

UNIVERSITY OF NEVADA

THE MINERVA MINE
AND SURVEY METHODS EMPLOYED IN CONNECTION WITH THE SAME
AT ATLANTA, IDAHO

A THESIS
SUBMITTED TO THE FACULTY OF ENGINEERING
IN CANDIDACY FOR THE DEGREE OF
MINING ENGINEERING

(DEPARTMENT OF MINING AND METALLURGY)
THE MACKAY SCHOOL OF MINES

By 20282

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Atlanta, Idaho

1911

Thesis
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THE MINERVA MINE, AND SURVEY METHODS EMPLOYED IN CONNECTION WITH THE SAME, AT ATLANTA, IDAHO.

LOCATION:

The property is located on the Grouse Creek Fork of the Yuba River, one of the tributaries of the Middle Fork of the Boise River, in the Middle Boise Mining District, Elmore County, Idaho, and is about five miles due south from the town of Atlanta. The elevation is approximately six thousand feet, and the adjacent country is very wild and rugged, being in the Saw Tooth Range of mountains.

CLIMATE:

During the summer months the climate is delightful, but during the winter the snow fall is very deep. The cold is not severe, and the general healthfulness of the district can be considered good.

THE PROPERTY:

The accompanying map will show the claims and their position. The seven claims represented on the plan, and named Minerva, Minerva No.1 to No. 6, and also the Hattie, have been patented. Recently the Company purchased an additional half claim, upon which the present milling plant is located. In all the holdings embrace something over one hundred acres.

GEOLOGY:

The initial rock or primary foundation of the district is a gray granite, or syenite, massive and with no clearly marked structural lines. At only one point in the district has any other rock been seen, and that is a basic eruptive dike which has cut the granite and, no doubt, bears some important relation to the formation of the vein. The dike makes its appearance about one mile to the north of the Minerva claims, and is on the patented ground of the Monarch Mines Company. The veins occur as simple fissures, with a general strike of about due east and west, and have a dip of approximately forty-five degrees to the north. In some parts of the district, and particularly to the north of the town of Atlanta, there is considerable evidence of faulting. My attention was called a few months ago to an old river channel which is now some two thousand feet above the present level of the Boise River, and about two miles northwest of Atlanta. This bed carries considerable placer gold, is all located, and, when water is available during the early spring, is worked on a small scale. The vein filling, or gangue, is principally quartz, but in places there is considerable gouge and talc. With the present depth attained no water level has been reached, and work is now being carried on in the zone of oxidized and also sulphide ores. The oxidation products in the main

are limonite and hematite, while the undecomposed ores contain pyrite, arsenopyrite, and some antimony. Silver predominates over the gold but only to a very small extent. The ground where the present active operations are being carried on is termed "swelling ground" on account of the instability of the walls. The accompanying map of a cross section of the mountain upon which the mine is located shows the position of the vein and foot and hanging walls.

DEVELOPMENT:

The mine is worked by a main cross cut or adit tunnel some eight hundred feet in length, and cuts the vein at a depth on the slope of about four hundred and fifty feet. Drifts have been extended east and west on the vein from the main cross cut aggregating about two thousand feet, and stoping has been carried on as rapidly as the ground could be opened up, and the ore sent to the mill. At the present time three levels are being worked from the main cross cut. The ore is dropped from level to level by a system of chutes, whence it is trammed to the ore bin. Electric lights and fans have been installed. The latter greatly assist the ventilation of remote parts of the mine, while the main workings receive their air supply from an air raise through to the surface. The underground passages are all well timbered. A great deal of time has to be devoted to this phase of the work for the ground tends to swell. The following buildings are maintained at the entrance: blacksmith shop, timber framing shop,

powder house, store room, and a large ore bin, together with necessary accessories.

HISTORY - EARLY AND GENERAL:

During the early sixties a great deal of prospecting work was done and at the present time much of this primary work is still intact. Considerable ore was mined at that time and treated in old arrastras, the remains of which are still in evidence on Grouse Creek near the Minerva Mill. The efforts of these early pioneers no doubt were concentrated on very rich pockets and seams, for the cost of mining and milling per ton of ore in the way that they were compelled to handle it precluded the handling of anything except high grade ore. The poorer material was left, and much of that is now being successfully treated. During the last few years the property has grown considerably in every way, which fact is largely due to the efficient management it has received since falling into the hands of W. J. Keough, who is now the General Manager. Last summer the mill was increased to twenty stamps, and Johnson concentrators installed. This alone increased the work in every department, particularly so in the mine, where double the quantity of ore had to be mined, and the force of miners increased. Naturally, as this work was rushed along a great many problems came up concerning the underground workings, and from time to time the management found it necessary to have surveys made of certain parts of the mine, and of which a few follow.

SURVEY NO. 1.PROBLEM:

Find the length and bearing of a line that would join with the face of the "Old Powder Tunnel", and the top of raise in the east drift of the "A" level, at Bulkhead.

The accompanying map and notes of the survey will give an idea of the lay of the ground. The Old Powder Tunnel was run about the year 1870. It cross cuts the formation for a distance of about one hundred feet to the Minerva vein, and its distance, both horizontal and vertical, from the present operating tunnel is considerable, as will be seen from the plan of the claims, and also from Map No. 1. In surveying for this solution the Minerva Mine is entered by the Main Cross Cut from point "00", and a part of the traverse connecting this point with the face of the Powder Tunnel was made over a very rough country, and a portion of it is surface work. Both terminations of the survey are underground. Progress was slow in the traversing of the east drift. Considerable water was encountered and much of it came from overhead, which was a constant source of annoyance, particularly so in the narrow winding drifts where frequent sights had to be made and many readings taken. Mine work was suspended in that part of the mine during the time that the work was in progress.

DIVISION NO. 1

THE MINERVA MINE

ECONOMIC CONDITIONS:

The economic conditions depend in a large measure upon the individual who has that phase to deal with. Timber suitable for all mining purposes grows in abundance. There is also sufficient water to develop power for all mining and milling purposes, and the same is utilized by all mines now operating in the district. Freight rates are not excessive. Supplies should be delivered during the summer months to get the best results from an economical point of view, for as soon as the fall snows come freight rates are increased. The headquarters for supplies is Boise, the capital of Idaho. Competent men for all departments of mining work are not hard to secure, and the salaries and wages paid are as good as at other camps and districts. The expense of installing heavy mine and mill machinery is very high, for the reason that all freight must come by wagon from Mountainhome, which requires time; and the other expenses attendant on the same make the cost of machinery, set up and ready to run, about twice what the first cost is on the outside. In the installation of a mill one should figure on double the factory cost by the time the same is installed and operating. The wages and salaries commanded in the district are:

	Rate per day
Miners - - - - -	\$3.50
Carmen - - - - -	3.50
Laborers - - - - -	3.50
Timber Cutters - - - - -	3.50
Tram Bucket Tenders - - - - -	3.50

Carpenters - - - - -	\$4.00
Tram Men - - - - -	4.00
Machinists - - - - -	4.00
Shift Bosses - - - - -	4.50
Timber Framers - - - - -	4.50
Blacksmiths - - - - -	4.50
Mine Foremen - - - - -	6.00
Mill Foremen - - - - -	5.00
Assayers - - - - -	5.00
Cooks - - - - -	75.00 per month

The cost of competent managers varies with different properties and can be placed at about \$250.00 per month and expenses.

The cost of supplies laid down is:

Mine timber, logs - - - -	7 cts. per running foot
Lumber - - - - -	\$28.00 per M
Lagging - - - - -	6 1/4 cts. apiece
Wood - - - - -	\$5.00 per cord
Powder - - - - -	20 cts. per lb.
Fuse - - - - -	1 ct. per foot
Caps - - - - -	\$1.00 per box
Candles - - - - -	\$6.42 per box
Shovels - - - - -	95 cts. each
Nails - - - - -	\$7.00 per keg
Blacksmith Coal - - - -	\$60.00 per ton
Oils and gasoline - - - -	50 cts. per gal.
Shoes and dies - - - - -	7 cts. per lb.

The price charged for board is \$1.00 per day. The total costs attendant on mining and milling that have come under my observation while considering two mills are:

No. of Stamps	Cost of Mining per Ton	Cost of Milling per Ton	Total
10	2.90	1.24	\$4.14
20	1.95	0.85	2.80

The above cost table applies only to mines and mills working to their full capacity, and aided not only by good management, but by close attention to detail as well.

The usual wagon freight rate during the months of July, August and September is 2 cts. per lb, direct from Boise, and $1\frac{1}{4}$ cts. from Mountainhome. Many of the teams avail themselves of the opportunity to load back to the railroad with concentrates at the rate of $1\frac{1}{4}$ cts. per lb.

DIVISION NO. 2

PROBLEMS 1, 2 and 3, EMBRACING THE CHARACTER
OF ENGINEERING WORK DONE

APPENDIX

1. Name of Property - - Minerva Group, Lode Claims
2. Locality - - - - - Middle Boise Mining District,
Elmore County, Idaho. T.
No. 5 N., Range No. 11 E.
3. Name of Claims - - - Minerva, No. 1, No. 2, No. 3,
No. 4, No. 5, and No. 6.
Fattie, and the east half
of the Gold King.
4. Area of Claims - - - 100 Acres, approx.

SURVEY NO. 2.PROBLEM:

1. Find a point in the "New Raise" in a vertical plane with the "Old Air Raise".
2. Whether the "New Raise" is above or below the "Old Air Raise".
3. Distance through to make connection.

The following map and notes show the relation of the two raises one to the other. The Old Air Raise, which connects with the surface, had caved from a point in the drift up along its course for a distance of some thirty feet or more, making it impossible to enter or take any bearings from there. As a result of this filling, the ventilation of the mine, as well as the safety of the men, was endangered, it being the only outlet to the surface. The Foreman put through another raise, starting some distance west, and raising on the vein intended to intercept the "Old Raise" on the slope. After rushing the work for some time, he failed to find the Old Raise. The accompanying maps and notes will show how the matter was worked out, and how easy it is for one to become confused underground. The nature of the passages in this part of the mine made it impossible to safely use a transit, so a compass was substituted. Connection was made without any difficulty, and proved to be just where the solution of the problem indicated.

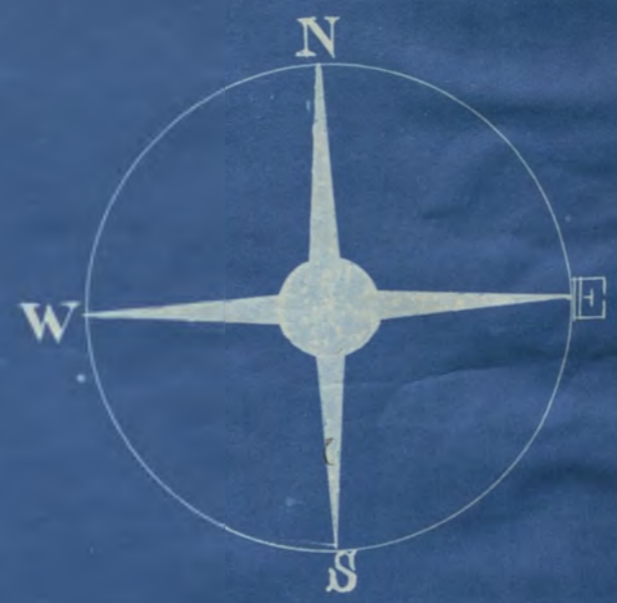
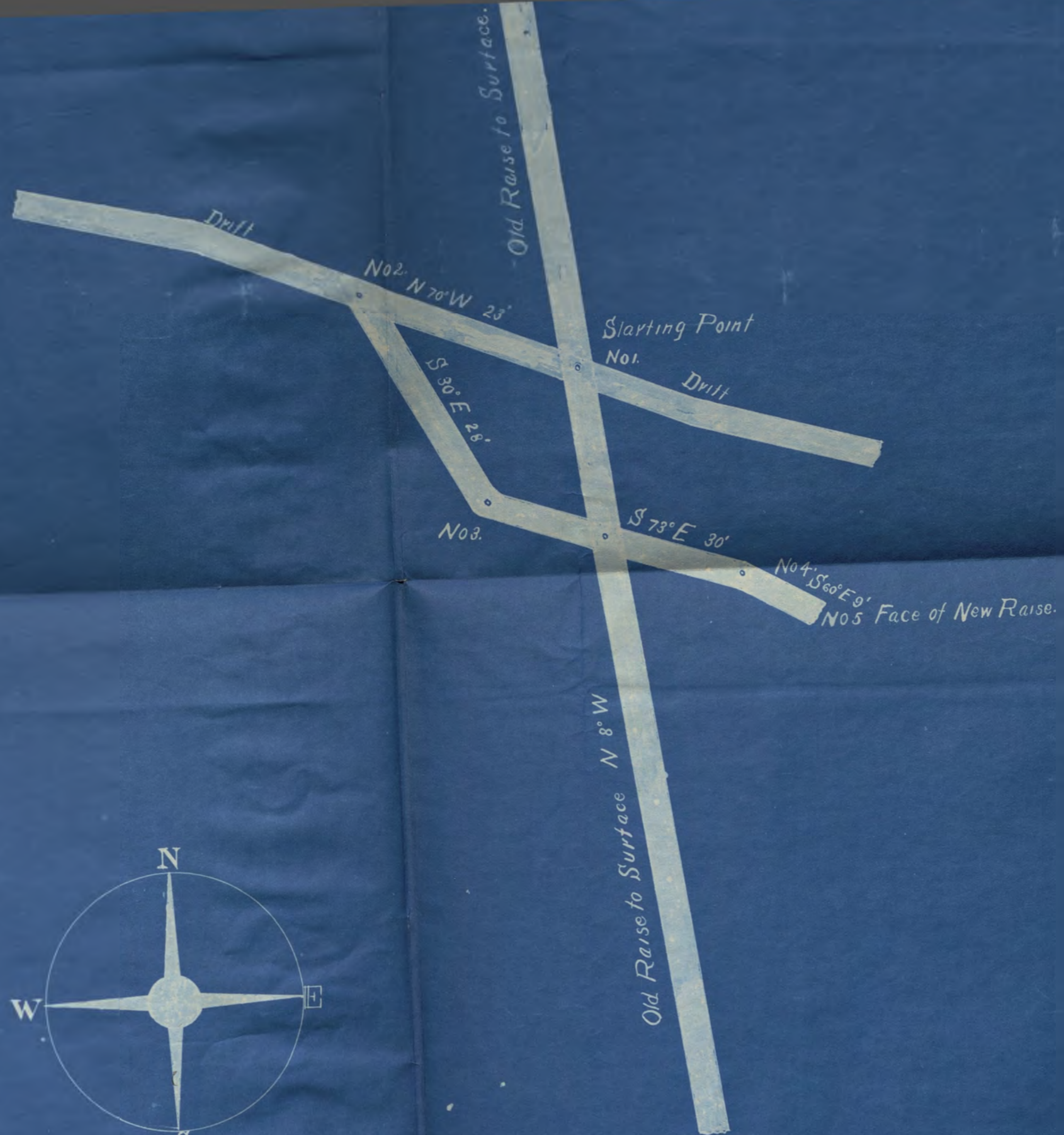
SURVEY NO. 3.PROBLEM:

1. Find the point in the Minerva Adit Tunnel to cross cut and intercept station No. 5, East Drift, on the shortest possible line.
2. Find the azimuth, vertical angle, and also the length of line to make connection.

This traverse was commenced from station No. 1 in the main cross cut, and continued to station No. 5, beyond turn, sheet No. 1, east drift. The field was closed for a base line to work with, and the triangle solved for the required sides.

CONCLUSION:

In the making of these surveys, a Stanley Londen Transit was used, and also one assistant. All stations were marked by a number of nails driven in the post supporting the cap, and corresponded to the number of the station, in which a screw eye was set. These stations were made visible by holding a candle directly back of a plumb line suspended from the screw eye. The starting point for the survey is a peg driven firmly in the ground on the west side of the car track, and about thirty feet from the first timber set at the entrance of the main cross cut tunnel. This peg was marked "00" and designated as the starting point, being given zero elevation. The true meridian had formerly been determined by a United States Deputy Mineral Surveyor, and was accepted as O.K.



Map. No. 2.

Plan of a Portion
 of the
 Upper Workings
 of the
MINERVA MINE
 Atlanta - Idaho.
 Feb 20th, 1911.
 Scale in Feet

0 10 20 30

C.C. Smith

Station and Turn Sheet
 +10.45
 3
 4 +12.17'
 5 +12.97'
 6 +14.17'
 8 +14.54'
 9 +15.65'
 10 +16.10'
 11 +16.43'
 12 +16.38'
 13 +16.65'

Minerva Vein No. 2
 East Drift
 Minerva Vein No. 1
 +9.35

1 +9.29'

13 +17.00'
 14 +17.05'
 Turn Sheet No. 1

1 +17.16'
 2 +17.74'
 3 +18.38'

4 +18.63'
 5 +18.67'
 6 +18.87'
 7 +18.89'
 8 +19.94'
 9 +19.77'
 10 +19.77'
 11 +19.77'
 12 +19.77'
 13 +19.77'
 14 +19.77'

East Drift

Adit Tunnel or Main CrossCut

Old Powder Tunnel
 4 +204.43
 3 +203.73

+202.93
 Powder Tunnel Dump

Open Cut Boarding

Starting Point 0 and Mine Buildings

-32.1
 Minerva Dump



Present Face of Drift
1128' East of Station.

Open Cut at Mine
Boarding House

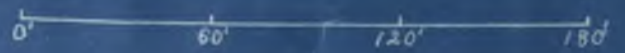
Surface Point East of Boarding House
Level with top of Raise, Vein Out Crop.



Map No. 1.

Plan of a Partial Survey
of the
SURFACE and UNDERGROUND WORKS
of the
MINERVA MINE
ATLANTA
IDAHO

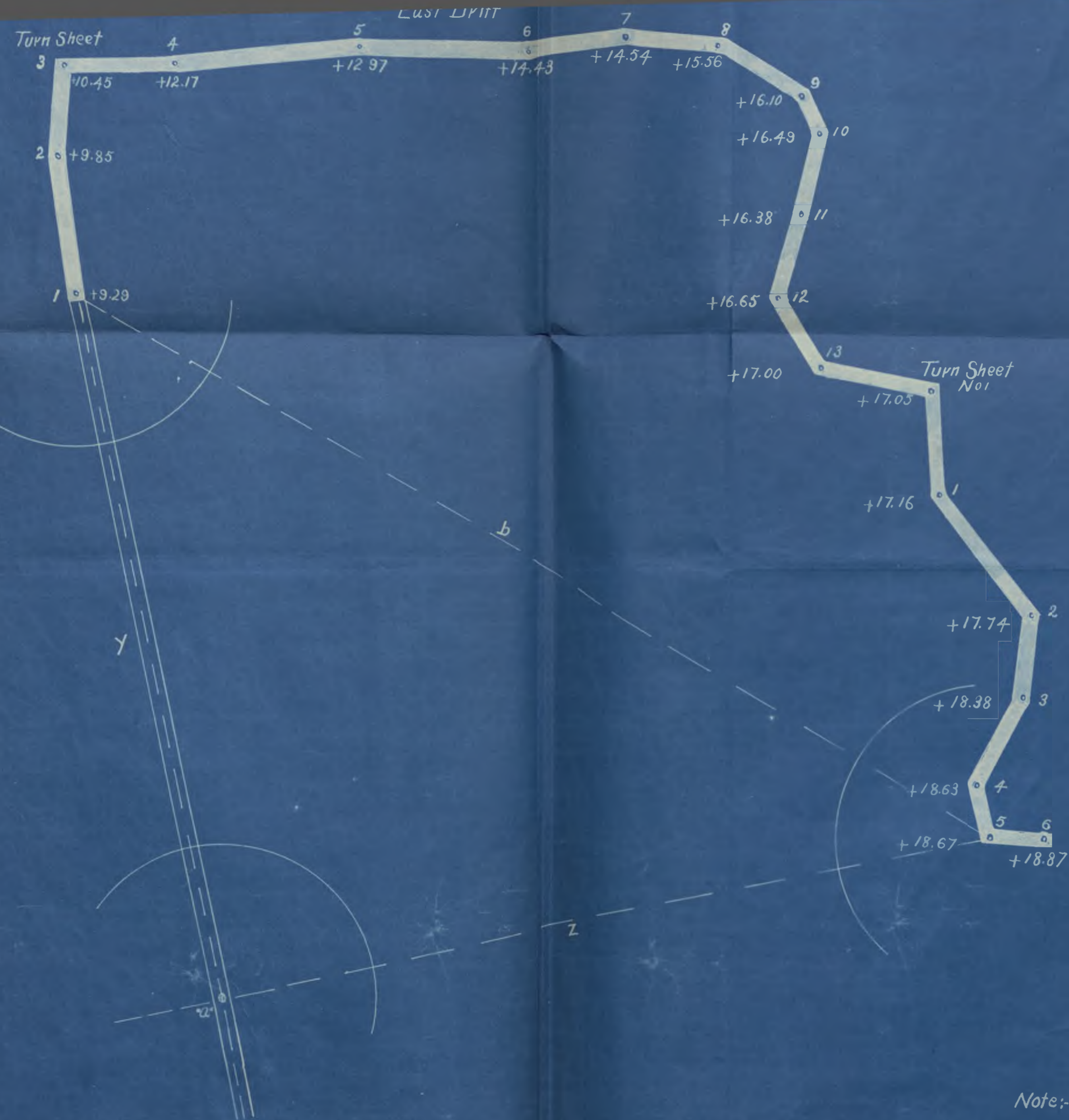
Scale in feet



FEB 12 TH, 1911.

C. C. Smith.

+ and - Figures indicate elevations from "00."



Map Nos.
 Plan of a Portion of the Underground
 Workings
 of the
MINERVA MINE
 Atlanta, Idaho
 Feb 24th 1911.
 Scale in Feet

0' 30' 60' 90' 120'

C.C. Smith

Note:-
 "a" is point where Cross Cut would connect with
 Adit Tunnel.

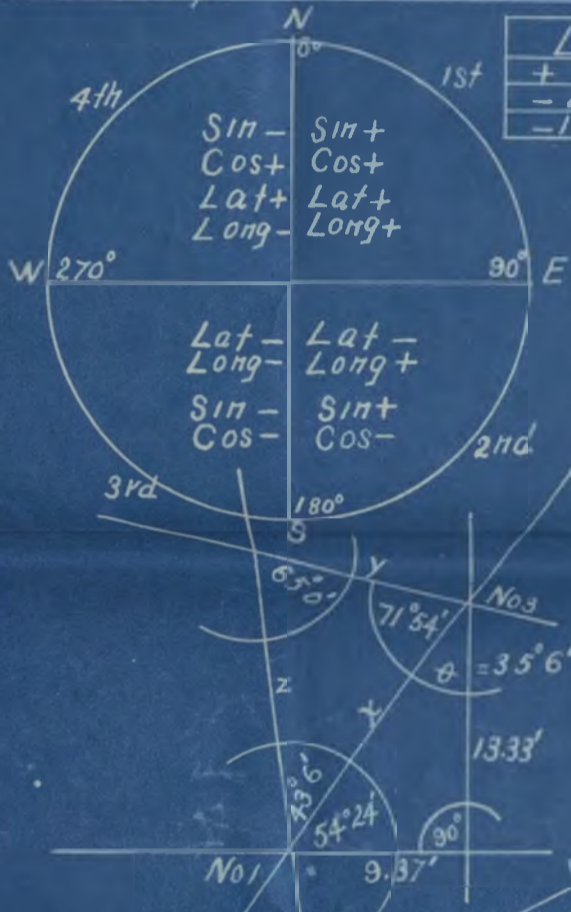
Map No 2.
Atlanta Idaho

Problems:

- (1) Point in New Raise in Vertical Plane with Old Air Raise.
- (2) Whether " " is above or below the " " "
- (3) Distance through to make connection.

Sta	Bear of Line	Slope D.	Hor D.	Vert L.	Elev	Lat	Dep	Remarks
1 to 2	N 70° W	23'	23.00'	+ 0'	0'	+ 7.86'	-21.61'	
2 " 3	S 30° E	28'	24.48'	+ 29'	13.57'	-21.19'	+12.24'	New Raise
3 " 4	S 73° E	30'	26.48'	+ 29'	14.57'	-7.74'	+25.07'	" "
4 " 5	S 60° E	9'	7.87'	+ 29'	—	-4.50'	+ 6.87'	Face
1 " 2'	N 8° W	—	—	- 30'	—	—	—	Down Old Raise

Lat and Dep from Sta No 1 to No 3.



Lat	Dep
+ 7.86'	-21.61'
-21.19'	+12.24'
-13.33'	- 9.37'

Line bears N.E. & S.W.

(1) $\text{Log } 9.37 = 0.97174$
 $\text{Log } 13.33 = 1.12483$
 $\text{Tan } \theta = \frac{9.84691}{9.75067} = 35^\circ 6'$
 $\text{Log length} = 1.20937 = 16.68' = x$

$\frac{y}{16.68} = \frac{\text{Sin } 43^\circ 6'}{\text{Sin } 65^\circ 0'}$
 $y = \frac{16.68 \times \text{Sin } 43^\circ 6'}{\text{Sin } 65^\circ}$

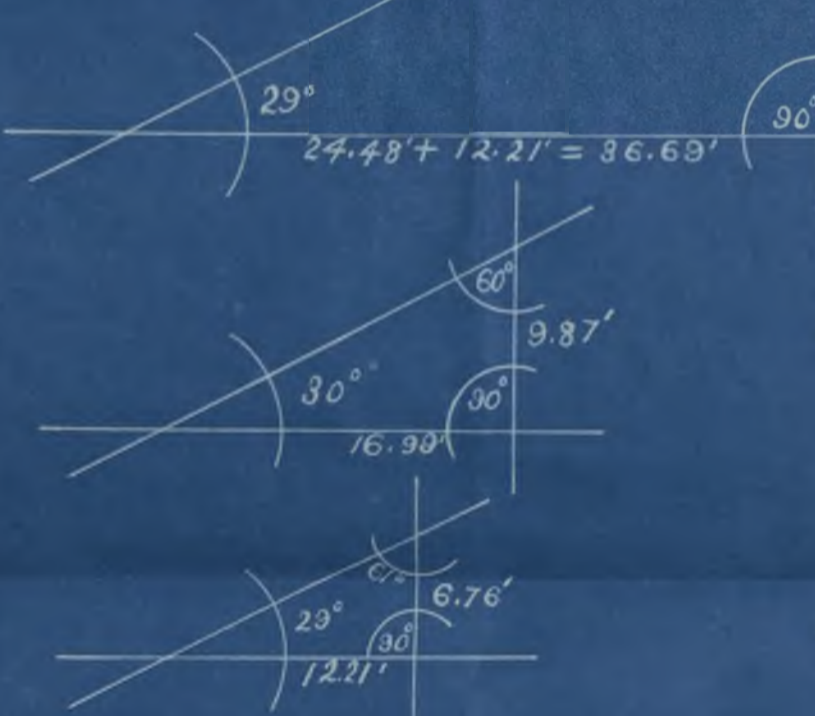
(2) $\text{Log } 16.68 = 1.20937$
 $\text{Log } \text{Sin } 43^\circ 6' = 9.83459$
 $\text{Log } \text{Sin } 65^\circ 0' = 9.95728$
 $\text{Log length} = 1.08668 = 12.21' = y$

$\frac{z}{12.21} = \frac{\text{Sin } 71^\circ 54'}{\text{Sin } 43^\circ 6'}$
 $z = \frac{12.21 \times \text{Sin } 71^\circ 54'}{\text{Sin } 43^\circ 6'}$

(3) $\text{Log } 12.21 = 1.08668$
 $\text{Log } \text{Sin } 71^\circ 54' = 9.97796$
 $\text{Log } \text{Sin } 43^\circ 6' = 9.83459$
 $\text{Log length} = 1.23005 = 16.99' = z$

(4) $\text{Log } 36.69' = 1.56455$
 $\text{Tan } 29^\circ = 9.74375$
 $\text{Log length} = 1.62273 = 41.95' \text{ on slope}$

$\text{Tan } 30^\circ \times 16.99' = 9.81'$
 $\text{ " } 29^\circ \times 12.21' = 6.76' + 13.57' = 20.32'$
 (5) Elevation of New Raise = 20.32'
 " " Old " = 9.87'
 Difference = -10.45'
 Less height of Raise timber 6.00'
 Distance through = -4.45'



Results

(1) Measure on slope up New Raise from point No 2	41.95'
(2) "New Raise is above "Old Raise"	
(3) Sink from "New Raise" at point on slope 41.84' up from point No 2	4.45'

Underground Traverse.
"00" to face of Powder Tunnel.

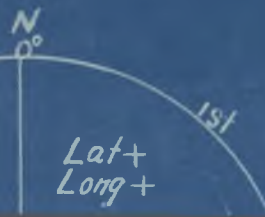
Dist	Vert Angle	Elev	Azimuth	Lat	Dep	Remarks
50.10'	—	- 0.32'	115° 08'	- 22.32'	+ 45.03'	Point on Minerva Dump
389.00'	31° 15'	+ 203.25'	19° 23'	+ 313.69'	+ 110.37'	" " Powder Tunnel Dump
93.20'	—	+ 0.80'	326° 22'	+ 93.01'	- 5.90'	" " " " Length of
52.60'	—	+ 0.70'	351° 18'	+ 51.99'	- 7.95'	Center of Face Powder Tunnel
		+ 204.43'		+ 436.37'	+ 141.55'	

2d Traverse
"00" to top of Raise East Drift

Dist	Vert Angle	Elev	Azimuth	Lat	Dep	Remarks
761.36'	0° 42'	+ 9.29'	349° 47'	+ 749.17'	- 135.05'	Adit Tunnel Mine Entrance
47.92'	0° 41'	+ 0.56'	352° 20'	+ 47.49'	- 6.39'	No. 1 Vein
31.82'	—	+ 0.60'	3° 00'	+ 31.77'	+ 1.66'	Turn Sheet East and West
38.28'	—	+ 1.72'	88° 28'	+ 1.02'	+ 38.26'	East on East Drift
63.64'	—	+ 0.80'	83° 56'	+ 6.72'	+ 63.28'	" " " "
58.70'	—	+ 1.46'	91° 32'	- 1.57'	+ 58.67'	" " " "
35.26'	—	+ 0.11'	81° 18'	+ 5.33'	+ 34.85'	" " " "
33.86'	—	+ 1.11'	97° 07'	- 4.19'	+ 33.66'	" " " "
34.04'	—	+ 0.45'	122° 40'	- 18.37'	+ 28.65'	" " " "
14.40'	—	+ 0.39'	154° 45'	- 13.02'	+ 6.14'	To Sparks Point No. 12
34.00'	—	- 0.11'	191° 48'	- 33.28'	- 6.95'	From " " " " to No.
29.35'	—	+ 0.27'	193° 14'	- 28.56'	- 6.71'	" " " " " 14 " "
28.45'	—	+ 0.35'	148° 07'	- 24.15'	+ 15.02'	Where " work ended Sta.
39.72'	—	+ 0.05'	102° 00'	- 8.24'	+ 38.85'	Turn Sheet No. 2 East Drift
35.42'	—	+ 0.11'	174° 45'	- 35.22'	+ 3.65'	X Cut to South
53.21'	—	+ 0.58'	141° 55'	- 41.88'	+ 32.81'	
28.18'	—	+ 0.64'	183° 10'	- 28.14'	- 1.55'	
34.63'	—	+ 0.25'	203° 26'	- 31.77'	- 13.77'	Turning West
18.20'	—	+ 0.04'	162° 26'	- 16.35'	+ 5.49'	" East
18.30'	—	+ 0.20'	92° 28'	- 0.78'	+ 18.28'	" " X Cut to Vein
49.48'	—	+ 0.02'	77° 06'	+ 10.04'	+ 48.23'	
24.80'	—	+ 1.05'	90° 42'	- 0.29'	+ 24.79'	Raise East Drift
4.14'	—	+ 0.47'	219° 30'	- 3.19'	- 2.63'	Point in Cap under Raise
13.10'	47° 05'	+ 9.59'	182° 42'	- 8.91'	- 0.42'	In Raise
23.00'	61° 00'	+ 20.11'	182° 42'	- 11.13'	- 0.52'	" "
27.90'	59° 00'	+ 23.91'	182° 42'	- 14.34'	- 0.67'	" "
41.51'	62° 30'	+ 36.65'	182° 42'	- 19.13'	- 0.90'	" "
13.75'	55° 00'	+ 11.26'	182° 42'	- 7.87'	- 0.37'	Top of Raise Bulk H
		+ 121.93'		+ 64.79'	+ 134.75'	
		+ 4.77'				Inst height at Raise
		+ 126.70'				

Results.

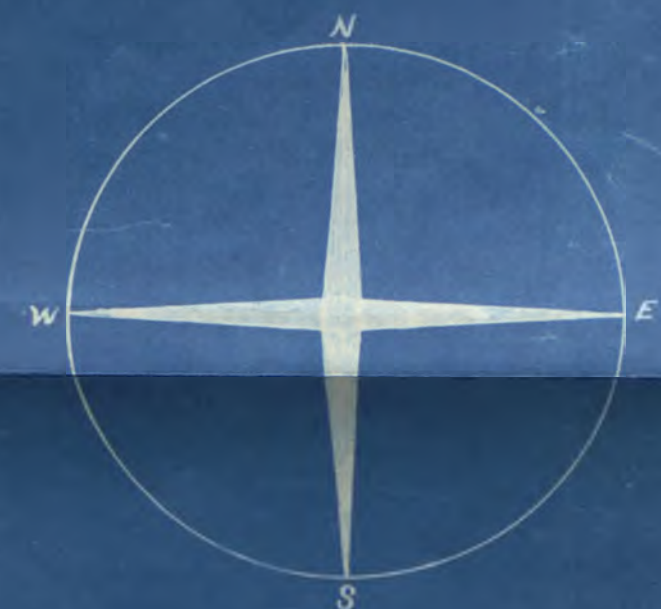
Length of Unknown Side	
Bearing " "	
Vertical Angle from Top of Raise	+
" " " Powder Tunnel	-



Add E. Long & N. Lat
Line bears N.E. & S.W.
 $\tan \theta = \frac{64.79}{134.75} = 0.481151$
 $\text{Log } \tan \theta = 9.68209$
 $\theta = 25^\circ 40' 54''$

Plan
of the
MINERVA - GROUP
of claims

II
Middle Boise --- Mining District
Elmore --- County --- Idaho
Area --- 103.48 --- Acres
Scale --- 300 --- feet to the inch
Variation $19^{\circ}25' E$



Survey Notes and Solutions
to
Accompany Map Nos.

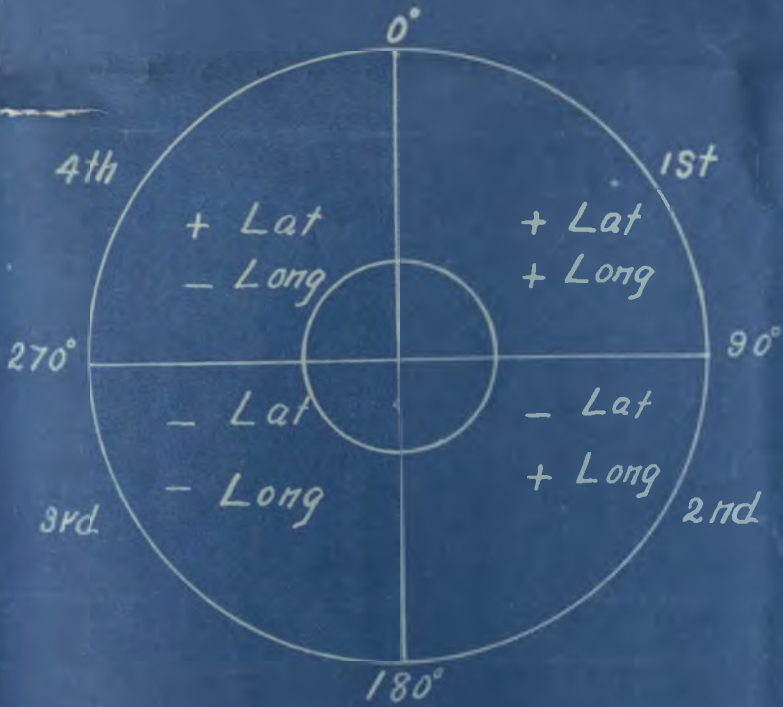
Problem:

- (1) Required a point in the Minerva Adit Tunnel to Cross Cut and intercept Station No 5, East Drift on the shortest possible line.
 (2) Required the Azimuth and Vertical Angle, also length of line.

Underground Traverse Starting Point Sta No 1. in Adit Tunnel 761.36' from Point "00"

Sta	Bear. of Line	Dist	Elev	Azimuth	Lat	Dep	Remarks
1-2	N 7° 40' W	47.92'	9.85'	352° 20'	+47.49'	-6.39'	Not Vein
2-3	N 9° 00' E	31.82'	10.45'	9° 00'	+31.77'	+1.66'	Turn Sheet East & West Drifts
3-4	N 88° 28' E	38.28'	12.17'	88° 28'	+1.02'	+38.26'	East on " "
4-5	N 83° 56' E	63.64'	12.97'	83° 56'	+6.72'	+63.28'	" " " "
5-6	S 38° 28' E	58.70'	14.49'	91° 32'	-1.57'	+58.67'	" " " "
6-7	N 81° 18' E	35.26'	14.54'	81° 18'	+5.33'	+34.85'	" " " "
7-8	S 82° 53' E	33.86'	15.56'	97° 07'	-4.19'	+33.60'	" " " "
8-9	S 57° 20' E	34.04'	16.10'	122° 40'	-18.37'	+28.63'	" " " "
9-10	S 25° 15' E	14.40'	16.49'	154° 45'	-13.02'	+6.14'	To Spark's Point No 12
10-11	S 11° 48' W	34.00'	16.38'	191° 48'	-33.28'	-6.95'	" " " " 14
11-12	S 13° 14' W	29.35'	16.65'	193° 14'	-28.56'	-6.71'	" " " " 15
12-13	S 31° 53' E	28.45'	17.00'	148° 07'	-24.15'	+15.02'	End of Spark's Work
13-T.S.	S 78° 00' E	39.72'	17.05'	102° 00'	-8.24'	+38.85'	Turn Sheet No 2
T.S.-1	S 5° 55' E	35.42'	17.16'	174° 45'	-35.22'	+3.65'	Cross Cut to South
1-2	S 38° 05' E	53.21'	17.74'	141° 55'	-41.88'	+32.81'	" "
2-3	S 3° 10' W	28.18'	18.38'	183° 10'	-28.14'	-1.55'	" "
3-4	S 23° 26' W	34.63'	18.63'	203° 26'	-31.77'	-13.77'	" "
4-5	S 17° 34' E	18.20'	18.67'	162° 26'	-16.35'	+5.49'	Turning East Sharp Bend
					-192.41'	+324.56'	

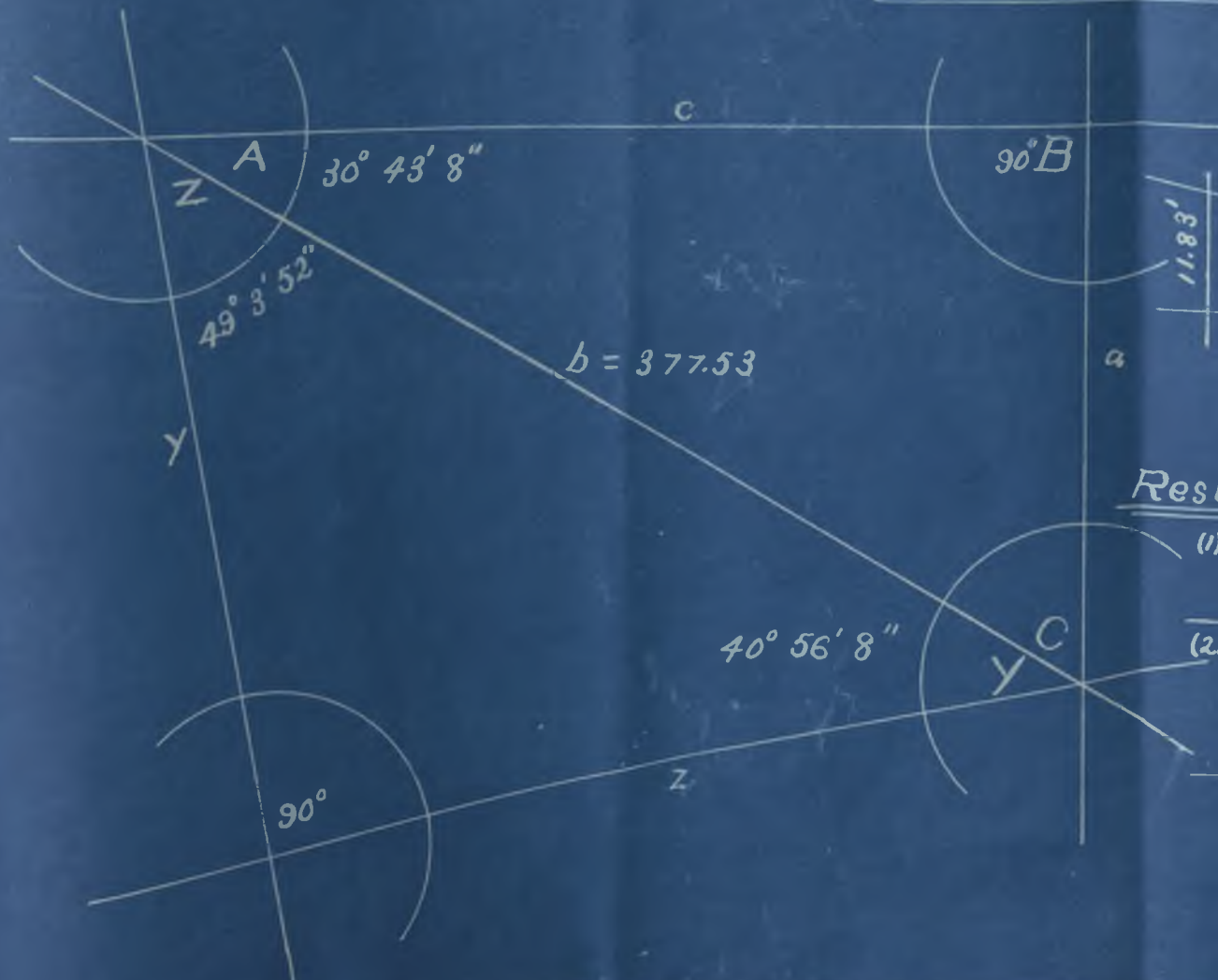
Line bears N.W. & S.E.



$$\begin{aligned} \text{Log } 192.41 &= 2.28423 \\ \text{Log } 324.56 &= 2.51129 \\ \text{Tan } A &= \frac{192.41}{324.56} = 0.59284 \quad A = 30^\circ 43' 8'' \\ \text{Sin } A &= \frac{192.41}{377.53} = 0.50966 \\ \text{Length } A &= \frac{192.41}{\text{Sin } A} = 377.53' \end{aligned}$$

$$\begin{aligned} \frac{y}{377.53} &= \frac{\text{Sin } 40^\circ 56' 8''}{\text{Sin } 90^\circ} \\ y &= \frac{377.53 \times \text{Sin } 40^\circ 56' 8''}{\text{Sin } 90^\circ} = 247.37' \\ \text{Log } 377.53 &= 2.57696 \\ \text{Sin } 40^\circ 56' 8'' &= 0.65411 \\ \text{Log } y &= 2.39334 \\ y &= 247.37' \\ \sqrt{(247.37)^2 + z^2} &= 377.53 \\ z &= 285.19' \end{aligned}$$

Elev Sta No 1 = 6.84'
 " " " 5 = 18.67'
 Diff = -11.83'



$$\begin{aligned} \text{Log } 11.83 &= 1.07298 \\ \text{Log } 285.19 &= 2.45513 \\ \text{Tan } \theta &= \frac{11.83}{285.19} = 0.04145 \quad \theta = 4^\circ 9' 11'' \\ \% \text{ Grade } &= 4.15 \end{aligned}$$

Results:

- (1) Measure South from Sta No 1. 247.37' or 513.99' North from Sta "00" at entrance.
 (2) Azimuth from Adit Tunnel 79° 47'. Vertical Angle +4° 9' 11" From Adit Tunnel Length of Line = 285.19'

C.C. Smith
 Feb 28th 1911.

NORTH and SOUTH
SECTION - MINERVA - MINE
Atlanta - - Idaho.



Scale: --- 1-inch = 500 feet

C.C. Smith,
 Mar. 12th 1911.