinuous limestone pods at a few horizons in the hornfels sequence.

If a persistent zone of lenses in the hanging wall of the bed is admitted to be "dragged" ore, and if small variations in the thickness of hornfels between the Humboldt and Springer beds at different elevations are plotted on vertical sections, a semiconvincing argument in favor of a strike fault with vertical displacement is adduced. Crosscutting and diamond drilling in the upper levels of the mine indicate that no south segment of the Humboldt bed is present at these elevations within a 500 foot radius of the cut-off. On the IIOO foot level and below, a more persistent tactite lens lies in the hamging wall of the bed. If this, "dragged" ore, rather than a lens deposited at this horizon, it may indicate that the missing segment of the bed has been dropped below the deepest workings. The possible position of this hypothetical segment is plotted on the structural map.

Suggested Exploration. In order to plan development work and evaluate the probable life of the mine, it must be determined whether a displaced segment of the Humblodt bed exists. Its absence above the 975 foot level is almost certain. It is difficult to test a deeper zone in which the bed may lie by diamond drill. Therefore, the operators have planned a campaign of crosscutting from the I700 foot level. A crosscut will be driven to intersect the bed north of the cut-off (Z on map); another will be driven southward to explore for a missing segment. This program will require at least a year.

I have discussed with Mr. Heizer the feasibility of diamond drilling. He has decided to drill three, and possibly four, holes very soon: one horizontal into the hanging wall from the I700 station, one horizontal into both the hanging and footwalls at the south end of the II00 level, and possibly an inclined hole into the footwall from the same point. This program will explore for the Humboldt bed in unknown ground, and also test the George bed 800 feet below its lowest exposure. No further drilling seems war ranted at this time.

No capital expenditure to improve the Humboldt shaft and increase its hoisting capacity would be warranted whless another segment of the Humboldt bed is found.

# Springer Bed

The Springer bed can be traced from a fault in Springer Gulch northward for I400 feet. Whether it lenses out or is faulted off at the north end is not known. The Yellow Scheelite bed in the Stank

mine may be a faulted segment of the Springer bed south of Springer Gulch.

The bed has been mined between the surface and the 975 level for an average length of 750 feet, and an average width of three feet. Average grade is about 0.75% WO $_3$ . The northern half of the ore shoot on the 600, 725, 850, and 975 foot levels has been low grade. The block between the 850 and the 975 foot levels, estimated to average less than 0.3% WO $_3$ , was not mined.

Small wedges of ore, a few hundred tons each, remain above the 975 foot level, but they will be expensive to mine. A larger block may be found in a faulted segment between the surface and the tunnel level. A crosscut is how being driven to the bed on the IIOO foot level. If the northern part of this shoot is not mineable, only between 5,000 and 7,500 tons of ore will be developed. If the full length is ore, IO,000 tons will be developed.

There is little likelihood that any worthwhile ore shoots occur in the Springer bed north of present workings. In most north headings, and in drill holes farther north, the bed is too narrow to mine. This area is also disturbed by faults.

It may be difficult to maintain production from the Springer bed during the year unless development work is started on a lower level. Such a program, in view of the labor shortage, is not feasible until the length and grade of the shoot on the IIOO foot level are determined. There is no way to satisfactorily gather this information by drilling.

No recommendations can be made at this time. After the surface geology has been studied, it may seem worthwhile to attempt to

find the Springer bed south of Springer Gulch.

## George Bed

The George bed lies about 250 feet west of the Springer, cropping out intermittently for almost a mile. It varies between 3 and 20 feet in which. On Humboldt Hill, a 500 foot interval of the bed contains ore. Prospect crosscuts have been driven to the bed on the tunnel, 400, 500, 600, and 725 foot levels. On these levels the bed contained considerable unreplaced marble and limestone, but a few small stopes of good ore were mined.

A sub-level has been started along the bed at an elevation of 50 feet above the collar of the shaft. If the bed contains a stoping width of ore for half the length of the mineralized outcrop, this sub-level will develop I5,000 tons. Such a block of near-surface ore could sustain production from the Humboldt mine while development work was being pushed on the lower levels.

I have no recommendations to make concerning the George bed.

If the block now being developed contains a substantial tonnage of ore, the operators will explore the bed on the 300 foot level. Past experience suggestes that the bed can be picked up by crosscutting without preliminary drilling. As the bed exibits large variations in grade of ore within short distances, its worth can only be determined by drifting along it.

#### Reserves

Mr. Heizer will make no statement concerning the reserves of ore. The estimates set forth in the following section are based upon our observations, and indicate order of magnitude only.

A note concerning low-grade ore is appropriate to allay suspicions concerning unstoped areas in the mine. No large tonnage of low-grade ore remains in developed parts of the mine. In stopes, only enough of the hanging wall portion of the bed was left standing to prevent collapse of the overlying hornfels, and consequent dilution of broken ore. The change from ore to almost barren bed is characteristically abrupt, and mining has generally been carried to the limit. A few stopes that averaged only 0.25% WOz have been mined. I have seen only two unstoped low-grade zones that contain a substantial tonnage. One of these blocks is between the I450 and the I575 levels and may be stoped soon.

<sup>\* 0.25%-0.4%</sup> WO3

# Summary of Reserves

	Low-grade Ore 0.25%-0.5% W03 Tons	20,000 7,500 80,000	3,500	No Estimate 35,500
	Level	Shaft Area North End 1500 level	975 North	
	Month's Supply at		4 4	77
Straight of the Straight of th	Indicated and inferred oreTons	None	(II00 Level) 7,500	12,500 12,600
	Month's Supply at present quota	50 01 00 Horton		HIH ES
	Measurable ore. 0.5%- I% WOg-Tons	6,000 5,000 11,000	3,000 3,000 10,000	25,500
	Bed and level Humboldt	Broken ore 1400 stope Total	Springer Broken ore 975 stope Wedges Total	George Sub-level Total Grand Total

STRUCTURAL MAP PART OF THE SPRINGER-HUMBOLDT MINE SHOWING CONTOURS ON THE HUMBOLDT BED M.R. KLEPPER U. S. GEOLOGICAL SURVEY C.W. CHESTERMAN FEBRUARY 10,1943 EXPLANATION SCALE Contours on footwall of Humboldt bed at elevations of levels or as noted. Stoped above & below level: Stoped above tevel Stoped below level: Above. To be stoped: Ore lenses, may be dragged segments of Humboldi bed low grade factite 0.2% -0.4% WO, Low grade factite, partly marble 02%-0.4% WO3. Mostly morble <0.2% WO3. Bed unexplored, character uncertain: Cropping of bed. Igneous Rock Intrusive rock 000000000 Including granodiorite, aplite, and hornblende ondesite. Foults Prominent gouge fault. Bed terminotes at silicated fault zone: Bed terminates, cause uncertain: 30 · EL. 3720 Others Inocessible - information by aral communication or 2 2 2 2 ? from Nevada Massachusetts Company maps. Possible position of seg-ment of Humboldt bed 0000 0000 000 0000 CONFIDENTIAL J. S. GEOL, SURVEY EL 550 U.S. GOVERNMENT #1, W55% Collar Humboldt Shaft. 3070 0075 Item 76

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(see also map)

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#### Abstract

The tungsten deposits in the Eugene Mountains, 8 miles west of Mill City, Nevada, are in limestone beds that have been partly altered to tactite. These narrow but persistent limestone beds are part of a dominantly argillaceous sedimentary sequence that has been metamorphosed to hornfels. The sediments have been intruded by two small stocks of granodiorite, and by dikes of granodiorite, aplite, and andesite. Some of the limestone beds have been partly altered to tactite, and minable quantities of scheelite were introduced into some of the tactite.

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(I) Levels are designated according to footage clong the incline of the Humboldt Shaft.

The Springerbed parallels the Humboldt. It is explored to a depth of 1000 feet, and for a maximum length of 1500 feet. Width of ore averages 3 feet. The southern limit of underground explorations is at a fault. The bed has never been recognized south of this fault. In the northern part of the workings the bed is too narrow to be mined.

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Production from the Humboldt-Springer mine has been 700,000 tons of 0.75% WO3 ore. Of this amount, the Humboldt had has contributed more than 75%, the Springer 20%, and the George less than 5%. Total reserves of 0.75% ore are probably less than 50,000 tons. Although no large tonnage of low-grade ore remains in developed portions of the mine, reserves of possible low grade ore, containing from 0.25% to 0.5% of WO3, may amount to approximately 30,000 tons.

In recent months, mining of ore has closely followed development work. Within a few months, all of the ore now developed will be broken. Unless enough men to push necessary development drives become available, the rate of production from the Humboldt-Springer mine will probably declined by the end of 1943. One hundred feet of drifting along the bed no longer develops 75 feet of ore, as it did in the early days of the mine.

#### Location

The Humboldt-Springer is one of three tungsten mines in the Eugene Mountains that are operated by the Nevada Massachusetts Company, Inc. These mines, together with a few small and inactive mines and prospects, are situated in the low foothills along the east flank of the range, 8 miles west of Mill City, Pershing County, Nevada. A surfaced road connects the mine area, including the mills and the camp, with U. S. Highway No. 40 at Mill City. Mill City is also a station on the Southern Pacific Railroad.

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The beds are cut by faults of a least two generations. The first generation cuts only the sedimentary rocks. Fault zones belonging to this generation have been recrystallized to dense, hard, light-colored silicate rocks. Zones of similar silicate rock are common in the hornfels sequence, and some of them may represent the clied faults. Ore beds are rarely cut off sharply at these zones, but are commonly attenuated or dragged out for a few feet or tens of feet. Some of these faults are steeply dipping strike faults of small displacement; one is a low angle reverse fault with a horizontal component of displacement of applease 100 feet. Others that have not been solved probably exist.

# ScheDite Deposits

Scheelite ore deposit are confined to limestone beds that have been altered to tactite. Within these beds, minable quantities of scheelite occur in shoots of irregular size and shape. The factors that control localization of these shoots, have not been recognized. Proximity of intrusive bodies does not directly influence their location. In many places along the beds, marble, and even limestone are in contact with intrusive bodies. Some ore shoots lie adjacent to major intrusive contacts; others are from 1000 feet to 2000 feet distant from recognized major contacts.

The ore is a medium to coarsely-crystalline aggregate of quartz, garnet, epidote, calcite, pyrite, scheelite, and locally molybdenite and pyrrhotite. Proportions of the different minerals very markedly within a bed, and even within a single ore shoot. The ratio of garnet to other minerals is higher in the Humboldt bed than in the Springer.

#### Humboldt Bed

The Humboldt bed has yielded nearly half of the ore mined in this district. It can be traced on the surface from the Olsen granodicrite stock southward for 1750 feet. It has never been identified south of this point.

On levels above the 725', the bed averages 1700 feet in length and is in ore for about 75% of the entire length. Below the 725 foot level, the bed terminates at the southern end along a line that slopes about 40° north. The granodiorite cut-off at the north end dips steeply south. Consequently the bed is shortened from 1750 feet on the 725' level to a predicted 750 feet on the 1700 level, and it may be eliminated within a few hundred feet of the present bottom of the mine. The ratio of waste to ore also increases markedly on lower levels. A good shoot of ore occurs between the 1325 foot level and the 1450 foot level, but only low-grade ore has been found on the 1575 foot level.

Width of ore that can be stoped varies between 4 and 12 feet, averaging 6 feet. Grade of individual stopes (75x100x6 feet) has varied between 0.25% and 10% WO3, averaging 0.75%. Transition between ore and almost barren bed is rapid; very little 0.25%-0.50% WO3 ore remains in the mine.

Zones of very low-grade tactite and unreplaced limestone or marble occur along the bed at all elevations. The northern third of the outcrop is mostly unreplaced limestone and marble. Similarly the northern part of the lower levels of the mine is in marble that contains only a few small shoots of ore.

Problem of the Humboldt Bed: The cut-off at the south end progressively shortens the most consistently mineralized part of the Humboldt bed. No ore was found on the 1575 foot level, and there is no reason to anticipate that mineralization of the bed will be better on the 1700 foot level. Mining of the Humboldt bed cannot be continued for long unless a mineralized extension of the bed can be found beyond the cut-of at the south end, or unless a shoot of ore exists on the lower levels between the north headings and the granodiorite, a zone that has been poorly dineralized on higher levels.

The cause of the southern out-off of the Humboldt bed is not known. The structural map suggests that two factors have been responsible. Between the surface and the 725 foot level the cut-off inclines steeply to the south, and the bed maintains a constant length. Below the 725 foot level, the cut-off inclines flatly to the north, and the length of the bed decreases rapidly. This cut-off might result from:

- (1) Lack of sedimentation
- (2) Lack of sedimentation; faulting, possibly before consolidation, or
- (3) Combination of two faults.

(1) If the bed was deposited against an irregularly curving shoreline or in a basin with an irregular bottom, such a termination might occur. The lenges of ore that are often found beyond the termination of the bed might have been deposited in shallow pools along a shoreline or in depressions in the bottom of a basin.

In support of this hypothesis is the fact that I have never seen the full width of the bed abruptly truncated. Rather, it either pinches out gradually or passes out into a discontinuous train of ore lenses.

Mr. W. G. Emminger, Mine Superintendent, reports, however, that in some inaccessible stopes the cut-off has been abrupt.

- (2) Lack of sedimentation; faulting.— Either the upper or lower cut-off, both of which are similar in appearance but differ in inclination, may be due to lack of sedimentation; the other may be faulted off. Faulting while the beds were semi-consolidated is believed to be a possibility.
- (3) Combination of faults.— Lenses and small streaks of ore that occur in silicated rock beyond the termination of the bed, as well as from 20 to 50 feet in the hanging wall and footwall of the bed, are considered by some to be "dragged" ore. No proponent of this theory has clearly explained why such ore lenses are found at different distances in both the hanging wall and footwall of the bed on a single level. An alternative suggestion is that they were deposited as discontinuous limestone pods at a few horizons in the hornfels sequence.

If a persistent zone of lenses in the hanging wall of the bed is admitted to be "dragged" ore and if small variations in the thickness of hornfels between the Humboldt and Springer beds at different elevations are plotted on vertical sections, a fairly convincing argument in favor of a strike fault with vertical displacement is adduced. Crossentting and diamond drilling in the upper levels of the mine indicate that no south segment of the Humboldt bed is present at these elevations within a 500 foot radius of the cut-off. On the 1100 foot level and below, a more persistent tactite tens lies in the hanging wall of the bed. If this is "dragged" ore, rather than a lense deposited at this horizon, it may indicate that the missing segment of the bed has been dropped below the deepest workings. The possible position of this hypothetical segment is plotted on the structural map.

Suggested Exploration.— In order to plan development work and evaluate the probable life of the mine, it must be determined whether a displaced segment of the Humboldt bed exists. Its absence above the 975 feet level is almost certain. Testing by diamond drilling for a deeper zone in which the bed may lie is difficult. Therefore, the operators have plabned a campaign of crosscutting from the 1700 foot level. A crosscut will be driven to intersect the bed north of the cut-off (Z on map); another will be driven southward to explore for a missing segment. This program will require at least a year.

I have discussed with Mr. Heizer the feasibility of diamond drilling. He has decided to drill three, and possibly four, holes very soon: one horizontal into the hanging wall from the 1700 station, one horizontal into both the hangingwall and footwalls at the south end of the 1100 level, and possibly an inclined hole into the footwall from the same point. This program will explore for the Humboldt bed in unknown ground, and also test the George bed 800 feet below its lowest exposure. No further drilling seems warranted at this time.

No capital expenditure to improve the Humboldt shaft and increase its hoisting capacity would be justified unless another segment of the Humboldt bed is found.

#### Springer Bed

The Springer bed can be traced from a fault in Springer Gulch northward for 1400 feet. Whether it lenses out or is faulted off at the north and is not known. The Yellow Scheelite bed in the Stank mine may be a faulted segment of the Springer bed south of Springer Gulch.

The bed has been mined between the surface and the 975 level for an average length of 750 feet, and an average width of three feet. Average grade is about 0.75% WO3. The northern half of the ore shoot on the 600, 725, 850, and 975 foot levels has been low grade. The block between the 850 and the 975 foot levels, estimated to average less than 0.3% WO3, was not mined.

Small wedges of ore containing a few hundred tons each, remain above the 975 foot level, but they will be expensive to mine. A larger block may be found in a faulted segment between the surface and the tunnel level. A crosscut is now being driven to the bed on the 1100 foot level. If the northern part of this shoot is not minable, only between 5,000 and 7,5000 tons of ore will be developed. If the full length is ore, 10,000 tons will be developed.

There is little fikelihood that any economically minable ore shoots occur in the Springer bad north of present workings. In most north headings, and in drill holes farther north, the bed is too marrow to mine. This area is also disturbed by failts.

It may be difficult to maintain production from the Springer bed during the year unless development work is started on a lower level. Such a program, in view of the labor shortage, is not feasible until the length and grade of the shoot on the 1100 foot level are determined. There is no way to satisfactorily gather this information by drilling.

No recommendations can be made at this time. After the surface geology has been studied, it may seem advisable to attempt to find the Springer bed south of Springer Gulch.

#### George Bed

The George bed lies about 250 feet west of the Springer, cropping out intermittently for almost a mile. It varies between 3 and 20 feet in width. On Humboldt Hill, a 500 foot interval of the bed contains ore. Prospect crosscuts have been driven to the bed on the tunnel, 400, 500, 600, and 725 foot levels. On these levels the bed contained considerable unreplaced marble and limestone, but a few small stopes of good ore were mined.

A sub-level has been started along the bed at an elevation of 50 feet above the collar of the shaft, if the bed contains a stoping width of ore for half the length of the mineralized outcrop, this sub-level will develop 15,000 tons. Such a block of near-surface ore could sustain production

from the Humboldt mine while development work was being pushed on the lower levels.

I have no recommendations to make concerning the George bed. If the block now being developed contains a substantial tonnage of ore, the operators will explore the bed on the 300 foot level. Past experience suggests that the bed can be picked up by crosscutting without preliminary drilling. As the bed exhibits large variations in grade of ore within short distances, its worth can only be determined by drifting along it.

#### Reserves

Mr. Heizer will make no statement concerning the reserves of ore.

A note concerning low-grade ore is appropriate to allay suspicions concerning unstoped areas in the mine. No large tonnage of low-grade ore remains in developed parts of the mine. In stopes, only enough of the hanging wall portion of the bed was left standing to prevent collapse of the overlying hornfels, and consequent dilution of broken ore. The change from ore to almost barren bed is characteristically abrupt, and mining has generally been carried to the limit. A few stopes that weraged only 0.25% WO3 have been mined. I have seen only two instoped low-grade\* zones that contain a substantial tonnage. One of these blocks is between the \*0.25%-0.4% WO3

STRUCTURAL MAP PART OF THE SPRINGER-HUMBOLDT MINE SHOWING CONTOURS ON THE HUMBOLDT BED M.R. KLEPPER U. S. GEOLOGICAL SURVEY C.W. CHESTERMAN FEBRUARY 10,1943 EXPLANATION SCALE Contours on footwall of Humboldt bed at elevations of levels or as noted. Stoped above & below level: Stoped above tevel Stoped below level: Above. To be stoped: Ore lenses, may be dragged segments of Humboldi bed low grade factite 0.2% -0.4% WO, Low grade factite, partly marble 02%-0.4% WO3. Mostly morble <0.2% WO3. Bed unexplored, character uncertain: Cropping of bed. Igneous Rock Intrusive rock 000000000 Including granodiorite, aplite, and hornblende ondesite. Foults Prominent gouge fault. Bed terminotes at silicated fault zone: Bed terminates, cause uncertain: 30 · EL. 3720 Others Inocessible - information by aral communication or 2 2 2 2 ? from Nevada Massachusetts Company maps. Possible position of seg-ment of Humboldt bed 0000 0000 000 0000 CONFIDENTIAL J. S. GEOL, SURVEY EL 550 U.S. GOVERNMENT #1, W55% Collar Humboldt Shaft. 3070 0075 Item 76