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Mohave Co

REPORT ON

THE LEVIATHAN MINE

CEDAR MINING DISTRICT

SIXTY MILES SOUTH OF KINGMAN

BY

J. B. TENNEY, MINING ENGINEER,

TUCSON ARIZONA

JAN. 16, 1938

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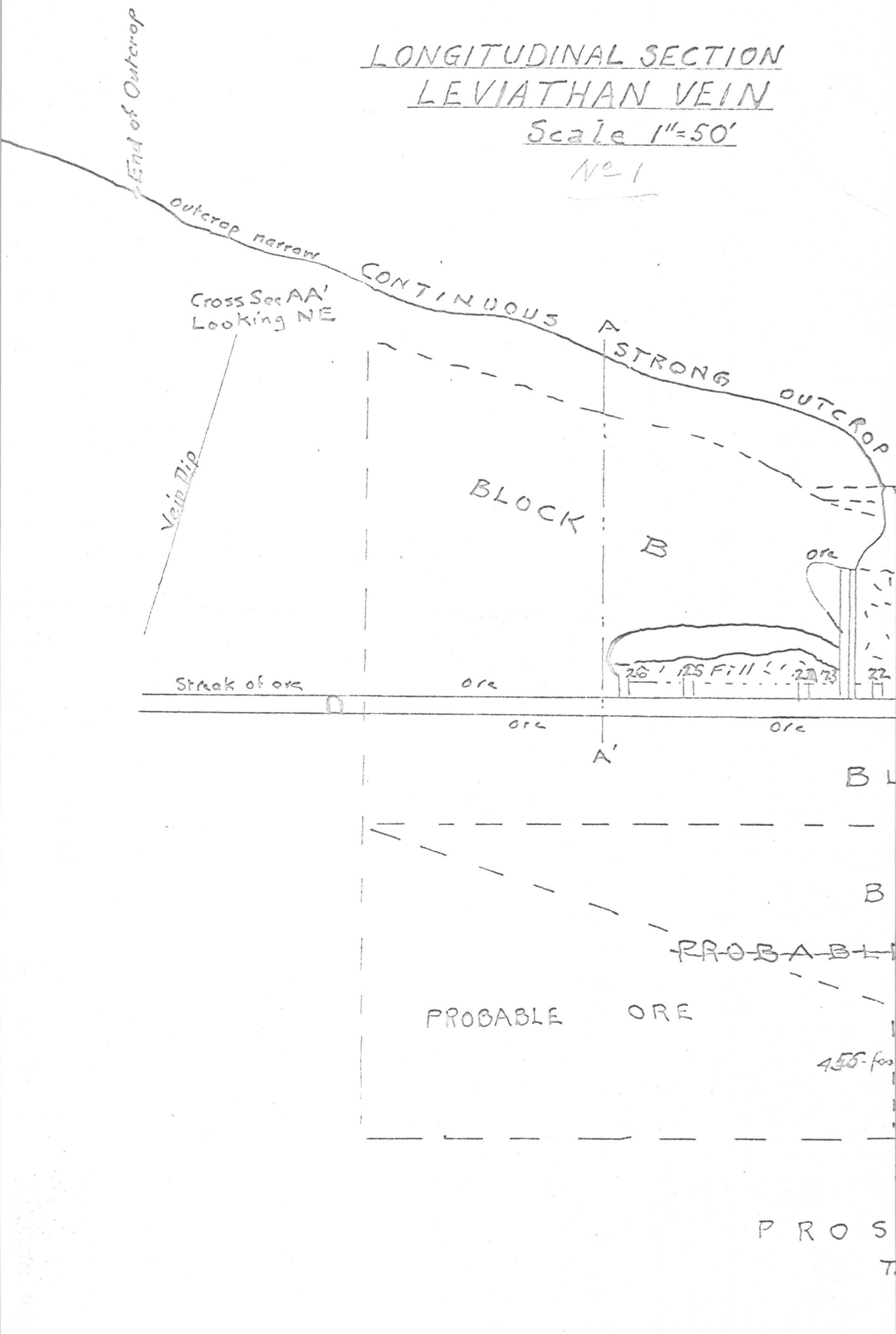
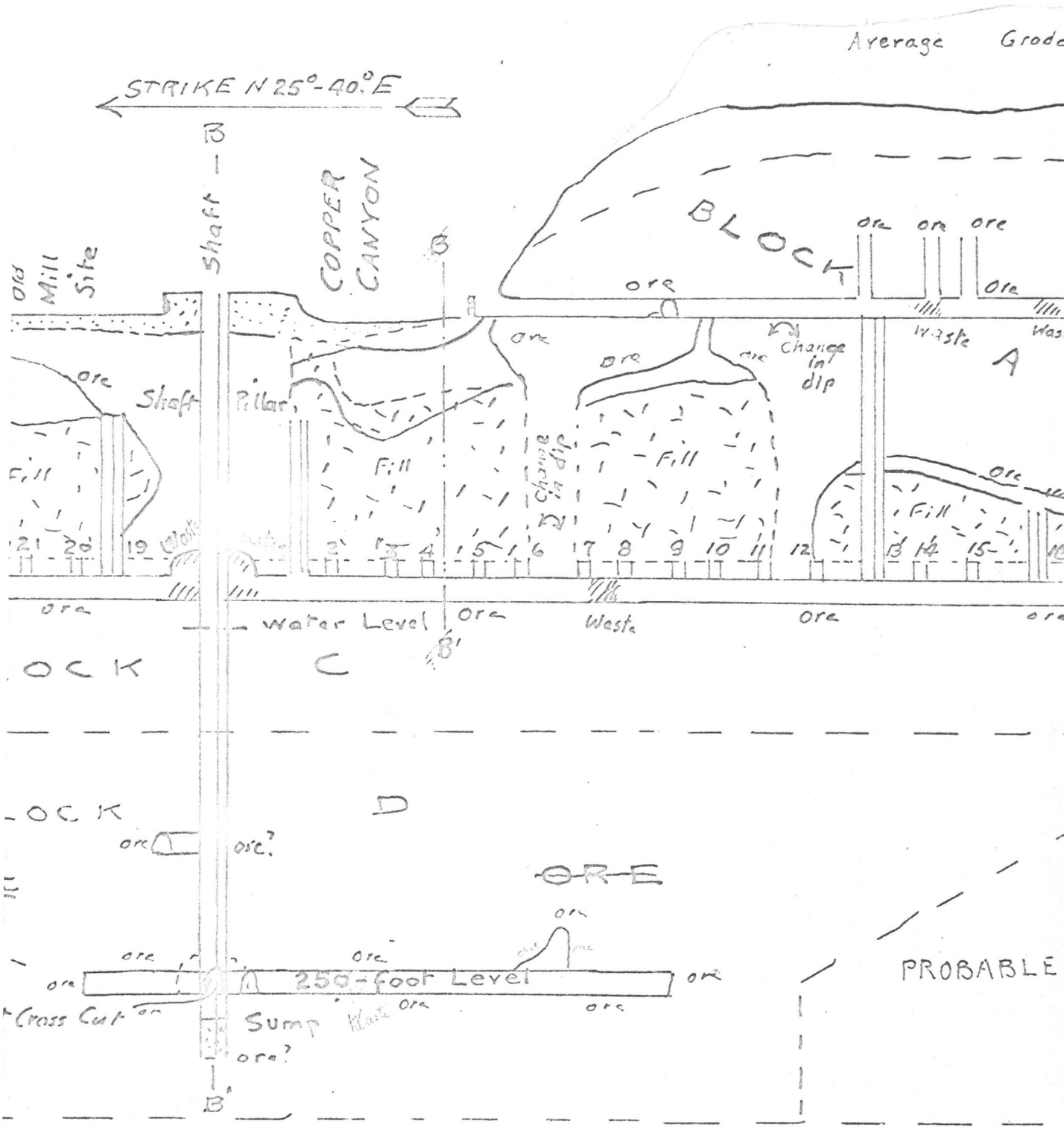
LONGITUDINAL SECTION
LEVIATHAN VEIN
Scale 1"=50'

No 1



Average Grad
Average Grad
Assumed Scree

Average Grade

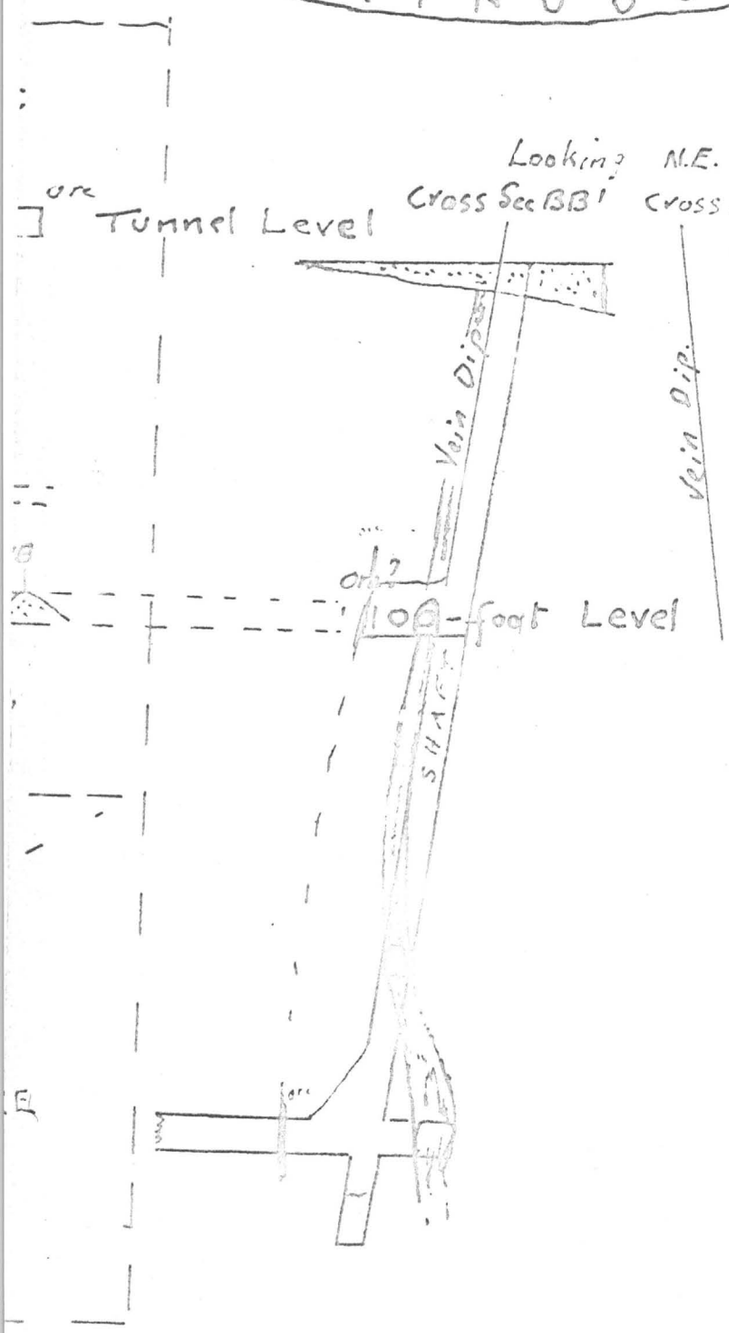


PECTIVE ORE

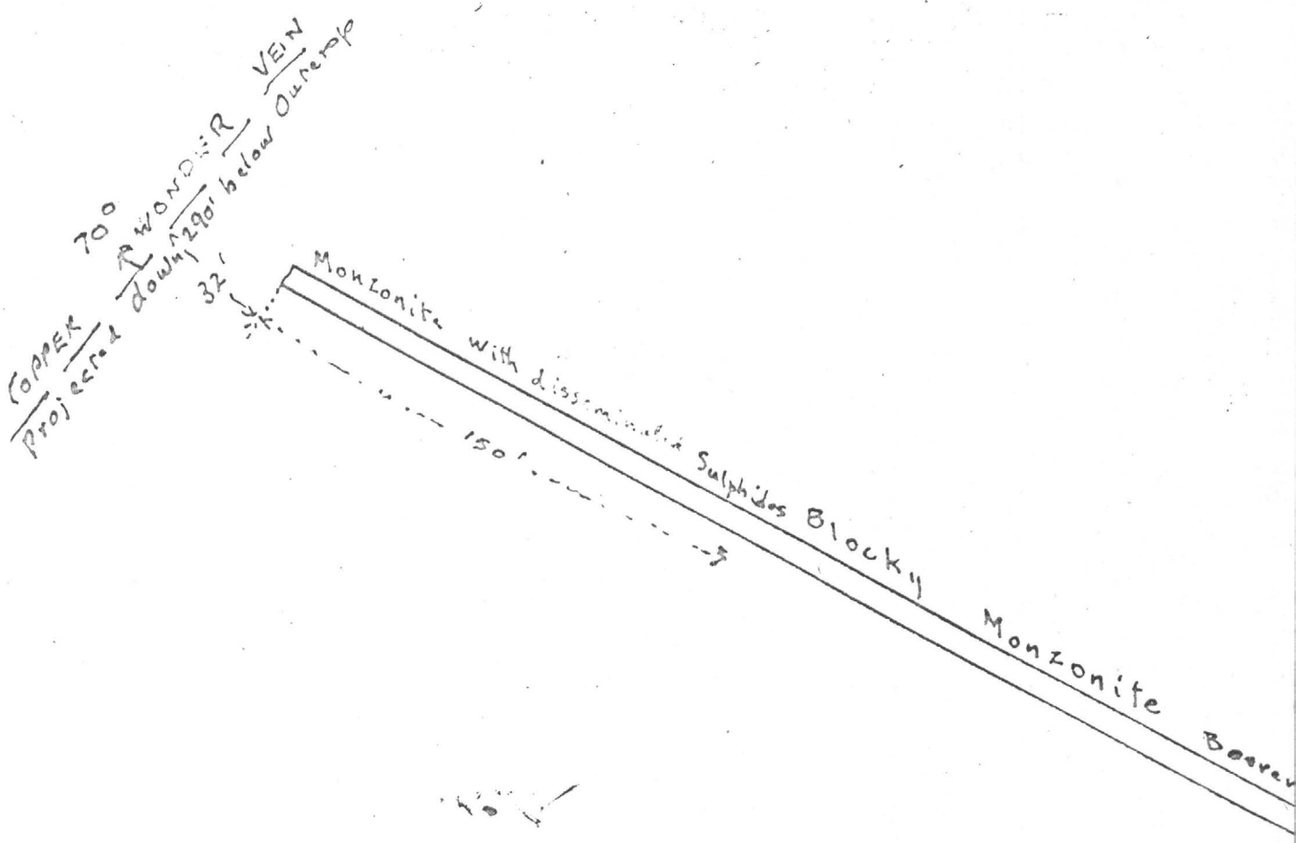
depth of 1000+ feet.

whole Vein above 100' Level including wasty spots 1.13% MoS_2, 0.65% Cu. $0.75
whole Vein above 100' level without wasty spots 1.20% MoS_2
re grade above 100' level 2% MoS_2, 1.5% Cu, $1.00 Au + Ag (50% rejected)
Average Vein Width 48"
250-foot Level 0.994% MoS_2 0.18% Cu
Average Vein Width 250' Level 49"

CONTINUOUS STRONG



PROSPECTIVE



SAMPLE MAP

LEVIATHAN MINE

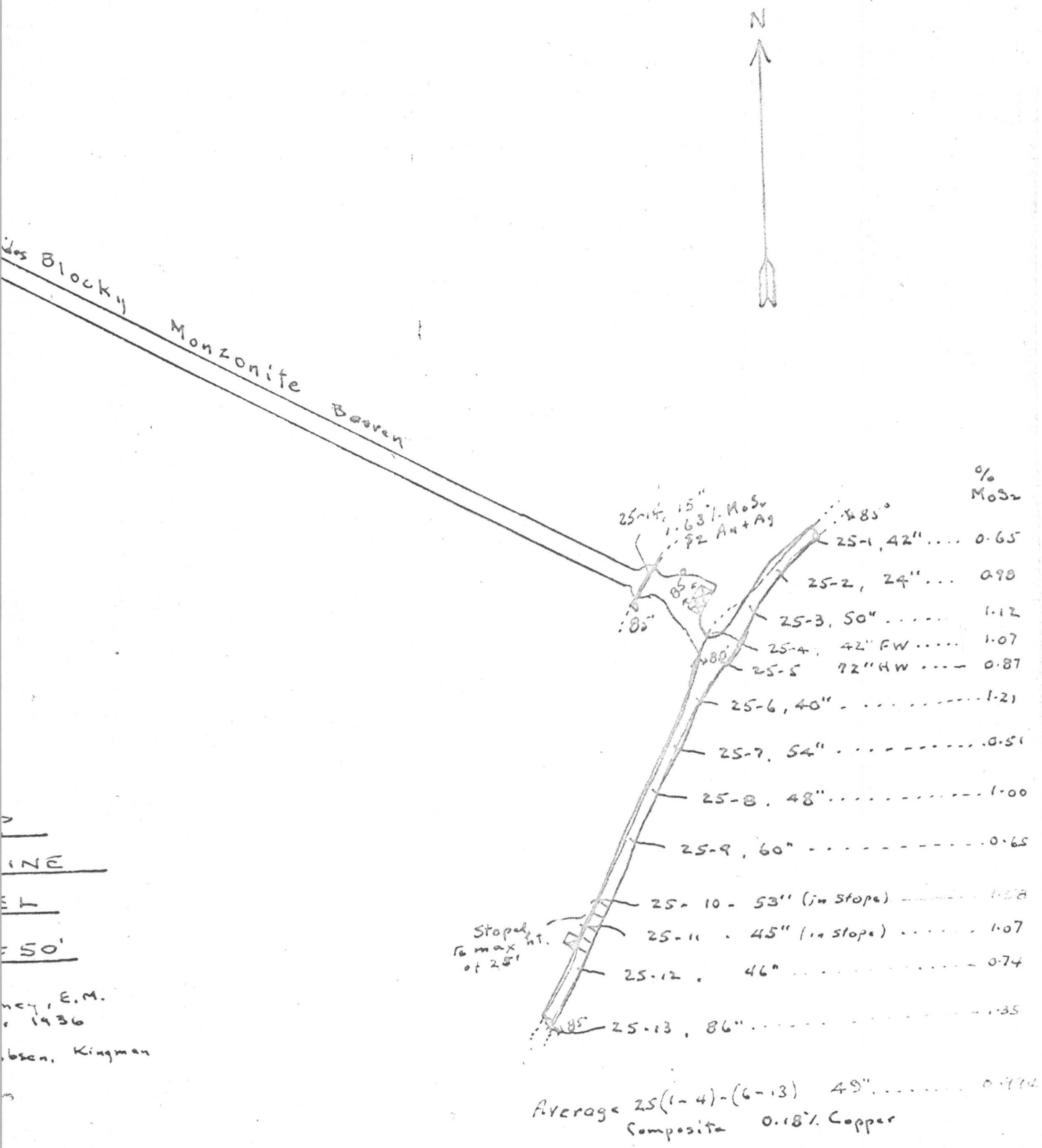
250-FOOT LEVEL

Scale 1" = 50'

Sampled by J.B. Tenney, E.M.
October 1936

Assayed by R.C. Jacobsen, Kingman

No 2a



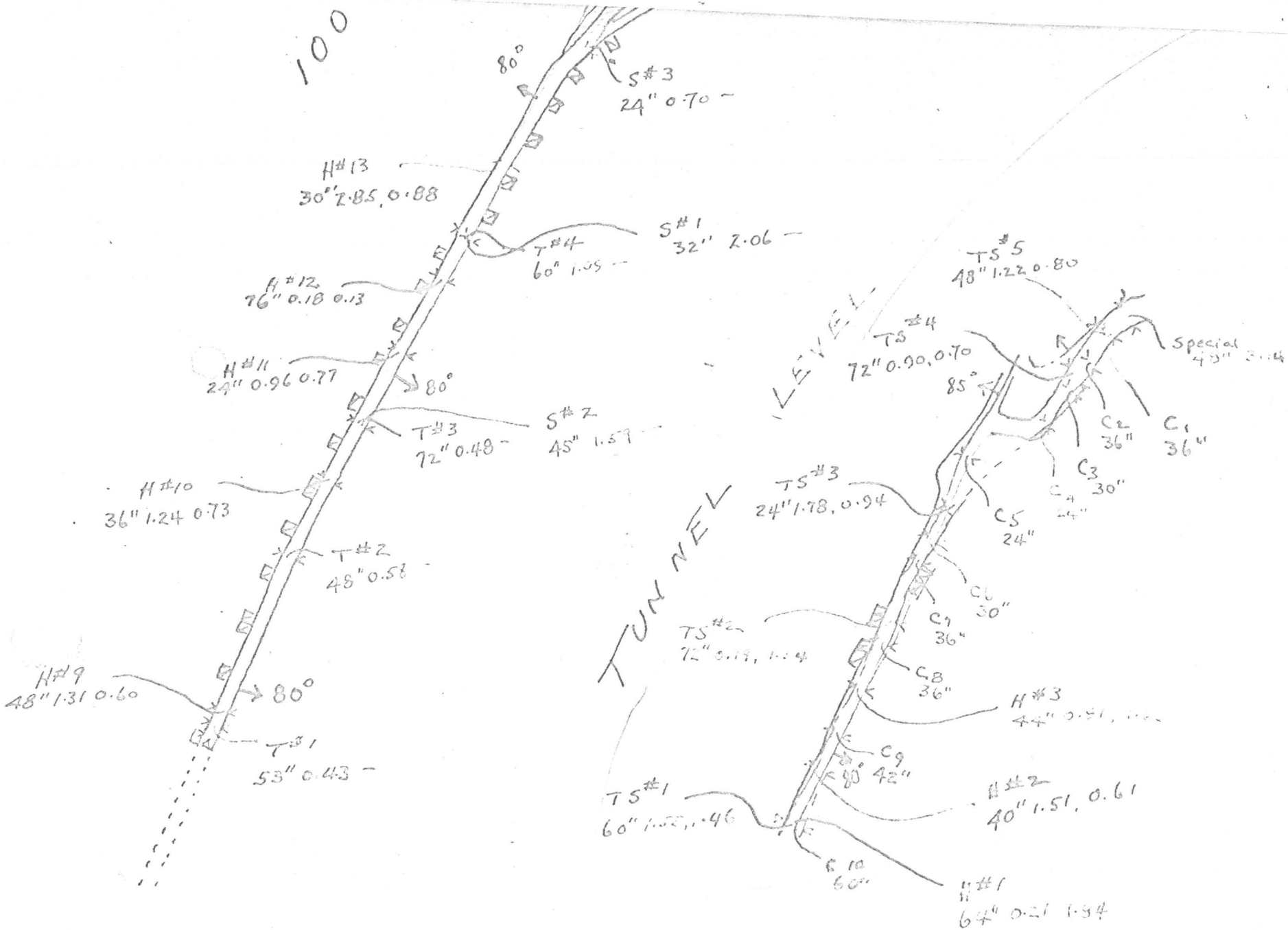
INE

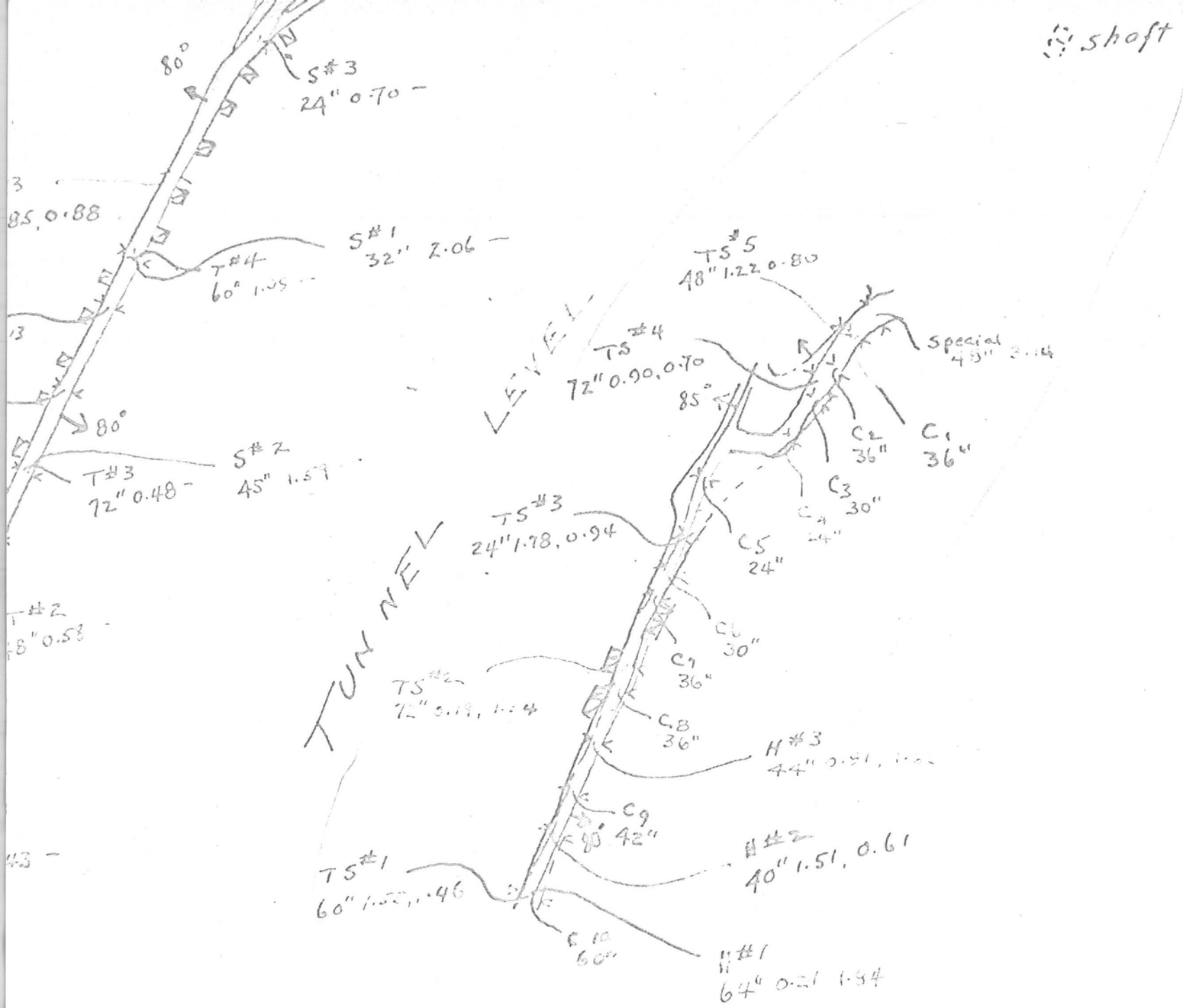
ET

50'

ney, E.M.
1936

bson, Kingman


100
80°
S#3
24" 0.70
H#13
30" 2.85, 0.88
S#1
32" 2.06
T#4
60" 1.09
H#12
76" 0.18 0.13
H#11
24" 0.96 0.77
80°
S#2
45" 1.59
T#3
72" 0.48
H#10
36" 1.24 0.73
T#2
48" 0.58
H#9
48" 1.31 0.60
80°
T#1
53" 0.43
TUNNEL LEVEL
TS#5
48" 1.22 0.80
TS#4
72" 0.90, 0.70
85°
Special
C2
36"
C1
36"
C3
30"
C4
24"
TS#3
24" 1.78, 0.94
C5
24"
C6
30"
C7
36"
TS#2
C8
36"
H#3
C9
42"
80°
TS#1
60"
H#2
40" 1.51, 0.61
C10
60"
H#1
64" 0.21 1.94



TUNNEL LEVEL

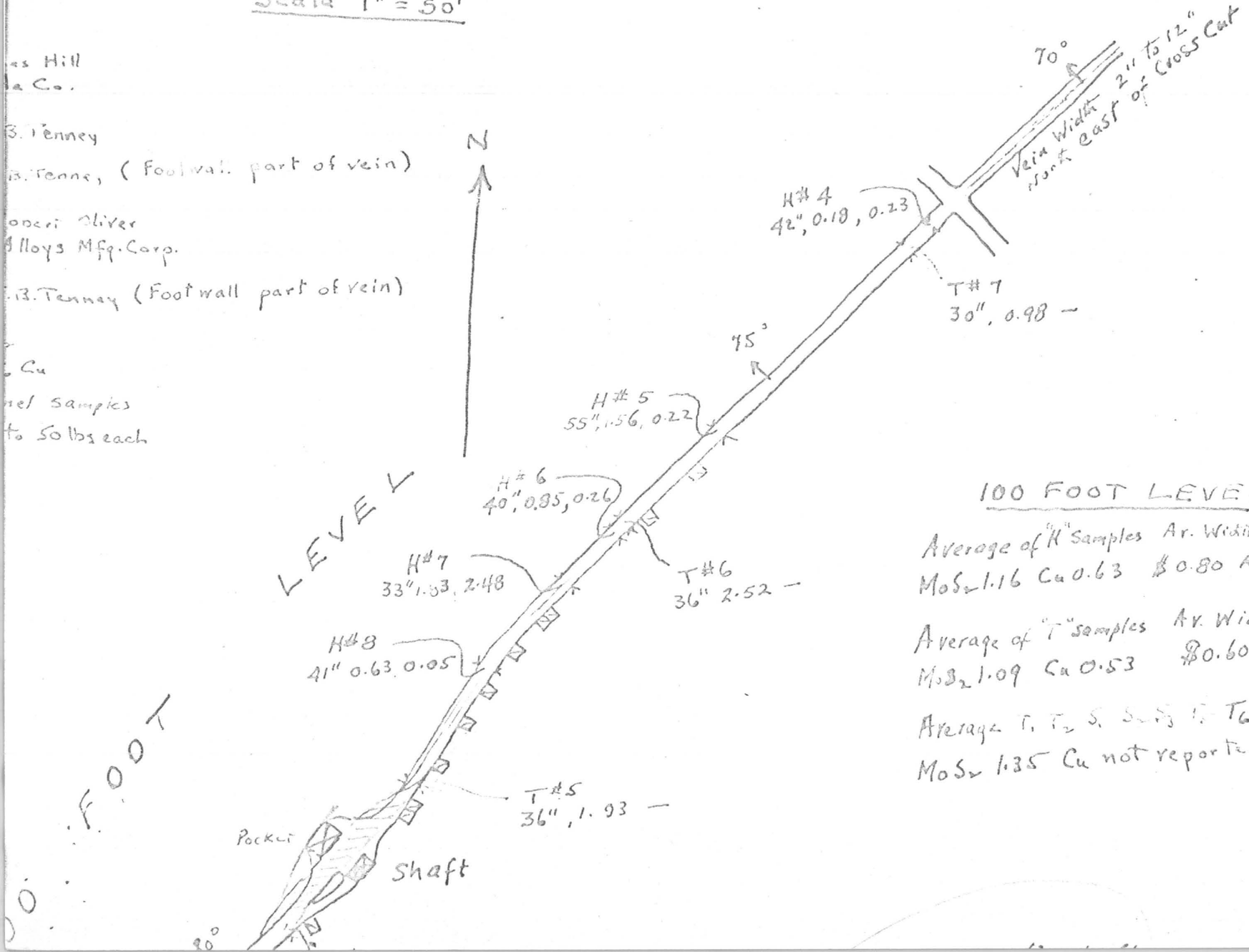
Composite of "C" samples. Av. width 35.4"
MoSr 1.78 Cu 1.53

Average of "TS" Samples Av width 55"
MoSr 1.13 Cu 1.05

Average "H" Samples (incomplete) Av. width 50"
MoSr 0.88% Cu 1.37% $0.78 /ton

LEVIATHAN MINE

Scale 1" = 50'



100 FOOT LEVEL

Average of "H" Samples Av. Width [illegible]
MoS_2 1.16 Cu 0.63 \$0.80 Au + Ag

Average of "T" samples Av. Width 49"
MoS_2 1.09 Cu 0.53 \$0.60 to \$1.00 Au + Ag (Reported Gold too high)

Average T_1 T_2 S_1 S_2 S_3 T_5 T_6 T_7 Av. Width 38"
MoS_2 1.35 Cu not reported

SAMPLE MAP

LEVIATHAN MINE

Scale 1" = 50'

EXPLANATION

H = samples by James Hill for Union Carbide Co.

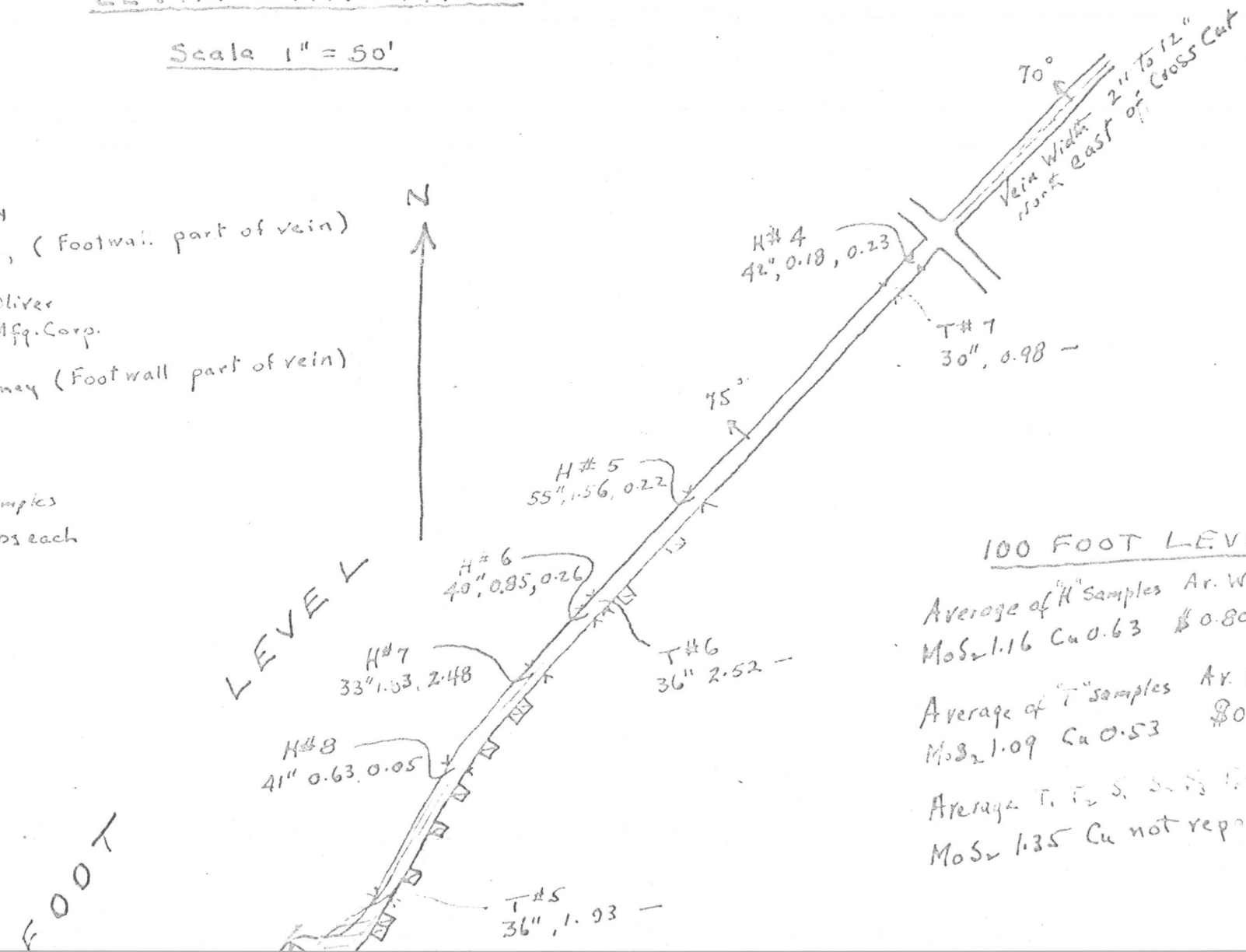
T = samples by J. B. Tenney

S = samples by J. B. Tenney, (Footwall part of vein)

TS = Samples by Robert Oliver for Titanium Alloys Mfg. Corp.

C = Samples by J. B. Tenney (Footwall part of vein)

First figure = % MoS_2
Second figure = % Cu
All samples channel samples weighing from 25 to 50 lbs each



100 FOOT LEVEL

Average of "H" samples Ar. Width [illegible]
MoS_2 1.16 Cu 0.63 $0.80 Au & Ag

Average of "T" samples Ar. Width 49
MoS_2 1.09 Cu 0.53 $0.60 to $1.00

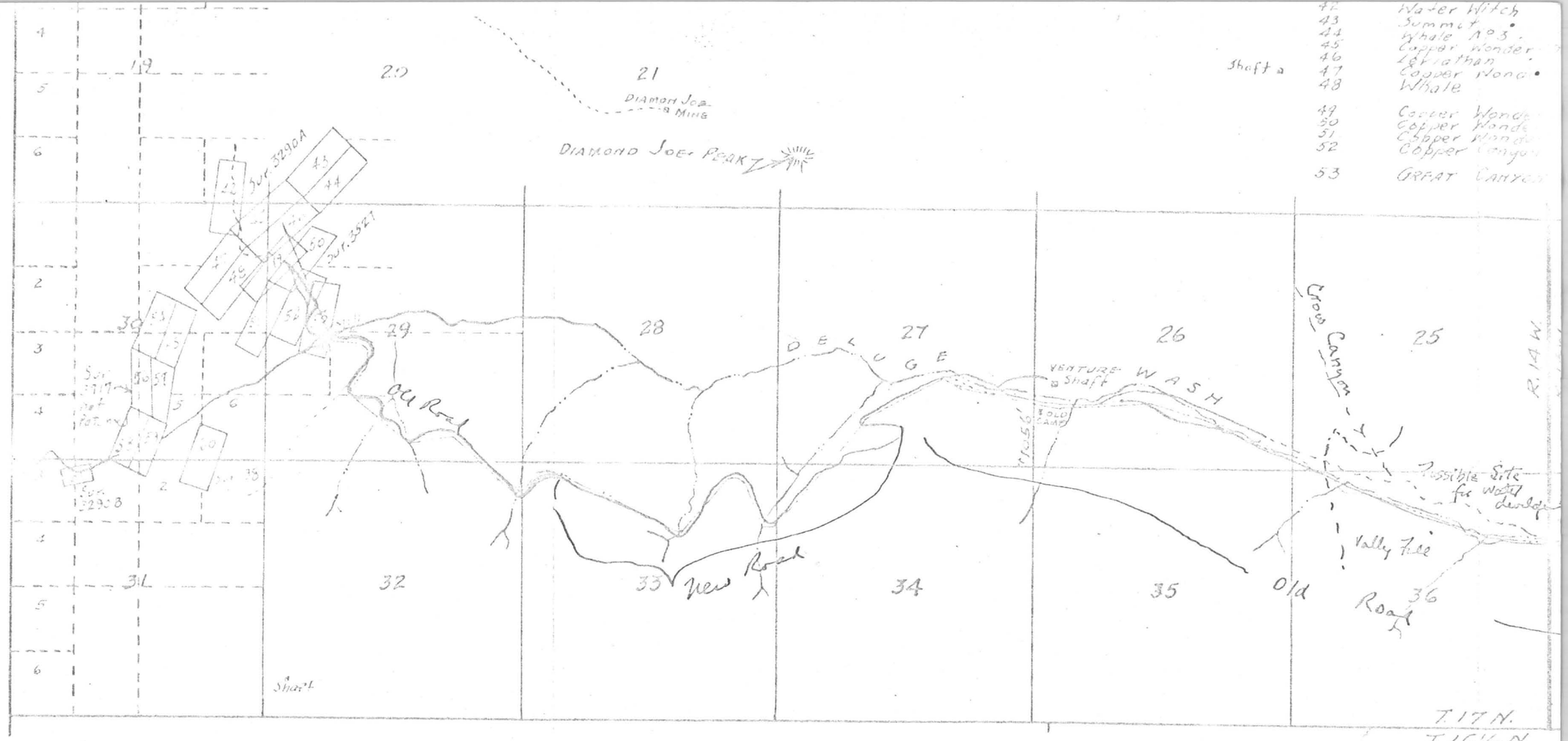
Average T, [illegible] S, [illegible] T6 T7
MoS_2 1.35 Cu not reported

nder No 2	3290A	Leviathan Mines Co. July 16, 1920	60	Congress	98	T.H. Blithe, et al Nov. 1, 1879
nder No 1						
nder No 3			61	Leviathan Mill Site	3290B	Leviathan Mines Co., July 16, 1920
nder No 5	3527	Minnie A Sawyer June 9, 1920				
nder No 4						
nyon						
nyon	3458	M.A. Sawyer & A.H. Smith, Jan. 27/22				

E THE NEW

½ & 17 N., R. 13 & 14 W., Gila & Salt River Meridian

1935



MAP SHOWING LOCATION OF

LEVIATHAN

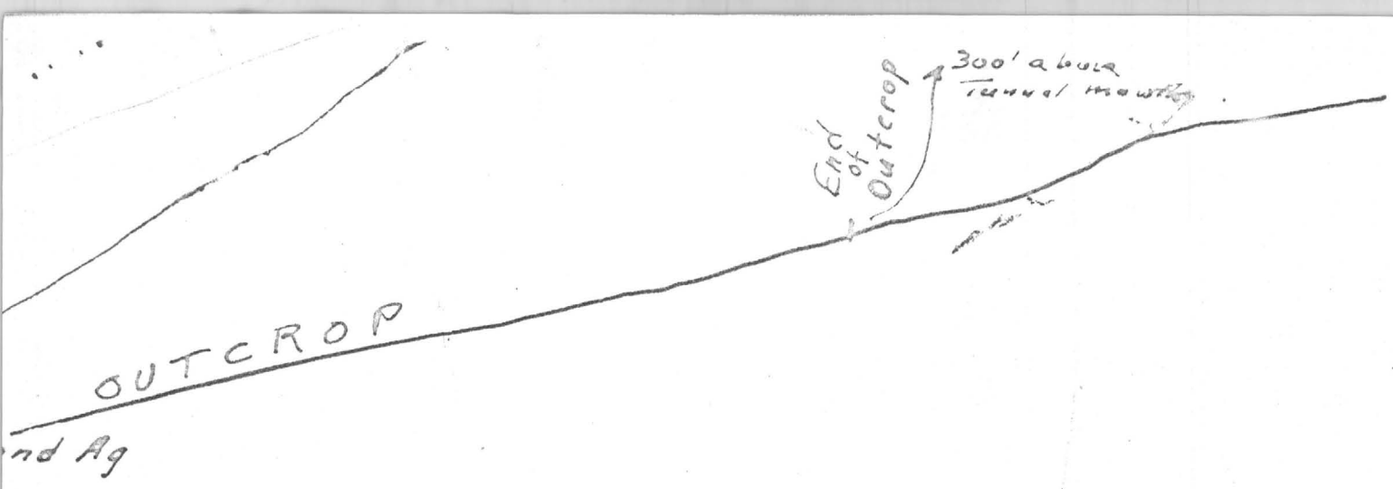
ROAD & PIPE LINE IN T. 16½

Cedar Valley Mining District

Mohave County, Arizona

Scale 2" = 1 Mile Sept. 193

Surveyed & Delineated By
E. Ross Housholder E.M.
Registered Professional Engineer
Kingman, Arizona


300' above
Tunnel mouth
End of Outcrop
OUTCROP
nd Ag

Mohave Co

FLOTATION TESTS ON

LEVIATHAN MOLYBDENITE ORE

FOR

MR. J. B. TENNEY

BY

JOHN F. GRAHAM

TEXAS COLLEGE OF MINES AND METALLURGY

EL PASO, TEXAS.

NOV. 23, 1935

* * *

* *
*

D K MARTIN & ASSOC
4728 No 21ST AVE
Phx Az 85015

Mr. J. B. Tenney,
1070 Mountain Ave.,
Tucson, Arizona.

Dear Mr. Tenney:

The Molybdenite ore which you sent me for testing assayed:

MoS_2 = 6.51% Cu. = .58%

This ore is identified as the Leviathan ore.

Your instructions were to test the ore in conformity to a flow sheet included in your letter. In the main I have followed these instructions, but I have deviated at times when it seemed more likely to give better results.

Because of the high cost of Molybdenum assays I have made little attempt at metallurgical balancing but have tried to pick out indicative samples for assaying.

The one balanced test that I made is summarized below:

Material	Weight	Assay			Recovery	
	Grams	MoS_2	Cu %	Insol.	MoS_2	Cu
Concentrate	42	83.45	.48	12.4	44.80	1.8
Middling	35	27.12	1.72		9.75	5.5
Middling	35	11.72	.98		5.25	3.2
Middling	300	5.64	.57		21.70	15.6
Tails	1658	.87	.49		18.50	74.0
	2070				100.00	100.1
Calculated Heads		3.80	.53			

This particular test was ground somewhat finer than most of the tests, being only 2% + 100 mesh.

The procedure of the test was:

Grind in a rod mill with a water-solid ratio of .8 to 1 and 6 lb of lime to the ton of ore. The amount of lime to be used will be governed by the ore, the water and the quality of the lime.

Float approximately one hour. At first Molybdenite came over freely, but after the first ten minutes the flotation was very slow. (You have accounted for this by saying that the coarse Molybdenite possibly should be removed from the tails by a classifier.)

The tails from this operation can be floated for copper with good results. In one test, not this one, I produced a copper concentrate assaying:

Cu = 16.28% Au = .02 oz Ag = 4.8 oz

with a recovery of 76.4% of the total copper.

Considering the low copper value of the heads of the ore tested, any saving of copper from this particular grade would be uneconomic. The reagents used were 1 lb $CuSO_4$, .1 lb Amyl Xanthate and pine oil to make a froth.

The rougher concentrate was then floated, using 2 lb. sodium cyanide as a copper depressant and pine oil sufficient to maintain a froth. Each concentrate made was refloated with 1 lb. sodium cyanide, calculated on the basis of original tonnage. This is more cyanide than is needed for these small concentrates, but it maintains the same cyanide strenth of solution.

In this test the rougher concentrate was refloated six times and then the various cleaner tails combined as shown on the table.

The computed heads for this test was 3.8% MoS_2 instead of the 6.51% shown by a sample of the ore. This can be accounted for by admitting that the head sample is incorrect, either in sampling or in assaying, or by admitting that the sample taken for the test, although quartered out, was actually lower than the true heads.

COMMENTS.

I feel that the 12.4% insoluble in the concentrate can easily be lowered either by regrinding or my manipulation thus bringing the product above the required minimum.

One test gave a concentrate from 2000 grams, of:

Wt. = 24 grams MoS_2 = 88.54% Cu = .50%

These are the only Molybdenite assays on the concentrate that I had made. I have copper assay of a second concentrate running .50%.

Besides the tail values shown in this test I have tail values of .93%, .41%, and .79% MoS_2.

The tailing assaying 179% MoS_2 was screened and the component parts assayed with the following results:

Mesh	Quality	Assay % MoS_2	Distribution of MoS_2
+ 65	9.5%	.89	10.0%
- 65, + 100	37.0	.01	43.0
- 100, + 150	14.5	.91	16.5
- 150, + 200	12.5	.58	9.0
- - 200	26.5	.65	21.5
			100.0

This shows that the Molybdenite losses in the tailing closely parallel the character of the grinding, with 150 mesh as an apparent dividing line. One third of the tailing losses can be avoided by grinding below this limit.

However, this is but one test and needs to be checked up for correctness, and for effect on copper content.

# # #

A test on the disposition of the copper gave:

Material	%Weight	Copper Assay	Recovery
Tails	92.1	.11	17.8
Copper Conc	2.65	16.28	76.4
Middling No. 1	3.25	.58	3.4
Middling No. 2	1.3	.65	1.5
MoS_2 Conc	.7	.72	.9
	100.00		100.0

# # #

2070 grams raw ore at 3.80%			=	78.66 Grams MoS_2		
1658	"	Tails at .87	=	14.42	"	"
42	"	Concentrate at 83.45	=	35.05	"	"
				49.47	"	"
370	"	middlings at 7.89	=	29.19	"	"
				78.66		

The actual recovery as concentrate is 35.05 grams from 78.66 grams or 44.8%. But if you admit that the mill makes no middling then the recovery is 35 parts out of 50 or a recovery of 70%. This presupposes a tailing of 1.14% MoS_2, and since I do not think you should get a tailing that high, your recovery should be higher than 70%.

All this is predicated on heads of 3.80% MoS_2. I would expect the value of the tails to be about constant regardless of changes in the grade of the feed and so the higher the fed value the greater the recovery. The actual value of the tailings will of course be modified by the care given them, such as regrinding, etc.

CONCLUSIONS

A low tailing value will be obtained if the rougher concentrate tailings are scavenged by repeated refloats, the concentrate made each time working back to the rougher machine or even to the ball mill.

A certain amount of copper persists throughout the cleanings into the final concentrate. I think cyanide can be washed in this part of the circuit endeavoring to depress copper which is in fact entangled with the Molybdenite. I believe that having obtained somewhat near the desired grade of Molybdenite a regrinding before the final cleaning might be effective in removing insoluble and releasing copper.

The percentage of recovery of Molybdenite is governed by the Molybdenite content of the tails. Therefore a great deal of attention can be given to the effectiveness of this part of the flow sheet.

I believe the flow sheet incorporated in your letter of October 8th is faulty in one respect. The middling from any machine should work its way back thru the machines ahead of it instead of being sent back to the ball mill. The middling is a middling because of a desire to make a clean concentrate and is not necessarily unfloatable Molybdenite. Why, for instance, dilute a 40% Molybdenite by dumping it into a 4% heads when there already is a machine handling 40 % product?

Likewise the concentrate from the machines scavenging the tails is low grade and should enter the circuit at a low grade point, preferably the ball mill, rather than into a comparatively high grade cleaner concentrate. I realize that the flow sheet sent me is still in an embryonic stage, but in making any changes I think the above criticism should be checked up.

I regret that I could not make a locked test. The ordinary laboratory flotation machines are made to work at their best when handling 500 grams. With a concentration of 50 to 1, for example, and a desire to have 500 grams in the final machine, the original sample would have to be 25,000 grams. Such an extensive test is not warranted until a reasonable certainty as to details is obtained. It would seem best to do it before building a pilot mill.

Yours very truly,

John F. Graham.

LEVIATHAN MINE

LOCATION:

60 Miles south of Kingman, Mohave County, Arizona.

ACCESSIBILITY:

Big Sandy highway 49 miles from Kingman. Partly constructed old road 11 miles to mine, needs repaid and 2½ miles of new road.

PROPERTY:

7 patented claims, 2 wide and 3 long, plus one extra claim to west.

OWNERSHIP:

Leviathan Metals Company, Theo Hollister, Pres., 422 Providence Bldg., Duluthm Minn. Am Arizona Corp.

DEVELOPMENT:

260-ft tunnel, driven on vein; 260-ft steeply inclined shaft, with 800 feet of drifting on 100-ft level and 235 feet of drifting on 250-ft level. Considerable shrinkage stoping between 100-ft and tunnel levels, filled with waste.

ORE OCCURRENCE:

Two parallel veins striking N 30 E dipping from 70 to 80 degrees to the West. Veins 400 feet apart. Vein outcrops consist of iron-stained sparsely copper-stained much fractured quartz. Where Copper Canyon cuts the veins molybdenite outcrops. Elsewhere no molybdenum minerals crop. Leviathan vein outcrop on which development has been done, outcrops about 1500 feet long with widths varying from 3 feet to 20 feet and averaging about 6 feet. Copper Wonder vein outcrop 2000 feet long with vein widths varying from 3 feet to 10 feet and averaging about 5 feet.

Country rock medium grained much fractured and iron-stained monzonite. At South end of property pre-Cambrian complex of granite and gneiss outcrops.

Underground work shows molybdenite and chancopyrite occurring chiefly as seams

and cementing material to quartz breccia fragments and sparingly disseminated through the quartz fragments. Consistent values found under the outcrop prospected. Average width of vein (Leviathan) 4 feet (surface outcrop width 6 feet). Values of molybdenite and chancopyrite strongest on footwall side of vein, especially where the vein width exceeds 6 feet.

No work, other than superficial pits and cuts, done on the Copper Wonder vein. The character of the outcrop of this vein is identical to that of the Leviathan vein.

GRADE:

Carefully cut channel samples taken by Jas. Hill, Robert Oliver, and J.B. Tenney show the average of all vein material to be 1.02% MoS_2, 0.6% Cu, and 50¢ Au,Ag. Discarding those samples under 0.4% MoS_2 assuming that these low-grade parts of the vein could be left as waste pillars, the remaining grade averages 1.2% MoS_2, 0.6% Cu and 50¢ Au Ag. Lo grade material I estimate as 10% of the total. Details are shown in the accompanying plans and longitudinal section.

ORE RESERVES:

Referring to the accompanying longitudinal section, it is seen that there are three blocks of ore, two above the 100-ft and one between the 100-ft and the 250-ft levels. Assuming 10% as waste, there remains a tonnage of about 50,000 tons of 1.2% MoS_2 material. The faces to the South are all in ore and there remains yet to be prospected about 700 feet of outcrop. The northern limit of the vein has been reached on the 100-ft level, coinciding with the end of the outcrop.

MINING:

Due to the fact that oxidation films develop rapidly on both the MoS_2 and chalcopyrite in this occurrence, a mining method will have to be used allowing for the removal of freshly blasted ore to the mill bins as quickly as possible. The walls tend, if left to stand, to slough. Probably the best mining method will be horizontal cut and fill, using slushers to scrape the broken ore to the chutes broken down on plank flooring. Little or no timbering will be required, as the wall sloughing does not extend more than 3 feet from the walls of the vein material. The contacts between vein material and wall rock are sharp and no values occur in the wall rock.

TREATMENT:

The ore is very similar to that of Copper Creek. Preliminary testing following Copper Creek procedure, by Prof. Graham of the Texas School of Mines At El Paso Showed that a clean molybdenite concentrate can be made, as at Copper Creek. Insufficient work has been done to show extractions. However; the solution of the molybdenite-chalcopyrite separation at Copper Creek, Cananea, and Utah Copper makes it entirely probable that it can be staisfactorily solved for Leviathan ore.

A possible out to the metallurgy is the use of the Cunningham-Donahue roasting and leaching process. If this were done, the milling would be such simplified as a bulk sulphide concentrate containing about 20% each of MoS_2 and copper would present no problem at all. The only drawback to this would be the more difficult marketing of calcium molybdate as against molybdenite concentrates. The difference in price of the two products would pay for the conversion plant in less than a year's operation. Prof. Cunningham estimates the cost of such a plant for the Leviathan concentrates (4 to 6 tons a day) would not exceed $25,000, and the cost of treatment not over 5¢ a pound of molybdenum. Royalty would be 1½¢ a pound of molybdenum.

ESTIMATED OPERATING COSTS AND PROFITS

A Assuming Concentration Plant to make MoS_2 and Copper Concentrates

1.2% MoS_2	24# @ 90% Extr.	21.6 # @ 40¢	$ 8.64
0.6% Cu	12# @ 80% Extr.	9.6 # @ 7¢ net	0.67
50¢ Au Ag @ 80% Extr			0.40
	Total		$ 9.71

Mining	$2.50
Milling,	1.50
Haul to King 4/70	0.06
Frt from King 20/70	.30
Taxes and overhead	1.00
Royalty 10%	0.95
	$6.31
Profit per ton of ore	$3.40

Cost per # MoS_2 = $\frac{6.31 - 1.07}{21.6}$ = 24¼¢

B Assuming Concentration plant and Cunningham-Donahue Plant.

1.2% MoS_2	24# @ 90%	21.6# MoS_2 @ 60% .... 13# Mo @ 80¢	$10.40
0.6 % Cu	12# @ 85%	10.2 # @ 7¢	0.71
50¢ Au Ag @ 80%			0.40
	Total		$11.51

Mining	$2.50		
Milling	1.25		
Haul to King 2/20	0.20		
Taxes and overhead	1.00		
Royalty 10%	0.98		
Conc.Trestment,13X5	0.65		
Patent Royalty 1½X5	0.20		
Frt.King,to Market	0.33	(20/60)	7.11
Profit per ton of ore			$4.40

Cost per # Mo = $\frac{7.11 - 1.11}{13}$ = 46.15¢

10% royalty payments assumed to owners, Cost figures assuming an extraction rate of 100 tons a day.

Plan A shows a yearly profit assuming 300 working days of $102,000
Plan B " " " " " " " " " $132,000

Molybdenum yield for either plan would be 390,000 lbs as comparedwith yield at Climax of 22,000,000 lbs a year in 1937.

WATER DEVELOPMENT:

An ample water supply would have to be developed in the valley of the Big Sandy River. Local spring water is too uncertain, as would be the damming of such streams as Deluge Wash, a large mountain canyon, a mile from the mine. The mine makes very little water. The most favorable site for water development would be where the Deluge Wash - Crow canyon washes debouch into the valley fill material of Big Sandy River. As both these canyons have a very large drainage basins, the probability of shallow water at this point is very good. At this point where the wash is several hundred feet wide, there is a healthy growth of wild willow and other water-requiring shrubs. This spot is just off the proposed new road 5 miles from the mine and about 1000 feet lower elevation.

ROAD CONSTRUCTION:

The site of the proposed new road was surveyed two years ago and the survey is spended. A local Kingman road contractor who has built most of the mine roads of the Kingman-Dhloride district gave me a contract price of $8,000. About 8½ miles of old road has to be repaired and about 2½ miles of new road. The total difference in elevation btween the Big Sandy road and the mine is about 1,500 feet. The elevation at the mine is about 4,000 feet above sea level.

CAPITAL EXPENSES

Assuming preliminary development by tunnels of both veins

Plan A Assuming 100-ton concentrator and marketing of MoS_2 concentrates

Preliminary Work

Road	$8,000	
Equipment	2,000	
1500 feet of tunnel	18,750	
		$28,750

Final Equipment

Water Development and Pipe-line and pump	15,000	
100-ton Concentrator	40,000	
Power Plant	20,000	
Mine Equipment	15,000	
Townsite	20,000	
Miscel.	10,000	
Working Capital	10,000	$158,750

Plan B Assuming 100-ton Concentrator and Treatment Plant at Kingman

Preliminary Work as for Plan A	$ 28,750
Final Equipm nt Same as for Plan A plus Treatment Plant, ...	155,000
Total	$183,750

Submitted by J. B. Tenney,
Mining Engineer.

C O P Y
1-26-38