Eugene F. Grossman
1455 - 4th Street
Santa Monica, Calif. 90401

C O P Y.

0930 0001

195

item 1

Report on

Northern Belle Mine
of the
Argentum Mining Company of Nevada.

This report covers the work done on the 1900 Level of the Northern Belle and such work done in the 1700 Winze during the development programme carried out from August 30th 1929 to March 15th 1930.

No attempt has been made to go into the geology involved which does not vary to any considerable extent from the 1700 and levels above that. A minor fault was encountered approximately fifteen feet east of survey station 19.28 though first picked up at a point approximately forty feet east of survey station 19.27.

Beyond the fault plane east of survey station 19.28 values were again picked up in the drift going east, note plan marked Rec No 3.

Between survey station No 19.32 and extending to a point approximately fifteen feet west of survey station 19.34 the vein shows evidence of great tightening up in the formation due to the close proximity of intrusive which can be identified with intrusive exposed in Pickhandle gulch.

However beyond this point the vein again becomes normal in its behavior and fairly consistent values are had to a point about twenty feet east of survey station 19.38, beyond which again is felt the influence of an intrusive mass on the hanging wall side of the vein.

It is believed that these areas where the vein has tightened up are nothing more than local in effect, similar occurences have been noted in the cross cuts driven above the 1900 level and also on the 1700 level.

The accompany sheets one for each working section, namely 1700 Winze, No 1 Raise, No 3 Raise, No 4 Raise and No 5 Raise, show on plan and in section the angle of the raise or winze driven, dip of the vein and the position of values in the various cross cuts opened.

The work done on the level has shown the existence of a strong vein, with consistently good values near the footwall and further development above the 1900 level by cross cuts from the top of the raises has shown the vein to carry consistent values over a width from twelve to fifteen feet, occasionally attaining a width of eighteen to twenty feet.

The two sheets on which are marked the various blocks of ore developed show three blocks marked respectively X? Y and Z.

Block Y is in the faulted area and while the disturbance in the vein is noted on the 1900 level no evidence of faulting was observed on the 1700 level and no radical change was observed on the 1700 level over this section and information is lacking on the 1700 level as to the size and values of the vein in the absence of any raises and cross cuts.

Block X is in the area noted as showing the influence of the intrusive in the hanging wall side of the vein and on the 1700 level while some values were had within this section the east end of the 1700 level was somewhat light in values and has the appearance of the 1900 within this area.

In Blocks 4, 5 and 6 it has been assumed that the extension of the 1700 level to the east will open up conditions similar to those on the 1900 level.

Attached hereto is a tabulation of the tonnages and values of the various sections and it will be noted that the tonnages in sections X, Y and Z have been noted as possible and it is believed that an ample allowance has been made in tonnage in view of the fact that the information regarding these areas is incomplete.

In view of the fact that no development has been attempted between the 1700 and 1900 levels and particularly in view of the favorable results attendant upon the work done on the 1900 level, which taken as a whole has shown better averages than the 1700 level, it is strongly recommended that certain connections be made from the 1900 to the 1700 levels which will, with the extending of the 1800 level to the east definitely open the block between the two levels so far developed.

It is recommended that the No 3 raise be extended upwards to connect with the hanging wall cross cut at survey station 17.60 on the 1700 level for the purpose of improving ventilation on the 1900 level. At a point corresponding to the 1800 horizon a cross cut from this raise be driven to the footwall on the 1800 level and the 1800 level extended to the east to a point opposite No 5 raise.

No 5 raise to be put up to the elevation of 1800 level and cross cut driven to the footwall to connect with the 1800 level drift along the footwall.

Crosscut at top of No 4 raise to be turned and drifted on along the footwall to connect with the first cross cut now driven at the top of No 5 raise.

This work outlined will develop the block from No 3 raise to No 5 on the 1800 level and will greatly facilitate operating conditions east of No 5 raise and work in this section below the 1900 level.

The 1800 level should be driven east from the short drift now opened on the 1800 level south of the shaft, to a point opposite raise No 1, and this raise should be extended upwards to the 1800 horizon and a cross cut to the footwall to connect with the 1800 drift.

This work will further develop Block No1 and definitely solve Block Z.

This particular piece of work will further determine the rake if any of the ore bodies so far developed and the possibilities of any ore under the 1700 level in this section.

It is to be here noted that the footwall drift of the 1800 level from the No 3 raise to the No 5 will also determine what rake if any the ore bodies have oxx the east side, this being a matter of considerable importance for there is a very strong possibility of ore opened up on the 1900 level in No 5 raise as having no connection with any ore bodies on the 1700 level so far opened up and that as both the 1700 and 1900 levels are advanced to the east additional ore bodies will be developed.

It is also recommended that the 1700 level be extended east to a point above No 5 raise at least and a footwall connection be made from the 1800 to the 1700 levels from No 5 raise.

At a point between survey stations 19.26 and 19.27 it is recommended that a winze be sunk at least fifty feet and after cross cutting that some development work be done both east and west from this winze.

Also that a winze be sunk at or near survey station 1937 and that after cross cutting that a drift be extended east from this winze.

These two winzes both in critical points should materially aid in the determination of the location of a main working winze and it is recommended that further development work and with the idea in mind for future working of the sulphide ore bodies that a main winze be sunk to a depth of two or three hundred feet, depending upon developments and such winze be equipped with an electric hoist and usual arrangements made to handle the rock which could then be trammed out to the 1900 station and cars caged as at present.

In conclusion I wish to say that developments on the 1900 have been most interesting and promising, there has been no evidence of either impoverishment of the vein or any danger of the vein losing its idonity by being squeezed out. There is nothing to fear from the intrusive exposed at different places and I am confident that any work below this 1900 level will be equally satisfactory as to values as this level has been.

Respectfully,

(SIGNED) JOHN C. RODDER.
Mining Engineer.

Tonopah Nevada.
March 19, 1930.

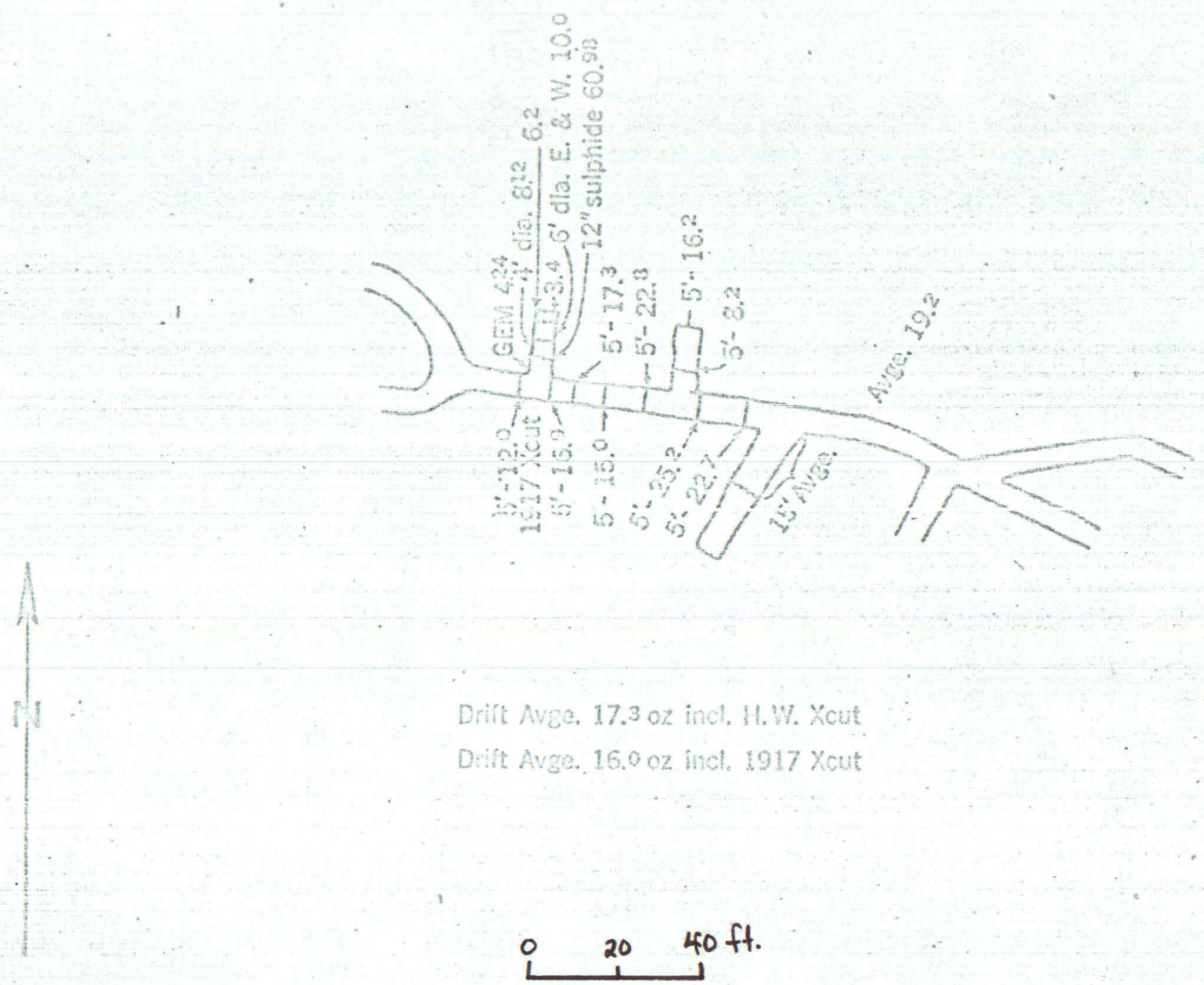
Block No 1	24000 Tons	12.9 ✓ ozs.
2	19000	9.9 ✓
3	7600	12.7 ✓
4	10200	7.8 ✓
5	13400	12.1 ✓
6	11200	12.1 ✓

Total Tonnage	85400 Tons
Total ounces	971650
Average value	11.3

31	Block No X	50% tonnage	7600 Tons	10.0 oz
	Y	Do	7600	10.0
	Z	Do	3800	10.0

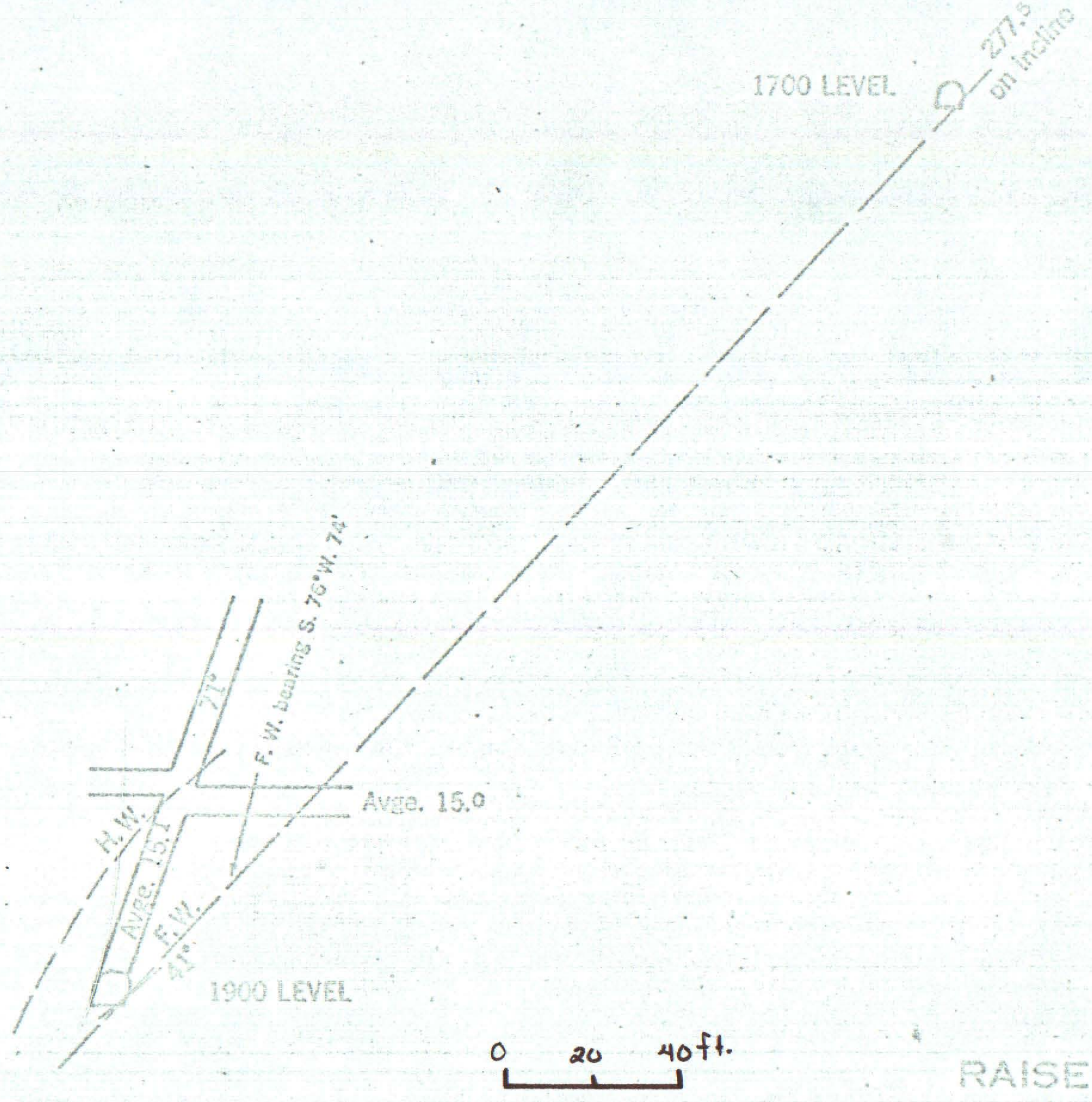
Additional tonnage	19000 Tons
Average Value	10.0 ozs.

The above estimated of tonnage and ore values in ounces of silver
per ton are based on the full width of the ore bearing zone or
sections as described on Page 1 Paragraph 8 of this report.
Under working conditions of mining ore for milling purposes the
higher grade widths overlying the footwall section can be mined
separately in paying tonnage.
This would reduce the above tonnage approximately 33% but increase
the average value in ounces of silver per ton of such tonnage,
which can be safely estimated would make a product of not less than
15 ounces of silver per ton to which should be added $1.60 gold
value per ton and a content of 1% lead, the latter should be recov-
erable by concentration, these latter values are taken from a com-
posit sample taken of all samples taken in my recent examination.



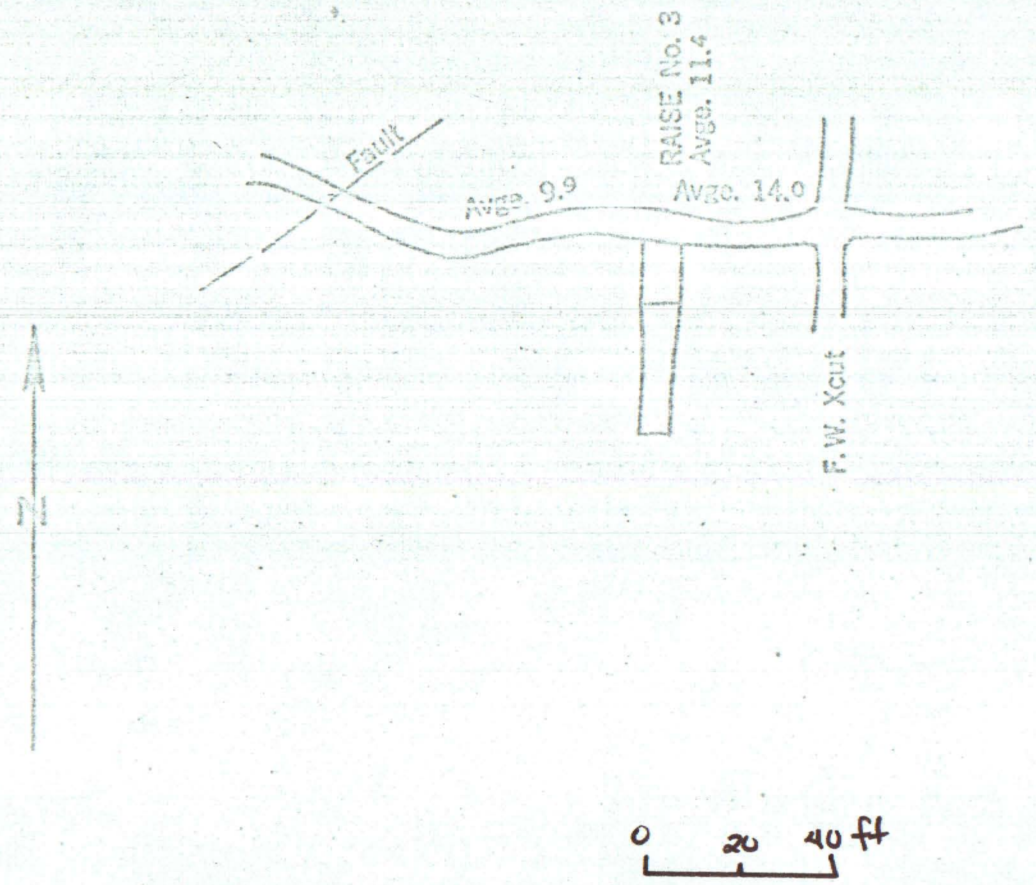
RAISE No. 1

Scale 1 inch 40 feet



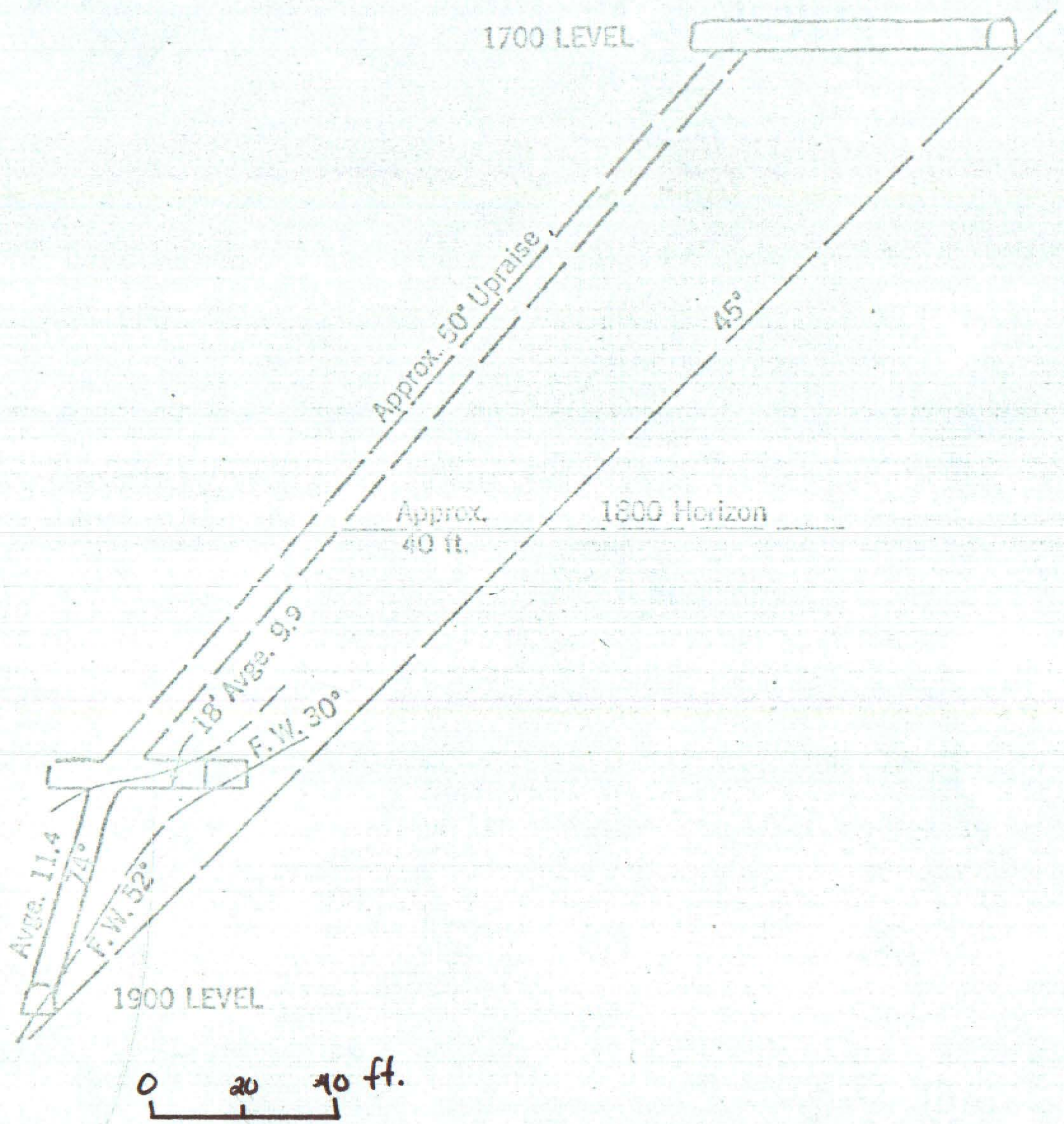
RAISE No. 1

Scale 1 inch 40 feet



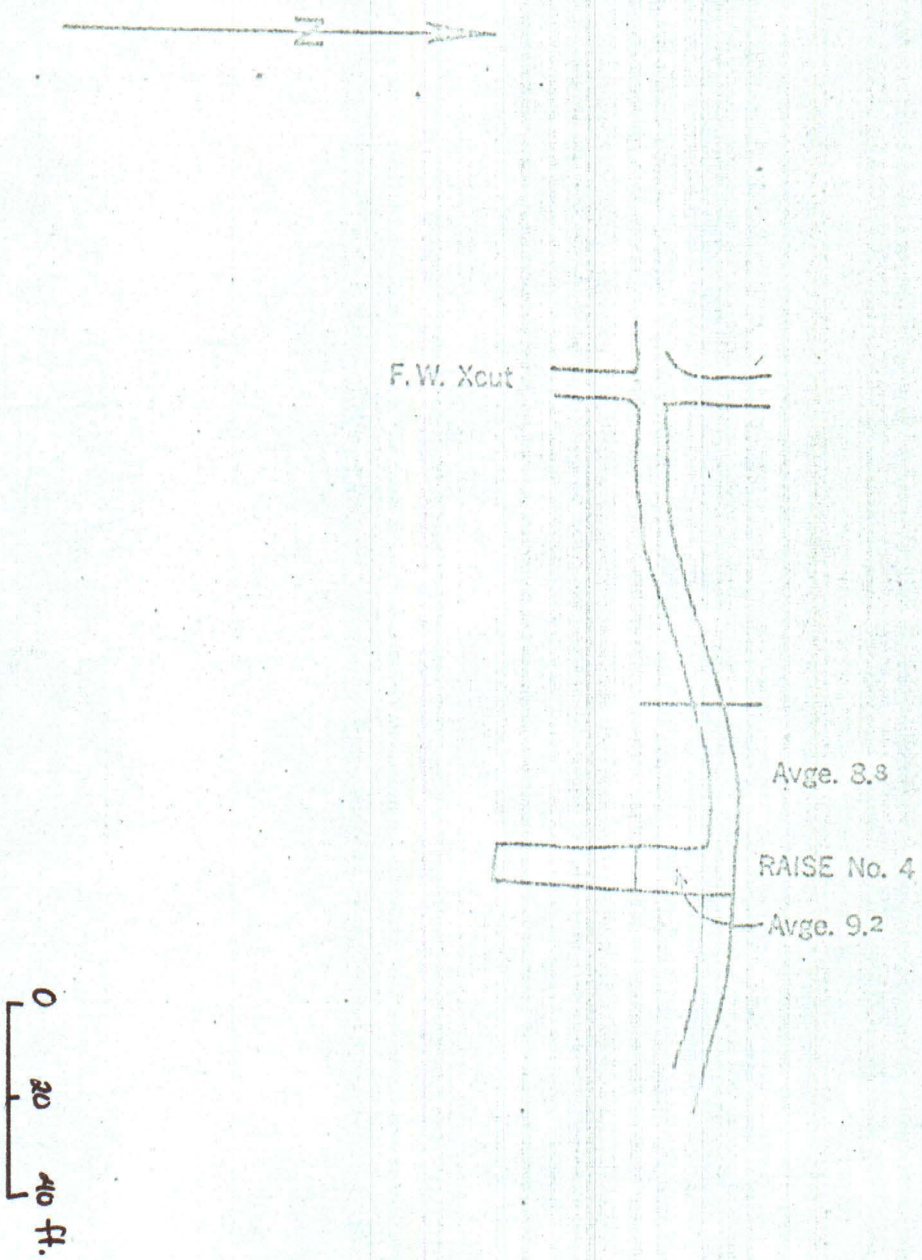
RAISE No. 3

Scale 1 inch = 40 feet

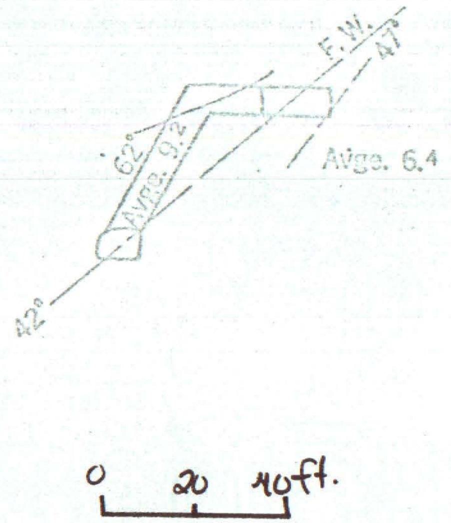


RAISE No. 3

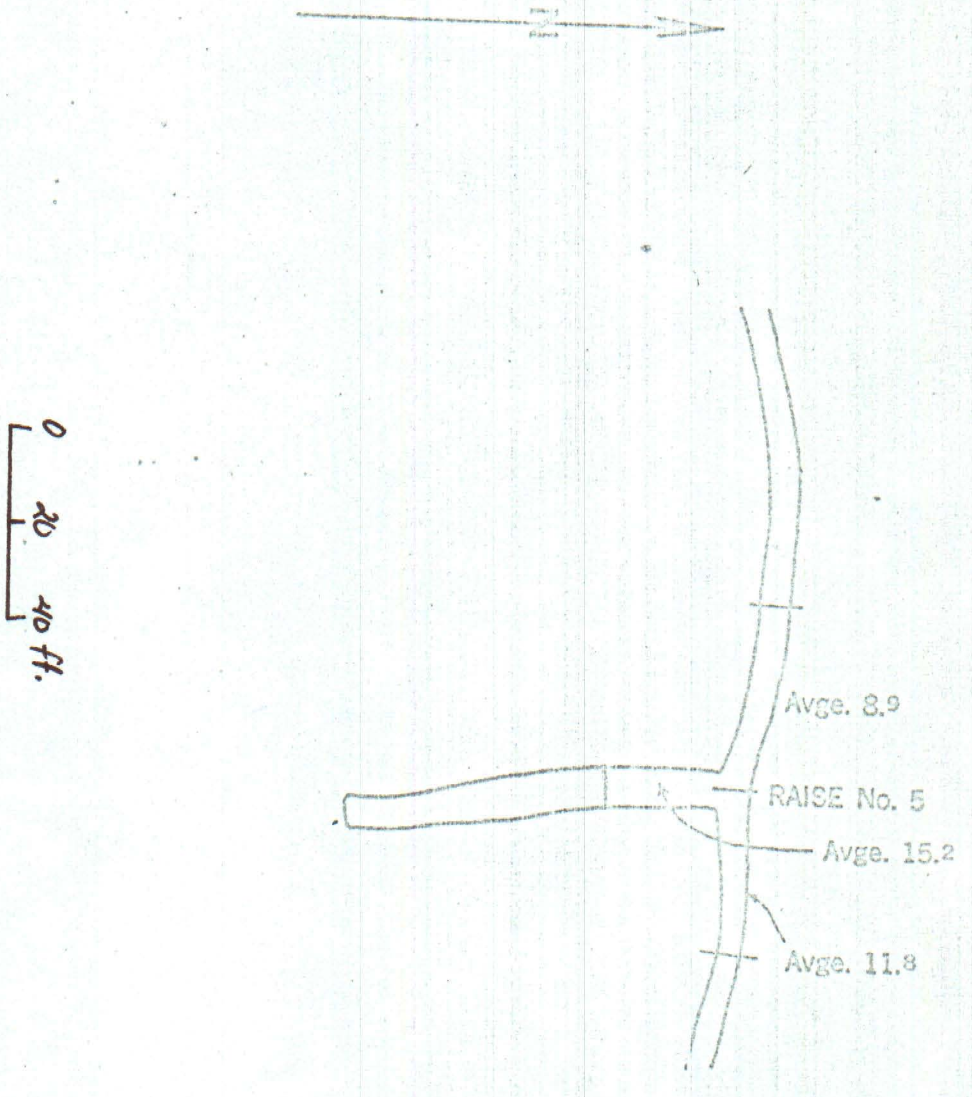
Scale 1 inch 40 feet



RAISE No. 4
Scale 1 inch - 40 feet

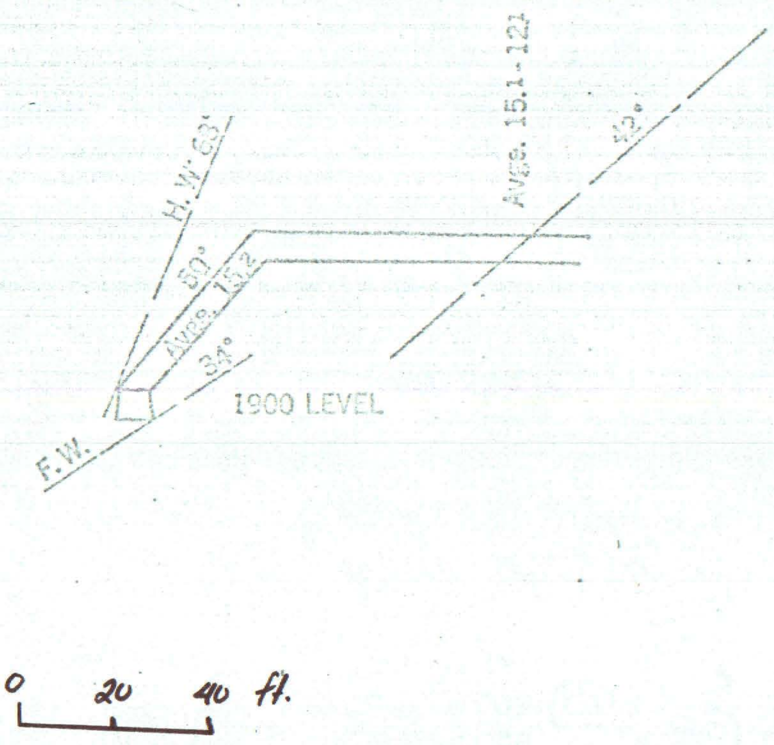


RAISE No. 4
Scale 1 inch = 40 feet



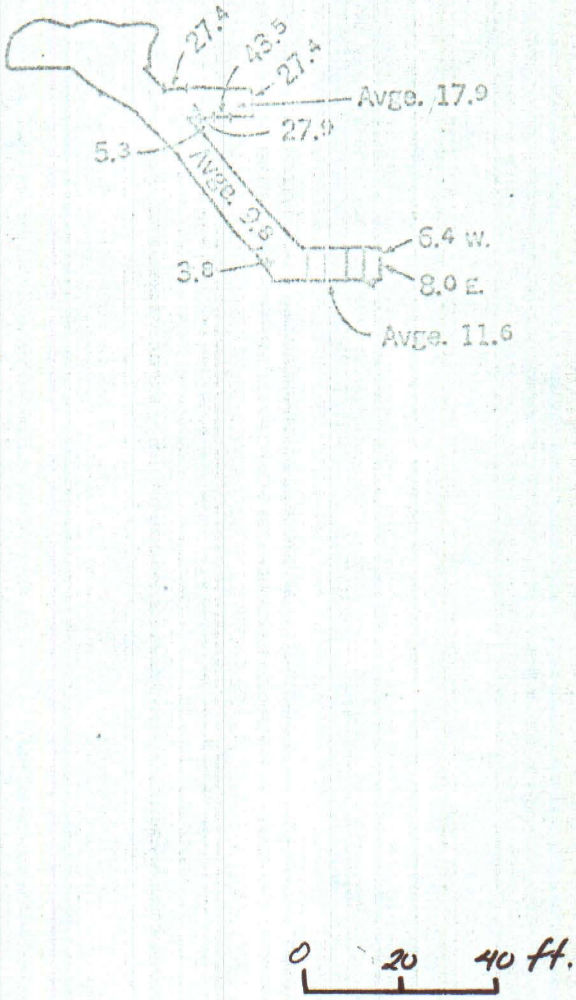
RAISE No. 5

Scale 1 inc. 40 feet



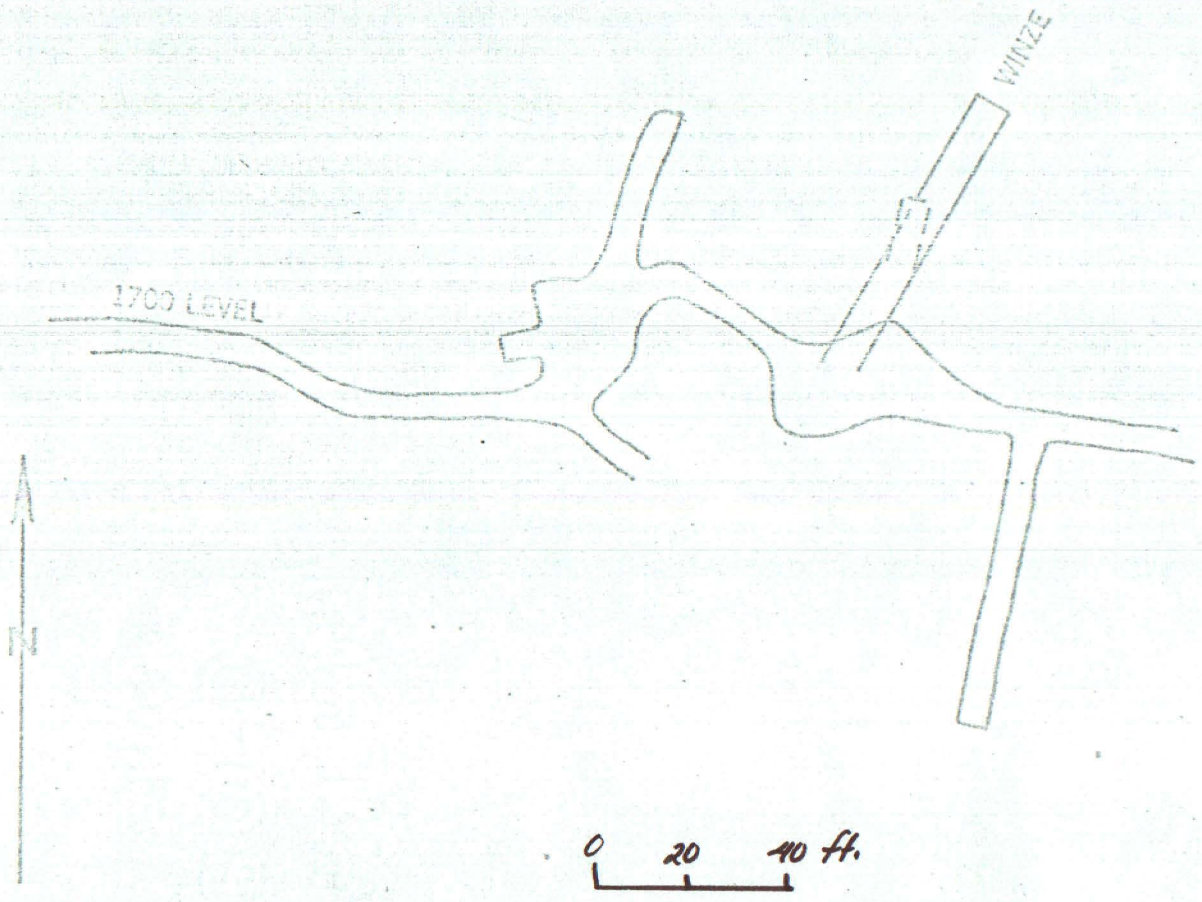
RAISE No. 5

Scale 1 inch - 40 feet



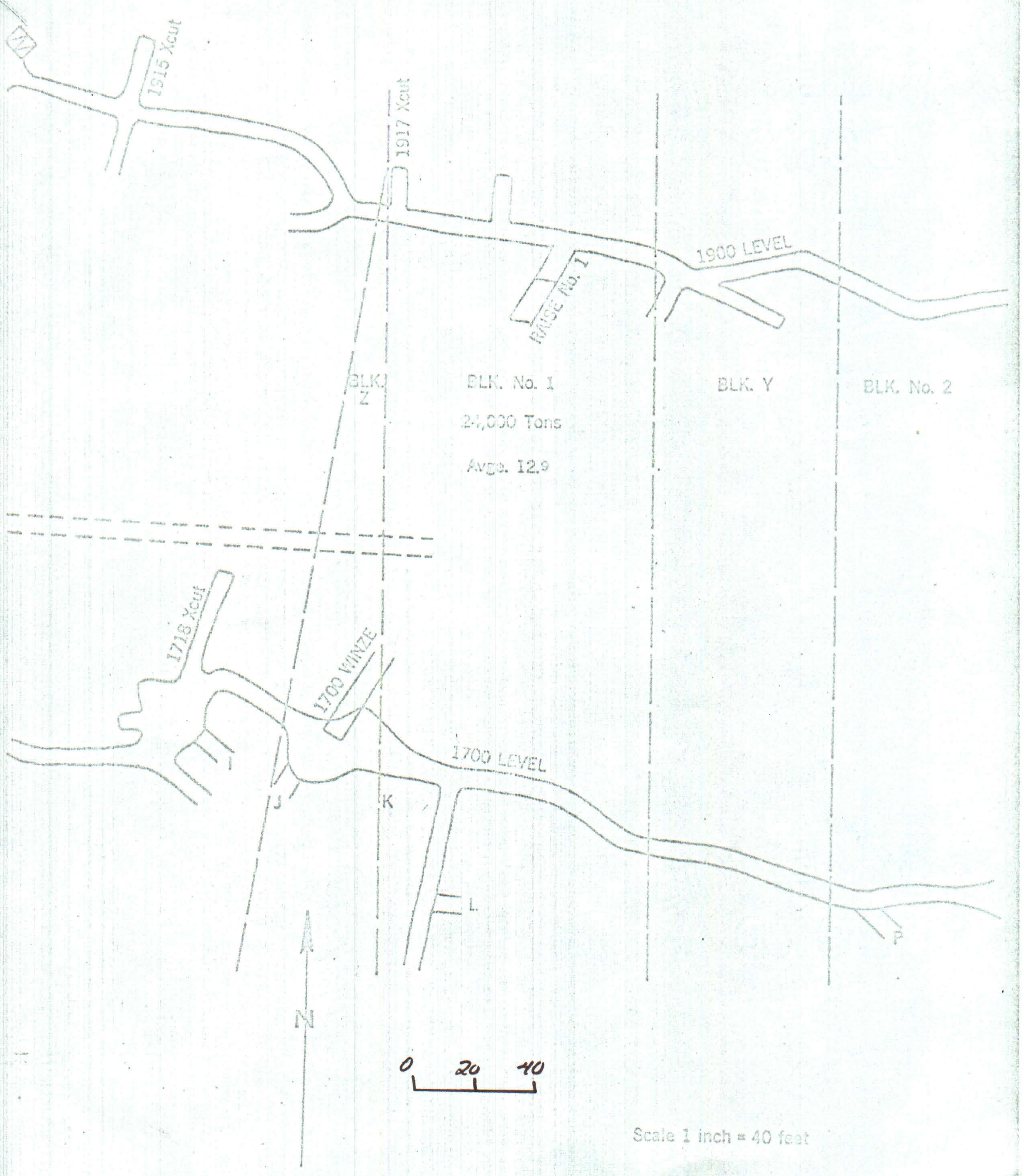
1700 WINZE

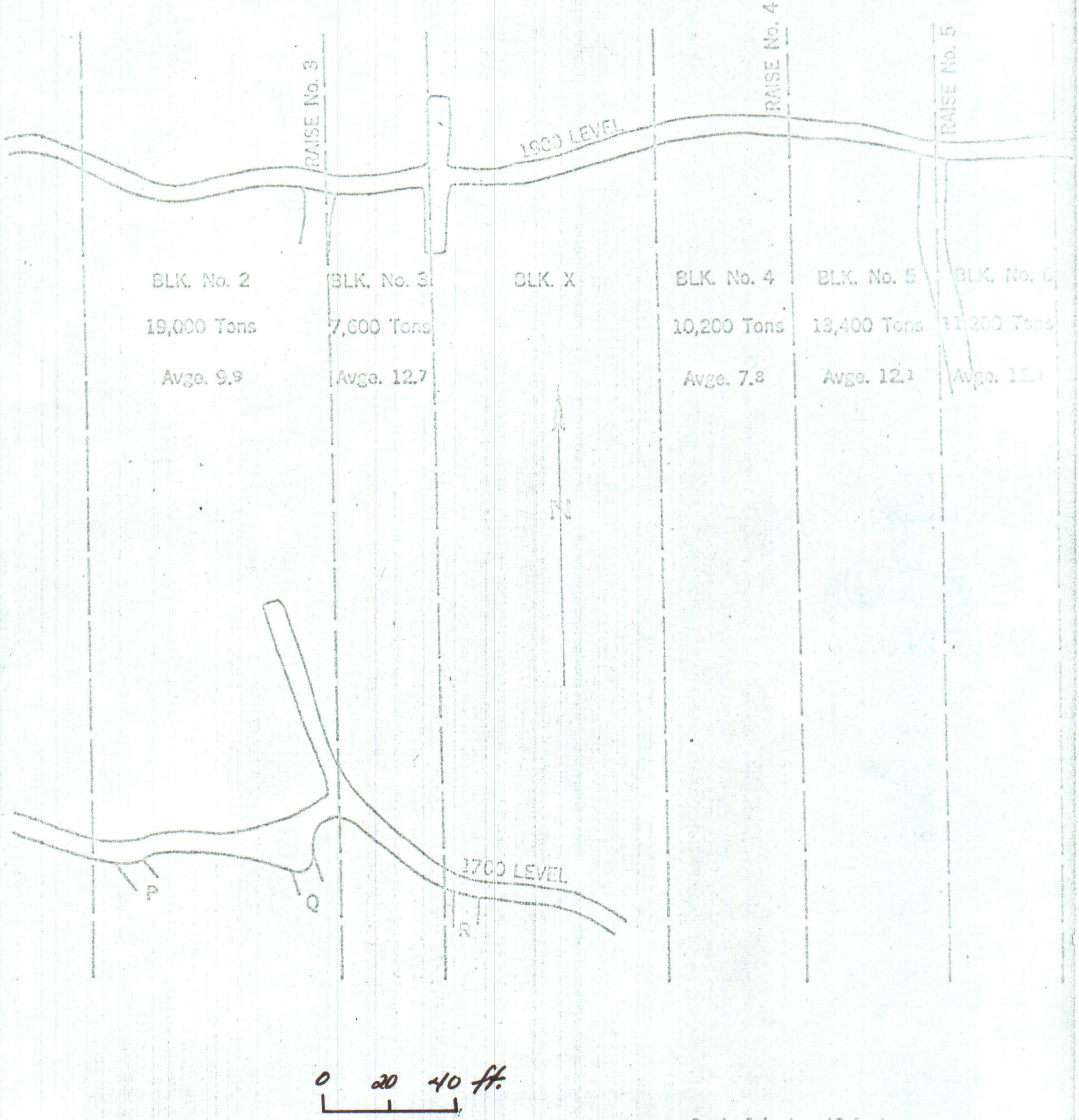
Scale 1 inch = 40 feet



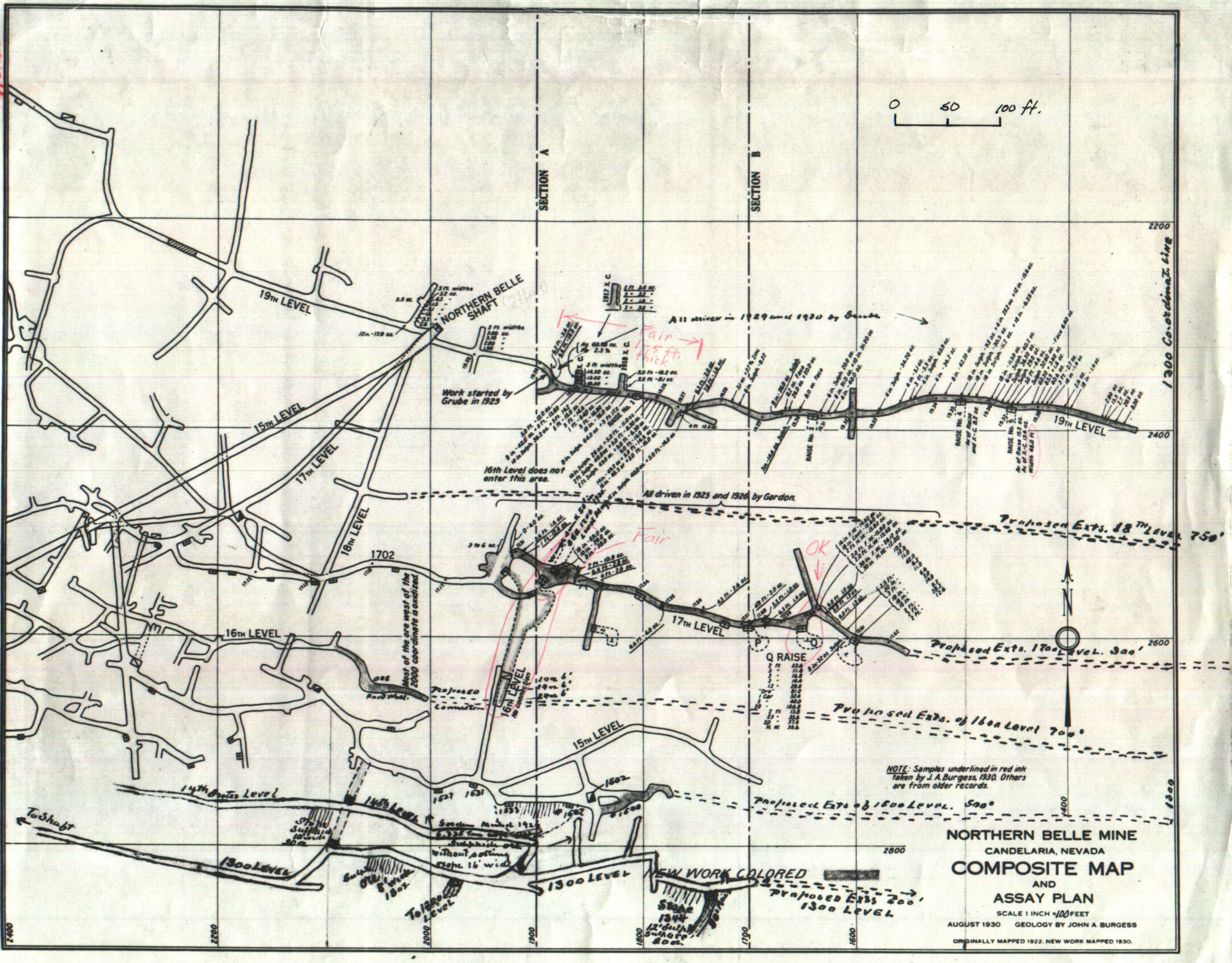
1700 WINZE

Scale 1 inch = 40 feet


1515 Xcut
1917 Xcut
1900 LEVEL
RAISE No. 1
BLK. Z
BLK. No. 1
24,000 Tons
Avge. 12.9
BLK. Y
BLK. No. 2
1718 Xcut
1700 WINZE
1700 LEVEL
J
K
L
P
N
0
20
40
Scale 1 inch = 40 feet



Scale 1 inch = 40 feet



NORTHERN BELLE MINE
CANDELARIA, NEVADA
COMPOSITE MAP
AND
ASSAY PLAN
SCALE 1 INCH = 100 FEET
AUGUST 1930 GEOLOGY BY JOHN A BURGESS
ORIGINALLY MAPPED 1922. NEW WORK MAPPED 1930.
NOTE: Samples underlined in red ink taken by J. A. Burgess, 1930. Others are from older records.
0 50 100 ft.
SECTION A
SECTION B
NORTHERN BELLE SHAFT
19TH LEVEL
18TH LEVEL
17TH LEVEL
16TH LEVEL
15TH LEVEL
1300 Co-ordinate Line
All driven in 1929 and 1930 by Grube
Work started by Grube in 1929
16th Level does not enter this area.
All driven in 1925 and 1926 by Gordon.
Most of the ore west of the 2000 coordinate is oxidized.
Proposed Exts. 18TH LEVEL 750'
Proposed Exts. 1700 Level. 300'
Proposed Exts. of 1600 Level 700'
Proposed Exts. of 1500 Level. 500'
Proposed Exts 200' 1300 LEVEL
NEW WORK COLORED
1300 LEVEL
14th Level
To Shaft
Q RAISE
RAISE No. 4
RAISE No. 5
1917 X C
1918 X C
1702
Fair
OK
2200
2400
2600
2800
1300
1400
1600
1700
1800
1900
2000

GEOLOGICAL AND SAMPLE MAPS

OF THE EASTERN PART OF THE

NORTHERN BELLE MINE

OF THE

ARGENTUM MINING CO. OF NEVADA

CANDELARIA, NEVADA

BY JOHN A. BURGESS
648 MILLS BUILDING, SAN FRANCISCO
CALIFORNIA

AUGUST 1930

LEGEND

ANDESITE ....

PORPHYRY DIKES ....

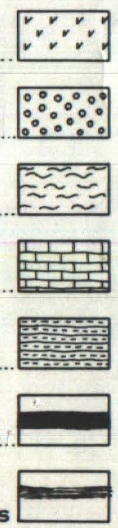
SERPENTINE ....

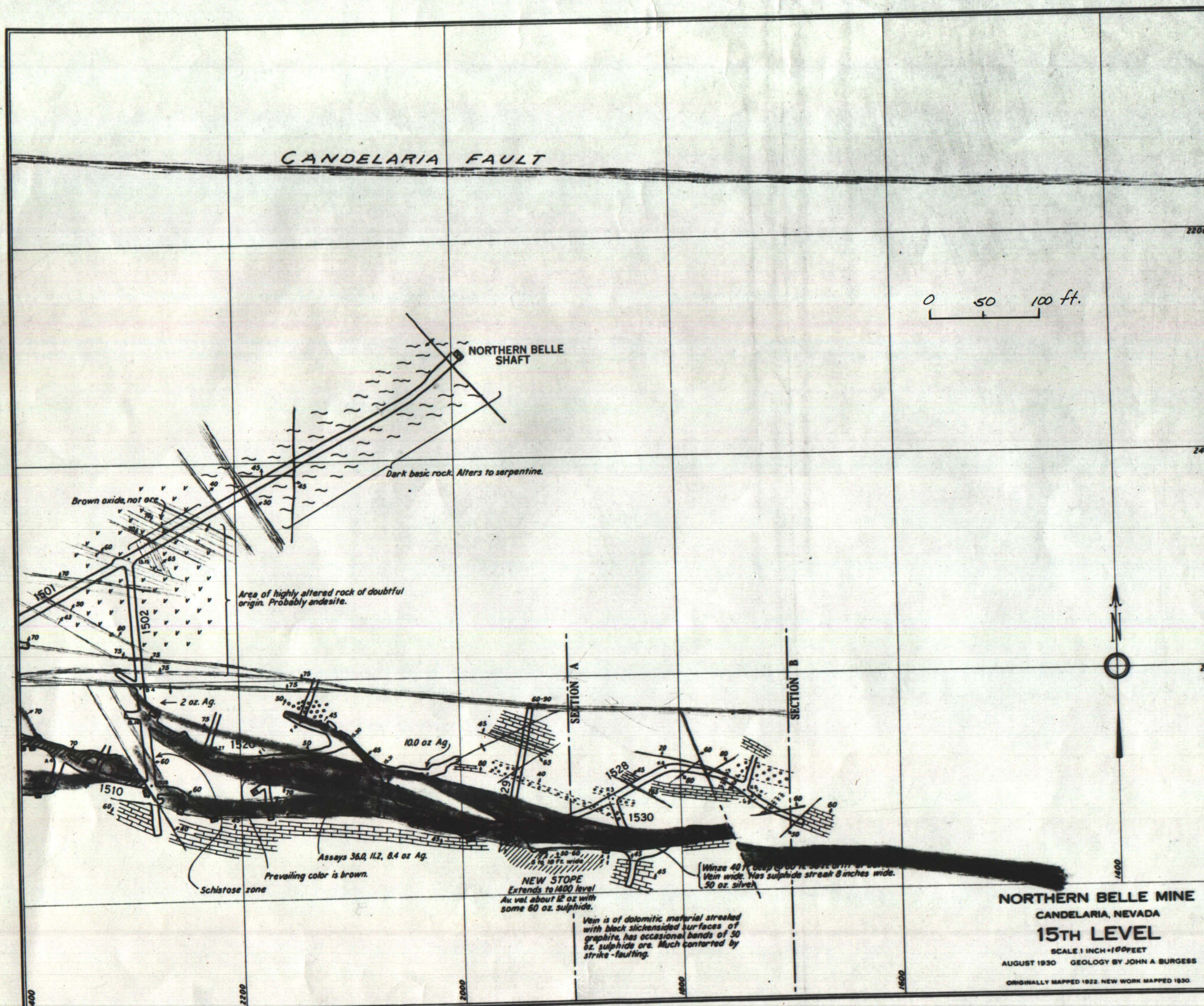
CANDELARIA SHALE ....

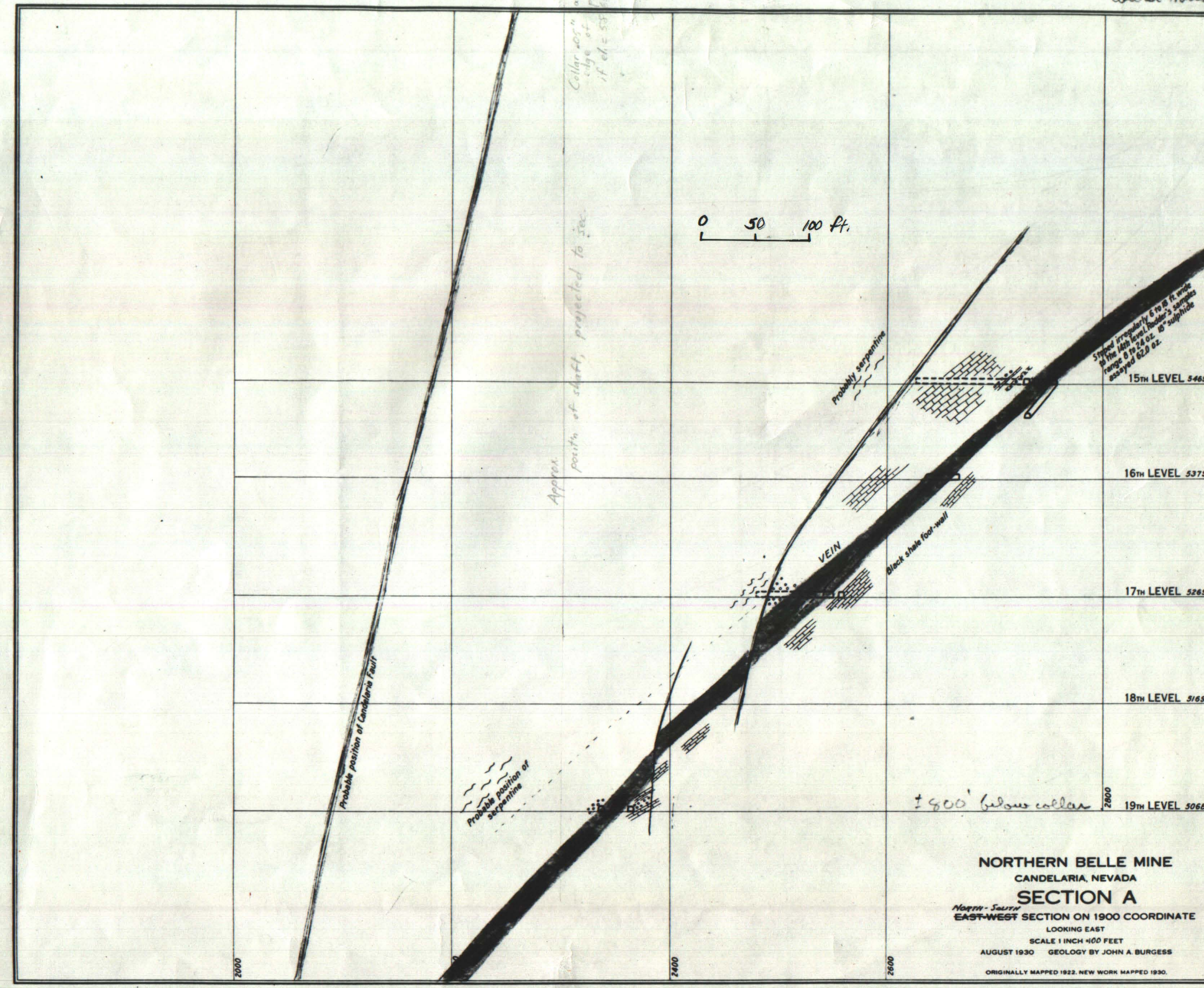
GRAYWACKE ....

VEINS ....

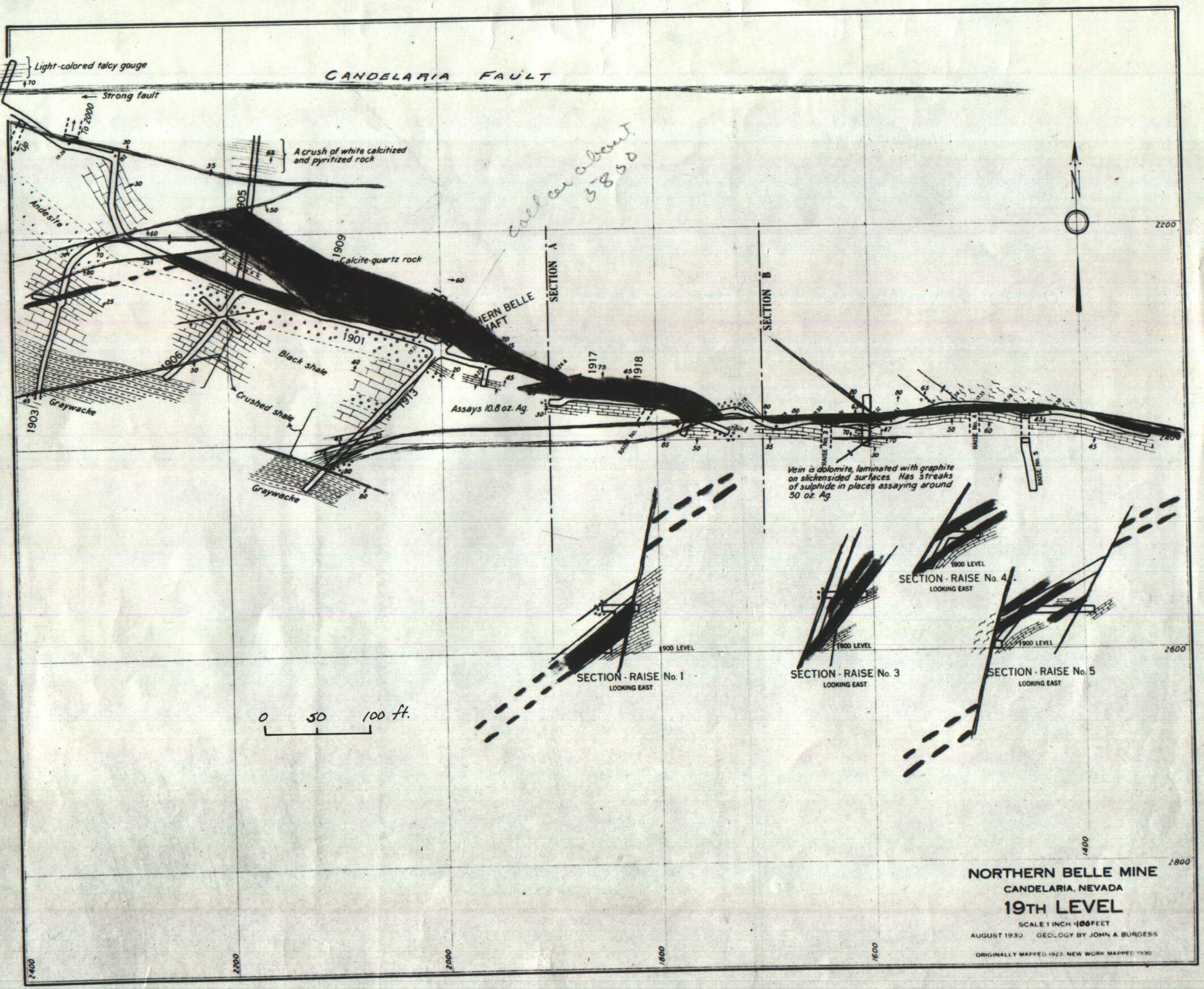
FAULTS, FISSURES, GOUGES



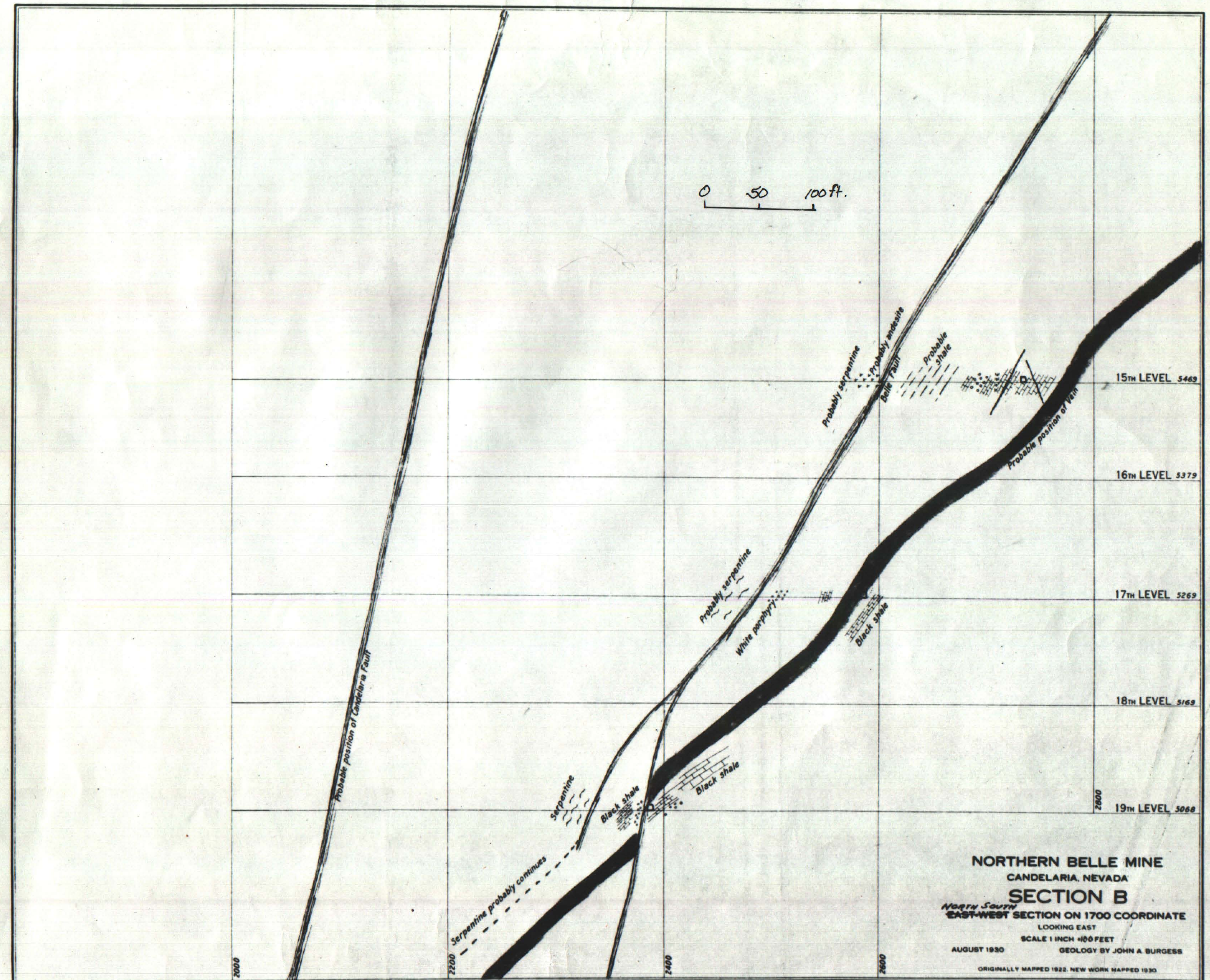

CANDELARIA FAULT
0 50 100 ft.
NORTHERN BELLE SHAFT
Dark basic rock. Alters to serpentine.
Brown oxide, not ore.
Area of highly altered rock of doubtful origin. Probably andesite.
1501
1502
1510
1520
1528
1529
1530
← 2 oz. Ag.
10.0 oz Ag.
SECTION A
SECTION B
Assays 36.0, 11.2, 8.4 oz Ag.
Prevailing color is brown.
Schistose zone
NEW STOPE
Extends to 1400 level
Av. val. about 12 oz with some 60 oz. sulphide.
Vein is of dolomitic material streaked with black slickensided surfaces of graphite, has occasional bands of 50 oz. sulphide ore. Much contorted by strike-faulting.
Vein wide. Has sulphide streak 8 inches wide.
50 oz. silver
2200
2400
2600
2800
2000
1800
1600
1400
N
NORTHERN BELLE MINE
CANDELARIA, NEVADA
15TH LEVEL
SCALE 1 INCH = 100 FEET
AUGUST 1930 GEOLOGY BY JOHN A BURGESS
ORIGINALLY MAPPED 1922. NEW WORK MAPPED 1930.

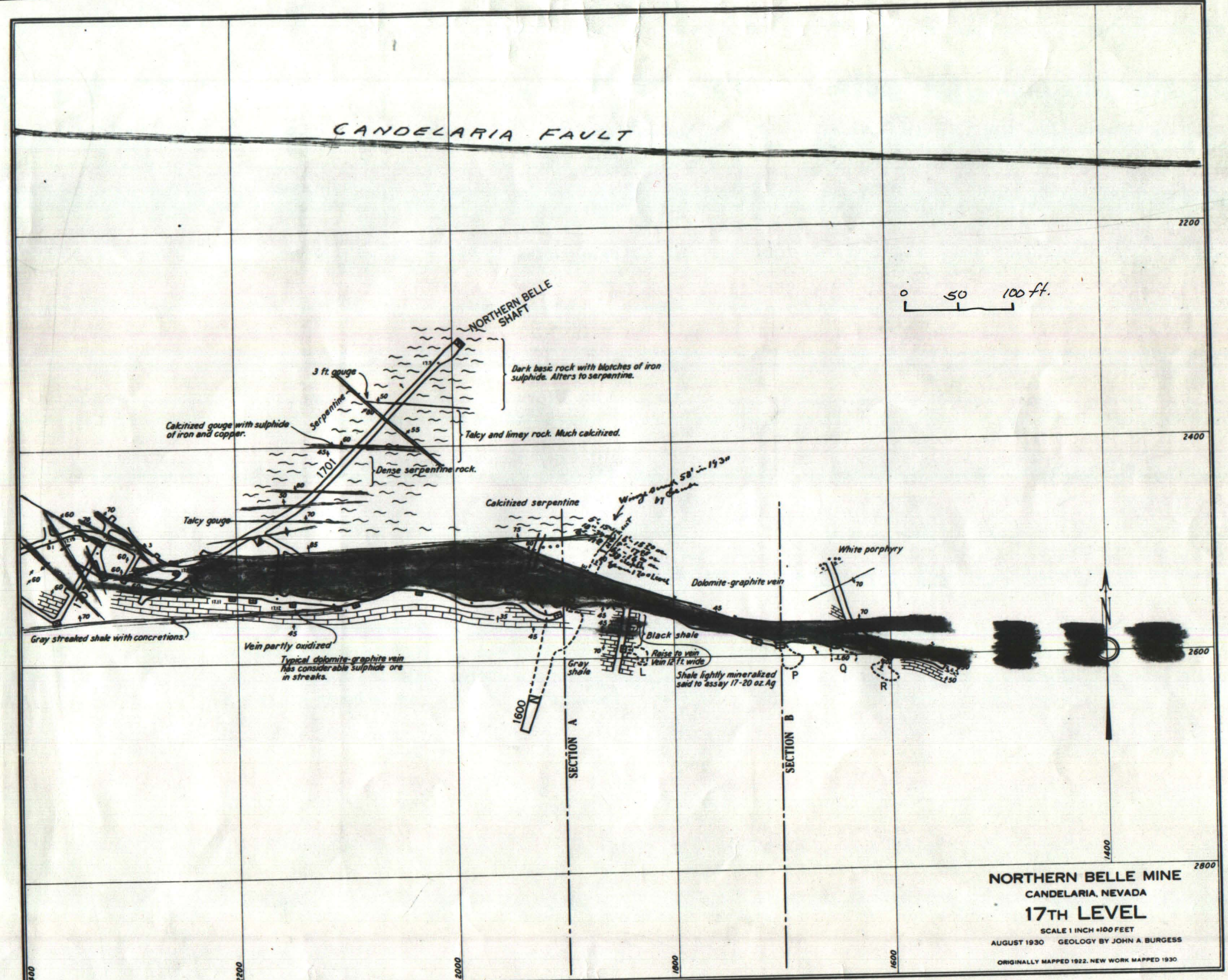


NORTHERN BELLE MINE
CANDELARIA, NEVADA
SECTION A
North-South ~~EAST-WEST~~ SECTION ON 1900 COORDINATE
LOOKING EAST
SCALE 1 INCH =100 FEET
AUGUST 1930 GEOLOGY BY JOHN A. BURGESS
ORIGINALLY MAPPED 1922. NEW WORK MAPPED 1930.



NORTHERN BELLE MINE
CANDELARIA, NEVADA
19TH LEVEL
SCALE 1 INCH 100 FEET
AUGUST 1930 GEOLOGY BY JOHN A. BURGESS
ORIGINALLY MAPPED 1922, NEW WORK MAPPED 1930


NORTHERN BELLE MINE
CANDELARIA, NEVADA
SECTION B
NORTH SOUTH EAST-WEST SECTION ON 1700 COORDINATE
LOOKING EAST
SCALE 1 INCH =100 FEET
AUGUST 1930
GEOLOGY BY JOHN A. BURGESS
ORIGINALLY MAPPED 1922. NEW WORK MAPPED 1930
0 50 100 ft.
15TH LEVEL 5469
16TH LEVEL 5379
17TH LEVEL 5269
18TH LEVEL 5169
19TH LEVEL 5068
2000
2200
2400
2600
2800
Probable position of Candelaria Fault
Serpentine probably continues
Serpentine
Black shale
Black shale
Probably serpentine
White porphyry
Black shale
Probably serpentine
Probably andesite
Belle Fault
Probable shale
Probable position of Vein



NORTHERN BELLE MINE
CANDELARIA, NEVADA
17TH LEVEL
SCALE 1 INCH = 100 FEET
AUGUST 1930 GEOLOGY BY JOHN A BURGESS
ORIGINALLY MAPPED 1922. NEW WORK MAPPED 1930

0930 0001

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Item 1

REPORT ON THE GEOLOGY OF
THE NORTHERN BELLE MINE
OF THE
ARGENTUM MINING COMPANY OF NEVADA

A report supplementary to
that made on July 22, 1922
and referring especially to
the deeper sulphide ores.

By

JOHN A. BURGESS
648 Mills Building
San Francisco, California

September 5, 1930

September 5, 1930

Argentum Mining Company of Nevada
Candelaria, Nevada

Gentlemen:

At the request of Mr. F. G. Grube, I have made an examination of the development work done on the sulphide ore of the lower levels of the Northern Belle Mine.

Mr. Grube's instructions were to report on both the geological and economic features of the situation, and to discuss the possibilities of resuming work profitably if the price of silver should rise to 50 cents per ounce.

I hand you my report herewith.

Very truly yours,

John A Burgess

JAB:Q

INDEX

I N D E X
(continued)

I N D E X
(continued)

THE NORTHERN BELLE MINE

of the

ARGENTUM MINING COMPANY OF NEVADA

GEOLOGY

The general geology of the Candelaria District was fully described in a report to the Candelaria Mines Company, dated July 20, 1922. In this report only a very brief resume of the geology will be given, reference being made to the former report for details.

ROCK FORMATIONS

The formation at Candelaria consists of both sedimentary and igneous rocks, of which the sediments are the oldest. These were intruded by dikes and sills of various igneous rocks, and after subsequent erosion were finally covered with surface flows of tertiary rhyolite and basalt. Later erosion has reduced the surface to its present form.

The principal rocks with which this report is concerned are the Candelaria shale, in which the ore occurs, and a massive intrusive body composed mostly of serpentine.

The Candelaria shale is a thin-bedded rock usually black or gray in color. In the area under consideration the shale is tilted so that the usual dip is about 45 degrees to the north. The known thickness varies considerably; it has a maximum of about 700 feet in the Northern Belle Mine, but is usually much less.

The intrusive rock referred to as serpentine appears to be composed of several types of altered igneous rock, some of which is true serpentine, and some of which bears only a slight resemblance to serpentine. For convenience, the entire mass is called serpentine, or is sometimes referred to as the Pick-Handle Gulch intrusive.

It is probable that the serpentine forms a sill-like mass that extends east and west for a considerable distance, with its lower surface dipping 45 degrees noth, approximately conformable with the bedding of the shale, and not far above the ore horizon. The thickness of the serpentine is not known, but is probably not less than 500 ft., and it may be twice that width.

Sills and dikes of other igneous rocks, called by the general name of porphyry in this report, occur in the Candelaria shale. They vary from 2 ft. to 15 ft.

in width.

The accompanying maps and sections, under separate cover, illustrate the distribution of these rocks.

THE CANDELARIA FAULT

The Candelaria fault strikes approximately east, and dips 45-75 degrees north. It can be seen in the Columbus tunnel, 300 ft. from the portal; in the No. 10 and No. 11 tunnels; and on the 20th level. It passes a short distance north of the Northern Belle shaft. The fault is normal, and the downthrow on the north side has lowered the basalt capping down opposite the shale. The full extent of the movement is not known, but it is probably not less than 1000 ft., and may be much greater. The fault will cut off the Northern Belle vein about 500 ft. on its dip below the 19th level, and the downward displacement of the north block may be very large.

Consolidated Grey Dawn Claim taken out by Burgess as Containing the faulted NB Vein. 1800!

THE ALPHA FAULT

The Alpha fault shows in the bottom level of the Lucky Hill Mine, and at the surface north of the Lucky Hill tunnel. Its strike is a little south of west, and the dip is 50 degrees to the south. The displacement of the hanging wall block, above the fault, was 1200 ft. downward, in the vicinity of the Lucky Hill mine, but this may have been more or less at other points along the strike.

The Alpha fault intersected the Northern Belle vein-system, and threw its upper part downward to the south, so that the Lucky Hill-Diablo vein system is the faulted continuation of the Northern Belle vein. The Alpha fault is consequently post-mineral in age.

The fault probably extends eastward for at least several thousand feet though it has not been definitely traced east of the road in Pick Handle Gulch. If the fault has this extent, it must cut off the Diablo vein somewhere near the present bottom workings, in the same manner that it cuts the Lucky Hill vein.

The effect of the Candelaria and Alpha faults is shown in the drawings opposite page one.

BELLE FAULT

This is a steep east-striking fault that is seen throughout the Northern Belle mine from the 10th level to the 18th level. The movement was normal, and downward on the north side. The amount of movement, was not great, probably not more than 75 ft., but perhaps different in different places.

The steep east-west fault, encountered along the east drift on the 19th level, is too far north to conform with the place of the Belle fault as known in the upper levels, but the two may be regarded as related fissures having the same general direction and the same kind of movement.

WATER

No water has been encountered in the mine and it is not probable that any will be found for an additional depth of 500 ft.

MINERAL VEINS

The productive ore bodies of the Candelaria district occur in the shale, most of them near its lower border. This is the case at the Potosi, Northern Belle, Lucky Hill, and Diablo Mines, and in other prospects farther to the east.

The vein system consists of a mineralized belt of fissuring with a general east-west strike, a northerly dip of about 45 degrees, and generally parallel to the bedding of the shale. The main productive zone extends through the Northern Belle Mine; and south of the Alpha fault, it continues eastward through the Lucky Hill mine and the Diablo Mine. In the easterly workings of the 15th, 17th and 19th levels, where unoxidized ore is found the vein is in a single wide mineralized sheet, but farther west it spreads out into a scattered group of veins and ore bodies. It was from these scattered veins that most of the early day ore was mined.

Ore in its primary unaltered condition can be seen on the levels from the 15th to the 19th, east of the Northern Belle shaft. The vein, in these drifts consists of ferrodolomite in thin curving and overlapping sheets and lenses separated by black polished graphitic surfaces, the whole much contorted and deformed by strike-faulting within the vein. Adolph Knopf calls this gangue material ferrodolomite. The graphite and included black shale give the vein as a whole a black color. A small amount of quartz is seen. Occasional discontinuous lenses or broken sheets of solid sulphide ore are found up to 18 inches in thickness. These consist principally of pyrite, galena, and probably certain silver minerals. They assay up to 50 or 75 ounces silver, and occasionally higher. Probably the silver value of the lower grade parts of the vein is due to disseminated sulphides of the same character. There is a small amount of zinc in the ore. The ore is not oxidized. The vein in these levels is commonly 12 to 20 ft. thick, and it is stoped for these widths in places. Sulphide ore of this type is found mostly east of the 2000 co-ordinate, or in other words, east of the Northern Belle shaft. The ore that was opened in the east drifts, on the 1500, 1700 and 1900 levels, in 1926 and during the past twelve months, is of this type.

Practically all the ore mined by early operators was the oxidized ore found west of the 2000 co-ordinate, and between the surface workings and the 18th level. The black, graphitic sulphide vein of the East workings, when it extends west of the 2000 co-ordinate, becomes oxidized and shows little or no graphite except on the lower levels. The high grade ore found in early operations was the oxidized form of sulphide streaks similar to those that occur in the graphitic sulphide vein. It is now apparent that no secondary concentration took place, except possibly in the Lucky Hill mine.

The unoxidized character of the ore in the easterly workings is probably due, in part at least, to the uneroded covering of serpentine, which had the effect of protecting the underlying ore from the action of oxidizing water. In the western part of the mine the shales and the vein-outcrops are exposed to the surface, and the ore was consequently more freely exposed to oxidizing agencies.

That there has been considerable "strike-faulting" or slipping movement within the vein itself, is evidenced by the slickensided graphite surfaces, and by the contortion of the vein-structure into scroll-like and eddy-like forms and sheared-off bends. One effect of this "strike-faulting" was to break up the bands of high grade sulphide ore, which were at first in sheets of considerable extent, and to scatter them through a wider extent of vein, so that they cannot now be mined by themselves. In certain stopes, however, the sulphide is in sufficient quantity to add appreciably to the general grade of the ore.

METAL CONTENT OF THE SULPHIDE VEIN

The ore is essentially a silver ore, with small accessory value in gold. In the easterly workings, from the 1500 level down, the highest silver content is found in the sulphide streaks, most of which assay from 30 oz. to 60 oz. silver per ton, and sometimes up to 100 oz. These streaks vary in width from an inch or two, to 18 inches or 2 ft. They are always in the form of bands in the vein, and never form massive ore bodies. The main body of the vein, without the sulphide streaks, carries silver in varying quantity, which from records at hand range from 2.0 oz. to 14 oz. silver. Most of the sulphide ore assays from 30 to 60 oz. silver, but some samples on record show over 100 oz.

There is not sufficient data at hand to warrant setting a definite figure on the gold content of the ore, but from the 24 samples taken it appears that a value of ten cents in gold per one ounce of silver can be expected.

The silver is not uniformly distributed through the vein. The drifts pass through stretches of 2 oz. or 3 oz. ore, and then through 9 oz. to 14 oz. ore, and where the better grade of ore is found there are also the bands of high grade sulphide ore previously described. It is not thought that the 12 or 14 oz. ore will be found extending from level to level in regular blocks, but rather that they form an irregular pattern within the vein.

DEVELOPMENT WORK IN UNOXIDIZED ORE SINCE 1922

The development work, performed in the Northern Belle mine, in the unoxidized ores since 1922, was done to the east on the 1500, 1600, 1700 and 1900 levels. In approximate figures, the work consisted of drifts that exposed the vein for additional lengths of:

15th level	50 ft.
16th "	100 ft.
17th "	400 ft.
18th "	--
19th "	540 ft.

1966 Still abt the same E.G.

together with accompanying crosscuts and raises. The work is shown on the accompanying maps.

At the time of my previous examination in 1922, the black, graphitic, unoxidized ore was exposed in the faces of these south drifts, but the grade was low; and neither the old mills of the '80's and '90's, nor the projected cyanide mill of the Candelaria Mines Company were arranged to handle sulphide ores and there was no interest in them. In 1925 and 1926 some exploration of this type of ore was undertaken. The 15th level was driven to its present face, and additional work was done on the 17th level. In 1929 and 1930, drifting was started south on the 19th level, and it was driven to its present extent.

The work done in these drifts shows that the vein continues to the east with no change in size. It is a more compact, stronger vein, that the ore bodies in the old upper levels, where oxidized ore was found.

On the 19th level, east of station 19.27

the vein appeared to pinch out entirely for a short distance and thereafter, to the end of the drift, was found in irregular and usually narrow widths, with a steep well defined gouge forming the hanging wall. The explanation of this is not that the vein is becoming narrower at this place, but that the drift has followed along a nearly vertical east-west fault. At this elevation the fault has separated the vein into two segments, and the drift has followed the beveled lower edge of the upper segment. Raises on the south side of the fault show the vein in greater strength 40 ft. above the level. Sections through these raises are drawn on the map of the 19th level, and these show the effect of the fault. The vein would be found in its usual size north of the fault by winzes or by a deeper level.

POSSIBLE EXTENT OF THE UNOXIDIZED ORE

There is a good reason for believing that drifting to the east on the lower levels will continue to expose ore for 1000 or 2000 ft. or more. The ore bodies of the Northern Belle mine show that the ore bodies pitch to the east; and south of the Alpha fault, the ore bodies of the Diablo mine lie farther to the east. Ore also occurs in old workings east of the Diablo Mine.

It has previously been explained that the Northern Belle vein is the downward continuation of the Diablo vein north of the Alpha fault. This fact, with the tendency of the ore bodies to pitch to the east, makes it probable that the deeper levels can be extended in ore-bearing vein for a long distance farther to the east. A possible figure would be 2000 ft. The vein should extend 500 ft. on the dip below the 19th level before being cut off by the Candelaria fault, and it should extend up to the 13th level. This would give about 1250 ft. on the dip of the vein. How much this stretch of vein may be cut by minor faulting is an unknown factor. It is probable that there will be one or two intermediate faulted blocks between the 13th level and the Alpha fault. Whether or not these blocks can be mined will depend on how badly they are broken.

I believe that the vein will be cut off by the Candelaria fault about 500 ft. below the 19th level on the dip. The fault is known to be a strong continuous fault with a large displacement, and while it is believed that the vein will continue north of the fault, the displacement downward may be so great as to render the faulted segment inaccessible. For this reason no ore is considered north of this fault.

It is thought that depth will not have any unfavorable influence on the grade of the ore, and that any exploration on the vein below the 19th level will disclose conditions similar to those on the 17th level. There is no reason to expect a general increase of silver content with greater depth, nor to find any concentration of value at water level.

The hope for finding ore of higher grade lies in the possibility of finding oreshoots of better grade in drifting to the east.

In comparing the grade of ore mined in early days with that found today, it must be remembered that the price of silver in the '70's and '80's was over $1. per ounce, and that $60. ore in those days would be $20. ore today. Considering this fact and also that the ore was sorted, it is not likely that the early day oreshoots were very much higher in silver than those found today.

SAMPLE RECORDS

During this examination I had access to a sampling report by Mr. John C. Rodder, dated March 19, 1930; and also to a large number of assays of samples taken during operations under Mr. Gordon which ended in 1926. I took 24 samples on the 1700 and 1900 level to give some check on the older figures.

As a check, my samples of general vein material were disappointing. My four samples across the side of 1917 crosscut and the drift averaged 3.3 oz., as compared with an average of 12.8 oz. from earlier sampling.

On the 17th level, I sampled across the vein where it is crosscut by the drift east of Raise "Q". These samples were from the side of the drift. My average was 1.2 oz., as compared with an earlier average of over 12. oz., which however was from the roof of the drift instead of along the side.

Others of my samples on ordinary vein material, not directly checking earlier samples, assayed 14 and 12 oz., and samples of sulphide streaks showed 32 oz. and 56 oz. silver. The check on the value of the sulphide ore is satisfactory.

After considering the available data it can therefore be stated that the streaks of solid sulphide assay from 30 to 60 oz. silver, and that other parts of the vein vary from two to fourteen oz.

While my check on the sampling of the general vein material was unsatisfactory, still it is impossible for this reason to disregard the mass of older samples and mill records. The few conflicting samples that I took are not sufficient to disprove the older records.

Bearing on this point, we have such records as 33 cars of ore from the 17th level that assayed 20 oz. silver, and 4.5 ft. of ore in the winze on the 15th level that assayed 22 oz.

The statement on pages 16 and 17 is a record of sulphide ore mined on various levels.

NEW CANDELARIA MINES COMPANY
PRODUCTION STATEMENT

FOR PERIOD FROM JUNE 1, TO END OF OPERATIONS SEPT. 24, 1925

				Ounces Silver	Tons Forward
Stope in sulphide ore below 1300 level:					
1300-A	420.0 Tons, average assay			11.75	420.0
Stopes in sulphide area on 1400 level:					
1420,	200.00 Tons,	7.04 Ounces			
1421,	999.0 "	10.52 "			
	1,199.0 "		Average assay	9.94	1,199.0
Ore from Sulphide Area on 1,500 levels:					
1527,	1,306.5 Tons	11.35 Ounces			
1531,	1,270.5 "	11.04 "			
1533,	790.5 "	13.04 "			
1537,	738.75 "	9.8 "			
1540,	868.00 "	11.59 "			
1502,Wnze	360.75 "	9.51 "			
	5,335.00		Average assay	11.23	5,335.0
Ore from Sulphide Area on 1,700 level:					
1702-F	123.75 Tons	9.14 ounces			
1702-I	630.75 "	8.24			
1702-J	783.00 "	8.57			
1702Drift	708.00	10.66	Average assay	9.17	2,245.5
Fills in Sulphide Area below 1,300 level:					
1300-A	352.00 Tons	10.65 Ounces			
1341	305.50 "	13.45 "			
	657.60		Average assay	11.95	657.5
Oxidized Area, 1500 level:					
1500-C	144.75 Tons	14.59 Ounces			
1503	78.00 "	10.18 "			
	222.75		Average assay	13.05	222.75
			Tonnage forward		10,079.75

					Ounces silver	Tons
			Tons brought forward			10,079.75
Fills drawn from 1500 level at 1700:						
1701	979.5	Tons		Average assay	9.60	979.50
Development Tonnage in Sulphide, 1,500 level:						
1502	99.75	Tons	7.5	Ounces		
1539	57.75	"	6.2	"		
				Average assay	7.02	157.50
Development Tonnage in Sulphide, 1,700 level:						
1702-K	59.25	Tons	6.44	Ounces		
1702-Q	9.75	"	6.80	"		
1702 Winze	94.50	"	9.02	"		
	163.50			Average assay	7.95	163.50
				Total, Ore		11,380.25
Waste Tonnage, 15,000 and 1,700 levels:						
1537	30.00	Tons	2.94	Ounces		
1539	1.50	"	4.40	"		
1502Drift	153.75	"	3.71	"		
1502Winze	14.25	"	5.28	"		
1702Drift	825.00					
	724.50			Average Assay	3.76	979.50
				Total Waste		979.50

There seems to be sufficient evidence to warrant the assumption that a considerable quantity of ore can be mined with an average value of 12. oz. or 14 oz. silver. This would undoubtedly necessitate some degree of selective mining; that is, it would be necessary to avoid stoping low grade parts of the vein, and the grade could be varied up or down according to the care with which this was done. Obviously, the percentage of the ground that could be mined would be less if the average grade were kept high than if the grade were lower.

It is possible that one third of the vein could be mined so as to produce 14 oz. silver ore. The only way in which a more definite statement could be made would be by a complete sampling of the drifts and raises on the sulphide vein. If Rodder's sampling is correct, 12 oz. ore could be produced from one half of the area of the vein.

TONNAGE ESTIMATES

The data at hand is not sufficient to warrant a calculation of ore "blocked out", but it will be useful to calculate the tonnage in the vein and to make certain assumptions regarding it.

The distance on the dip of the vein from the 15th to the 19th levels is about 500 ft. A block of the vein between these limits, taken 12 ft. wide, and 500 ft. along the drift, measures 214,000 tons; and if one third of this will make ore, it will produce 71,000 tons. This is from a block 500 x 500 x 12 ft. between the 15th and 19th levels. There should be an equal amount below the 1900 level, and half that amount above the 15th level or about 175,000 tons above and below the new work on the 19th level. The uncertain factor in this is the grade of ore that can be produced, and consequently the percentage of the vein that can be mined.

It has been stated previously that there is a very good chance that the vein will extend 2000 ft. to the east, past the face of the 19th level. If this be true the above figures of tonnage can be multiplied by five; again, the uncertainty is in the grade of ore, but since drifting to the east would be following below the Diablo ore body, there is a distinct possibility that better ore would be found.

175,000
5
875,000
Tons
14 oz
Silver
1/10th oz
Gold

ECONOMIC VALUE OF 12 and 14 OZ. SILVER ORE

Three factors that work against the profitable operation of the Northern Belle Mine are:

Low silver content of the ore

Low recovery made in milling

Low price for silver

The silver content of the ore cannot be changed but by selective mining a maximum grade can be secured, and there is a chance of finding better ore to the east.

The recovery of silver from the oxide ores was demonstrated to be about 60 or 65% by cyaniding. No report on tests of working the sulphide ore by flotation have been reported to me, except a statement that 90% recovery can be made. There is no obvious reason why a good recovery cannot be made on the sulphide ore by flotation, unless the presence of graphite in the ore would complicate the matter.

The low price of silver is too difficult to discuss. Unless some way can be found to avoid the law of supply and demand, and recent developments in metal markets have demonstrated the difficulties in doing this; the outlook for improved price of silver is poor. The best hope would appear to be in the eventual rehabilitation of the silver markets of India and China.

I think it can be taken for granted that the Argentum Mine cannot be worked at present price of silver, that is 35 cents per ounce. The following calculations are based on a hoped-for improvement in the price to 50 cents per ounce, on the hoped-for metal recovery of 90% by flotation, and on 12 and 14 ounce ore:

	Silver Content	
Gross silver content	12 oz.	14. oz
Value @ 50 ¢ silver	$6.00	$7.00
Add Gold value	1.20	1.40
	$7.20	$8.40
90% recovery in milling	6.48	7.56
Cost of mining, milling marketing and developing	6.00	6.00
Profit	$ 0.48	$1.56

With silver at the present price of 35 cents per oz. neither of these grades of ore would show a profit. If the price should improve to 50 cents per oz., there is a good chance that the mine could be operated profitably on 14 oz. ore. It is very doubtful whether a higher grade than this can be produced.

Assuming that further developments in the mine prove satisfactory, and that the price of silver rises to 50 cents per oz., the possibility is that the mine will produce 875,000 tons of 14. oz. ore from which a profit of $1.50 per ton may be made. It must be understood that this is not a statement of present ore reserves, but is a calculation of what can happen with sufficiently favorable developments. Favorable developments are clearly within the range of possibility, but an operator who might undertake the work would have to take his chance on them, as he would in developing any unproven mine. With silver at 50 cents per ounce or higher, the mine would warrant further development.

RECOMMENDATIONS FOR DEVELOPMENT

If it should ever be decided to make a further test of the possibilities of the mine, I would recommend driving the 17th level 1000 ft. or 2000 ft. farther east, the amount of work depending upon what might be found. Work on this level would avoid the 1900 fault, and unless unexpected complications were encountered, it would expose any higher grade ore that may exist to the east. A certain number of crosscuts would be necessary as the drift advanced; the locations for which would be suggested by developments as the work progressed.

ADVISABILITY OF RETAINING TITLE TO THE PROPERTY

I have been asked to pass on whether the owners will be justified in retaining title to the property, and in continuing the upkeep for an indefinite period, in the hope that the price of silver may improve to a point where the ore can be worked at a profit.

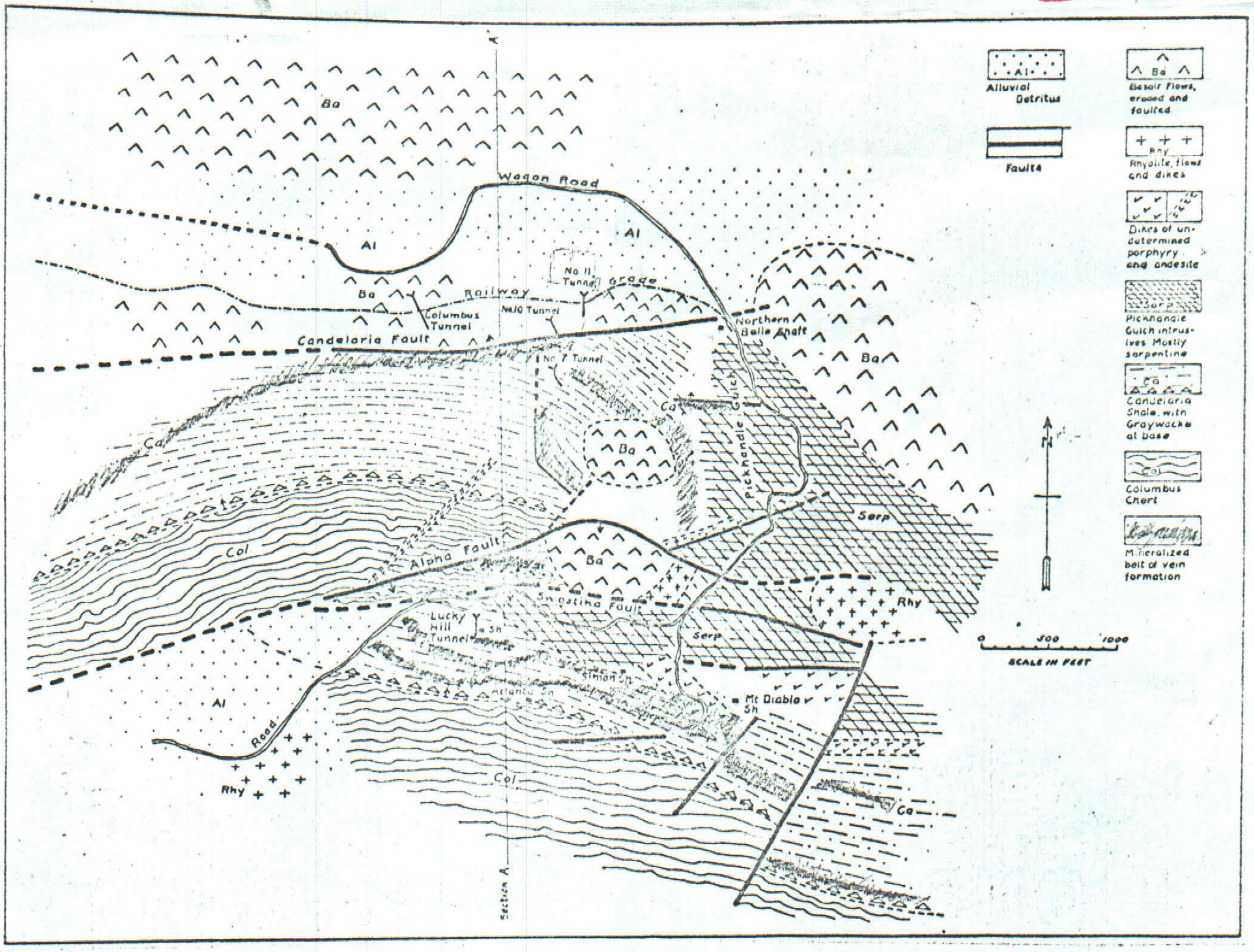
The chance to be taken in holding the property is principally a gamble on how the silver market will develop. I regard this as a gamble because I do not think anyone knows what will happen to silver. The outlook today seems very discouraging, and if there is an improvement in price it must be through some unexpected development. Often the unexpected happens.

I do not believe the owners would be justified in letting the property go for taxes at the present time, since it seems to have so much potential value. It will not cost a great deal to hold it for a few years longer, and during that time the outlook for the silver market will become better understood. We are too close to the recent drop in price to be able to appraise its permanency. However, I would not hesitate to drop the property in the course of say five years, if there should be no better prospect for silver than there is today.

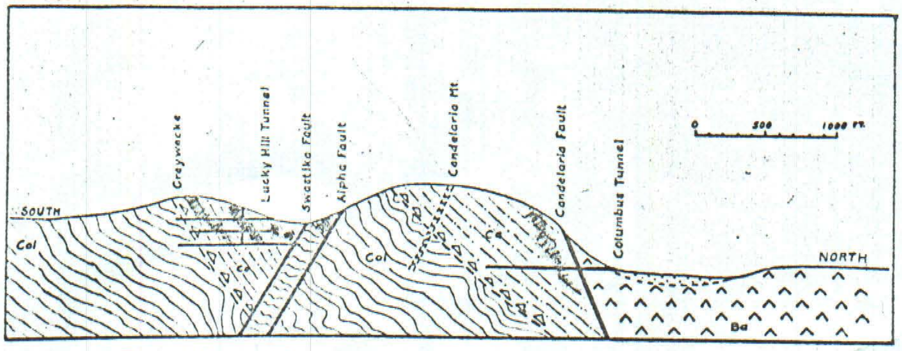
If there should be any important rise in the price of silver, the resulting enthusiasm would probably lead to an opportunity to sell the property.

I do not advise that any development work be done at this time, but if the price of silver should improve, the development work on the 17th level might be effective in helping the sale of the property.

John A Burgess

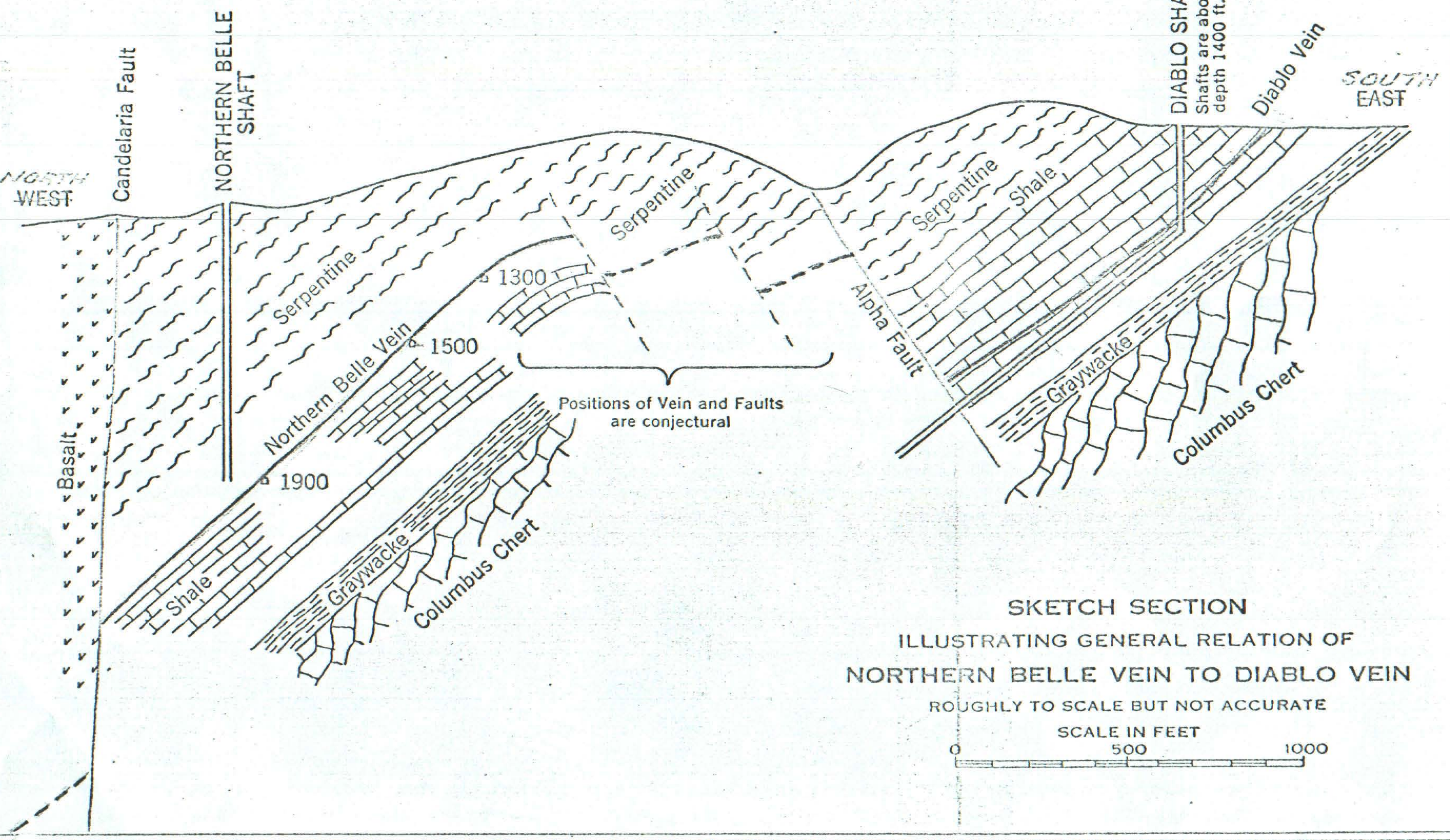


GEOLOGY AT CANDELARIA, NEVADA



Section through A-A Looking West

by John A. Burgess



SKETCH SECTION
ILLUSTRATING GENERAL RELATION OF
NORTHERN BELLE VEIN TO DIABLO VEIN
ROUGHLY TO SCALE BUT NOT ACCURATE

Argentum Mines
% F. W. Stake
Corey N.Y.

Report on the Geology of

T H E N O R T H E R N B E L L E M I N E

Candelaria, Nevada

-by-

John A. Burgess
643 Mills Building
San Francisco, California

July 20, 1922.

Preliminary Report on the

Geology of the Candelaria Mines

Candelaria, Nevada.

J. A. Burgess
648 Mills Building
San Francisco, California.

JOHN A. BURGESS
MINING ENGINEER AND GEOLOGIST
810 HILLS BUILDING
SAN FRANCISCO

August 1, 1921

Mr. C. D. Kaeding
Vice President & General Manager
Candelaria Mines Company
Candelaria, Via Mina
Nevada

Dear Sir:

I spent the period from June 25 to July 14, 1921, in studying the geology at your property at Candelaria, Nevada. The greater part of the time was occupied in detailed mapping of the Lucky Hill mine, and the balance in reconnaissance of the surface, and of the Argentum mine. My work as you know, is not finished, so that I cannot now give you a complete report on the property, but it has progressed far enough so that I can give you a fairly complete report on the underground geology of the Lucky Hill mine, and a provisional outline of the general geology of the camp.

The immediate requirement of information for mining purposes made it desirable

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The immediate requirement of information for mining purposes made it desirable to concentrate my first work on the Lucky Hill mine; otherwise it would have been a more logical method of procedure to map the surface and general structural features before proceeding to the detail of underground work. For this reason, additional work will be required to show definitely the relation of the Lucky Hill mine to the Argentum and Diablo mines. As hereafter stated, there is very good reason, at this stage of the work, for suggesting the probability that the Lucky Hill vein is the continuation of the Diablo vein, and that these two were once continuous with the Argentum vein; and that the separation has been caused by a throw on the Alpha fault with a horizontal component of something like 1800 feet. It is probable that the motion on the fault was more horizontal than downward. I shall, therefore, make this statement, as a working hypothesis, subject to revision if further study should prove it to be doubtful or incorrect. I think, however, that the probable existence of this situation is of sufficient importance to require its mention at this time.

GENERAL GEOLOGY:

The rocks of which the region is composed are sedimentary, metamorphic, and igneous. The sedimentary rocks consist of sandy, calcareous, and argillaceous shales; impure limestone; flinty chert in thin beds interleaved with partings of shale; and massive quartzite composed of coarse chert sand cemented into a flinty rock. The metamorphic rocks are serpentine, and silicified limestone. The igneous rocks are rhyolite, andesite, diabase, and basalt.

The general structure is that of a sedimentary formation, upturned so that the strata dip 45° - 60° to the north with an easterly strike, and eroded in pre-Tertiary times into mountainous relief. The basic intrusion, which by alteration resulted in the formation of the serpentine, was prior to the pre-Tertiary erosion. The age of the sedimentary formations is not definitely known but Mr. H. W. Turner, formerly of the U. S. Geological Survey, told me that fossils from that region had been determined as Carboniferous. The existence of a small area of rounded, waterworn, river boulders, on a hill between the Mt. Diablo and Lucky Hill mines, testifies to the former existence of a considerable stream at this elevation, the bed of which has been almost entirely removed by erosion.

In Tertiary time the country was subjected to intrusion and overflow by rhyolitic and basalt lavas. These probably once covered the greater part of the country in the vicinity of Candelaria, but subsequent erosion has left only patches and denuded volcanic necks of the rhyolite, and remnants of former extensive basalt flows. To the west and south of Candelaria large areas of the underlying sedimentaries are exposed. To the north, the surface is composed of an extensive tilted mesa of basalt. The top of Candelaria Mountain was probably never completely covered with basalt.

ORE FORMATION:

The orebodies were formed before the period of erosion that preceded the lava flows. They outcrop on the top of Candelaria Mountain but do not penetrate the basalt. The lode-system consists of shoots, lenses, and irregular bodies of ore. These are formed in a zone of silicified limestone and calcareous shale that lies above a footwall of bedded chert and chert-quartzite. The maximum thickness of this ore-bearing series, as far as determined, is in the neighborhood of 400 or 500 feet. In the Lucky Hill mine the orebodies take the form of two irregular veins known as the Baldwin vein and the Main vein, separated by a distance of about 200 feet. A somewhat similar situation exists on the 11th level of the Argentum mine, where a "front" and "back" line of orebodies are found, although with much irregularity and lack of continuity. A stope plan of this mine shows that there was a series of lenticular orebodies extending from the surface to the 19th level, and forming as a whole an ore-shoot with a distinct downward pitch to the southeast. The importance of the lode is attested by the U. S. Mint Report of 1883 (Burchard) in which it is stated that the Northern Belle (Argentum) mine had produced previous to that time $10,000,000, and had paid dividends of $5,000,000. The production for 1883 is reported as $764,000. The price of silver at that time was about $1.00 per ounce. Work under the earlier managements continued until 1893.

The Mt. Diablo mine was comparable in size and importance with the Argentum mine. The maps show that stoping was done on a strong series of orebodies which, as in the Argentum, formed a broad ore-shoot extending to about the same depth as that of the Argentum mine.

The Lucky Hill mine lies 1800 feet westerly from the Mt. Diablo shaft, and as far as has been determined, on the same lode. Between these two mines, the Simon mine, from which considerable ore was produced a few years ago, appears to be also on the same lode. The entire mineralized lode, including the Argentum, Lucky Hill, and Mt. Diablo veins, and eliminating the gap caused by the Alpha fault, is over 3800 feet long.

The ore consists principally of massive iron oxide with the value almost entirely in silver. The gold is usually less than $1.00 to the ton. It was formed by the oxidation of a primary argentiferous pyrite, accompanied by a small amount of copper minerals. There were probably also the sulphides of antimony and arsenic, and possibly of lead and zinc, in small proportion.

Although there was undoubtedly some secondary enrichment of outcropping orebodies, this could not have affected the lode as a whole. The lense-like distribution and isolation of numerous good orebodies show that their silver content was primary, and not caused by secondary enrichment. This fact encourages the search for the deeper orebodies wherever they may be found.

The primary ore was deposited as a replacement of impure limestone and calcareous shale, and to a large degree as a replacement of irregular pre-existing calcite veins. The presence of considerable calcite in most of the shales and other wall-rocks can readily be determined by the acid test. In the Lucky Hill mine, the calcite of the irregular veins can be recognized by its crystallization, although it is stained brown by limonite, and merges by gradual replacement into ore.

The gange of the ore is an intimate but variable mixture of quartz, calcite, limonite, and gothite (a hydrous iron oxide), with some manganese oxide. It varies from very hard, to soft and sooty. The ore and the walls are hard enough to stand well, and the old workings are rarely caved except in the neighborhood of serpentine rock or faults. The mines are dry and there is no standing water.

In the early history of the mines rich ore was produced. Shipments that assayed over $125 per ton are mentioned in the Raymond reports. At present writing, I have no record at hand of the grade of the general early production, but it must have been well over 30 ounces to the ton to overcome mining and milling costs. I understand that 24 ounce ore and higher was shipped from the Lucky Hill, Simon, and Mt. Diablo mines during the war. 1917-18

I have looked over the estimate of ore based on recent extensive sampling done by your Company, and can say that it is entirely reasonable. The sample-cuts in the mine show that careful work was done.

LUCKY HILL MINE:

This mine was opened by shallow workings from the surface, by an adit level, and by an inclined shaft on the Baldwin vein. Four levels have been driven approximately 100 feet apart. The extent of development work and the nature of the vein system is shown on the accompanying maps. The vertical section through A-A shows the disposition of the vein at depth.

The Baldwin vein extends to the 100-ft. level, but is not found on the 200-ft. level. The explanation of this is that the vein is cut off by the Gamma and Beta faults, which are parallel to the larger Alpha fault. The position of two faulted segments is suggested in Section A-A, and development work should be done in search of them. On the hillside just north of Pickhandle Gulch, a short distance below the Lucky Hill mine, there are several short tunnels, which I have not inspected, but which appear to be on vein material. Ore in this situation would probably represent blocks of "drag-ore" in the hanging-wall side of the Alpha fault. The intersection of the vein with the Alpha fault should get deeper toward the east.

The Main vein is found of good strength on the Adit Level, but it has not been developed on the 100-ft. level, except by driving the main south cross-cut through it. Where it is encountered by this cross-cut, the vein lies in the chert-quartzite and is not highly mineralized. It consists of irregular quartz veinlets, and silicified rock, stained brown with iron oxide. On the 200-ft. level, the vein is represented by only a 2-ft quartz vein, and streaks of iron oxides. The interruption of the vein between the Adit level and the 100-ft. level is probably due to the main fissure entering the flint-like chert-quartzite, which on account of its insoluble nature is highly unfavorable for ore deposition. The interruption may be only local and the ore should be looked for on the 100-ft. level farther to the east. The general pitch of the ore-shoots in the district is downward to the east.

This tendency of the ore to avoid the harder rocks, and to follow the softer and more soluble ones is well shown by the main vein on the Adit level, where its strands have followed an intricately curved and involved pattern. The Baldwin vein is more regular but it also has a tendency to split into branches. It is this characteristic of the veins that calls for an unusual amount of work in their development.

The ore in this mine is of the type common to the district, consisting mostly of massive limonite and gothite in a gangue of calcite and quartz, all stained a dark, blackish brown. The richer ore, mined for shipment by lessees, was taken from gloryholes and stopes, mostly above the Adit level. In the gloryholes the vein was 35 feet wide.

The country rocks are shown in Section A-A and will not here be discussed in detail. The silicified limestone shows, under the microscope, principally quartz and calcite, with disseminated pyrite crystals. Together with the softer and more calcareous shales, it formed the principal locus for ore deposition. All of the intrusive rocks are so decomposed that their accurate determination is impossible. The rock marked "rhyolite" at the entrance of the Adit tunnel shows rounded quartz phenocrysts, altered biotite and completely decomposed feldspars, but its original crystalline structure was so well developed that it may be a fine-grained grano-diorite. A fine-grained white kaolinic rock found commonly throughout the mine closely resembles an altered felsitic rhyolite, but specimens examined under the microscope show angular fragmental quartz grains, and it is therefore classed as shale. A rhyolite dike on the 200-ft. level shows quartz-phenocrysts, and is probably connected with a similar rhyolite on the surface west of the mine. The andesites in the dikes on the 200-ft. level are in a highly altered condition, and hardly recognizable.

Post-mineral faulting is not an important feature of the Lucky Hill mine, except as regards the Alpha, Beta, and Gamma faults. A great many small faults are found, as shown on the maps, but their movement has not been large. The vertical, or steeply inclined, open fissures that occur with some frequency, are shrinkage cracks, and have caused but little fault movement. There has undoubtedly been some movement on the numerous flatly inclined faults, but, in no instance that I have observed, does it seem to be over 20 or 30 feet, and usually is much less. These faults occurred prior to the oxidation of the ore, and in some places they acted as a dam to the downward migration of surface waters. In this way, they had the effect, locally, of stopping the secondary enrichment that took place in the upper parts of the vein. It is for this reason that the vein is sometimes of good grade above one of these faults and poorer below.

Because the Lucky Hill vein is cut off by the Alpha fault, its continuation below the fault should be sought for. The same conditions probably exist at the Simon mine. The old Argentum mine maps do not show any workings near the fault, and this leaves a very favorable area for further exploration.

CORRELATION OF THE ARGENTUM AND LUCKY HILL-DIABLO VEINS:

The reasons for suggesting the identity of these two veins are:

1. The presence of the Alpha fault is shown on the 200-ft. level of the Lucky Hill mine, at the surface north of the portal of the Adit tunnel, at the south end of the Argentum 600-ft. level. It should show in the Lower Holmes tunnel, but the tunnel is blocked by a cave outside of where the fault should be. However, an old map shows a strong fault in the position that the Alpha fault should occupy. There is also strong faulting in the general direction of the Alpha fault in the upper Holmes tunnel. The fault probably stops against the serpentine near the bottom of Pickhandle Gulch.

2. The occurrence of both veins in a belt of silicified limestone and soft shales, with bedded chert on or near the footwall.

3. The presence of serpentine on the hangingwall side of both veins, though not forming the immediate hangingwall. The serpentine is not found directly north of the Lucky Hill mine because of its having been cut off by the fault, but it is found a short distance to

the east. In the Argentum mine the portal of the No. 11 tunnel is in serpentine.

4. The general strike of both veins is not identical, but the difference is not sufficient to deny their correlation.

5. The dip, and general character of both veins is almost identical.

RECOMMENDATIONS FOR DEVELOPMENT:

Lucky Hill Mine

The haulage tunnel that is planned to enter the mine from the east, at a depth intermediate between the adit and the 160-ft. level, will give a good opportunity for developing the extension of the vein east of the present workings, and thus to test the theory that the ore-shoots have a flatly inclined pitch to the east. For this reason no work easterly from the present openings will be recommended.

Intermediate Level

Intermediate No. 1. Start a crosscut at the north end of 14. Drive north 30 west 15 feet and then turn north and crosscut under the east Gloryhole. The vein at this point should also be explored to the northeast. See recommendation S.1.

Intermediate No. 2. Continue Drift I 6 south-westerly on ore. The face now shows good ore. The last sample assayed 42 ounces silver.

Intermediate No. 3. At the south-westerly end of I 6 there is vein material pointing directly south. A few rounds should be driven on it.

Intermediate No. 4. Start a crosscut from I 2 where it is crossed by Section A-A. Drive south to shale contact.

Intermediate No. 5. Start a hangingwall cross-cut from I 1 at a point 5 feet west of I 1-1. Drive north about 25 feet.

Intermediate No. 6. Start a hangingwall cross-cut 15 feet east of I 1-3. Drive about 30 feet north.

Intermediate No. 7. Continue I 1-5 30 feet additional in its present direction. If the shallow open stope on the surface shows good ore, continue the cross-cut under the open stope, if any appreciable depth will be gained thereby.

Adit Level

A-1 Start a crosscut from the north end of the north-easterly drift on the Main vein east of the Adit. Drive north 35 west about 25 feet.

A-2. Start a hanging wall crosscut north 20 west 40 feet. See map.

A-3 Continue crosscut A3-9 to the south for 40 feet additional.

A-4. Connect A3-7S and A7-5 by a crosscut. If assay values in this part of the mine have been uniformly low, this work can be omitted, but there is a good probability of a strand of the vein passing between these crosscuts.

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Development to the east of present workings can best be done from the proposed haulage adit, and therefore no work in that direction is suggested on the adit level.

<u>100-ft. Level</u>

100-1 Clean out 1-1 north sufficiently to see whether fault Gamma was exposed. If the fault is shown, look for drag ore and assay it.

100-2. Drive 1-4 northerly 100 feet to look for segment of vein between Beta and Gamma faults.

100-3 Drift eastward on strongest part of vein shown in crosscut 1-1 about 100 feet from south end. The vein will probably swing to the north as progress is made.

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Exploration from the proposed haulage level will determine whether more work to the east on this level is advisable.

200-ft. level

200-1. If the vein is not found in crosscut 1-4, and if no drag is found on the fault, a raise should be driven on the hanging-wall side of the Beta fault, in the shale, but not in the andesite dike.

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No further work is recommended on this level at this time. The veins should extend deeper, frather to the east, and, later on, a drift in that direction, or another shaft may be advisable.

Surface

S-1 The former mining of good ore from gloryholes is highly suggestive of secondary enrichment near the surface, a common occurrence in silver bearing veins. I consider it worth while to hunt for other orebodies of this kind by means of trenches on the surface, very imp.

across the direction of the veins. The first of these trenches should be centered at the East Gloryhole, and the others should be spaced at 100 foot intervals to the west for 400 feet. It may also be desirable to have a trench east of the East Gloryhole.

GENERAL POSSIBILITIES:

Aside from ore now developed, and from small blocks throughout the old workings, I believe that the district offers excellent opportunities for opening entirely new orebodies. The ground to the north and northwest of the Northern Belle mine has big possibilities, if the geological situation is what my preliminary work indicates. The Simon mine also may be of importance and worth acquiring. This possibility is suggested by its position with reference to the Lucky Hill and Mt. Diablo mines and to the Alpha fault. I did not go down the mine.

Respectfully submitted,

JOHN A. BURGESS

SUMMARY OF REPORT ON CANDELARIA MINES COMPANY

CANDELARIA, NEVADA

The camp of Candelaria made a large production of silver in the '70s and '80s. The principal mines were the Argentum (formerly the Northern Belle) and the Mt. Diablo, which together produced in the neighborhood of $30,000,000 insilver.

The ore consists of limonite carrying silver, formed by the oxidation of pyrite. It was deposited by replacement, in calcareous strata of sedimentary rock. The orebodies, as shown by old stopes, were in the form of shoots, lenses, and irregular bodies, which, taken togehter in each mine, formed large ore-shoots dipping at 45° to the north and northeast. The principal developed ore-reserves are in the Lucky Hill mine mostly above the Adit level. These have been estimated by your engineers at   tons of   ounce silver ore. The estimate seems reasonable. The Lucky Hill vein is cut off by several small faults (Beta and Gamma) and one large main fault (Alpha). Between these three faults there should be two large segments of the vein which can be found by crosscutting from the Lucky Hill workings.

The Alpha fault separates the Lucky Hill mine from the Argentum mine by a distance of 1800 feet. The old Argentum workings do not extend to the fault on the lower levels, and have left unexplored a large area of ground favorable for development. The downward extension of the Lucky Hill and Simon mines should be looked for below the fault.

The extension of the vein system, or the existence of another large ore-shoot, is possible north of the Argentum workings. This is a very attractive possibility and the geology of that part of the mine should be carefully studied. It may be advisable to secure an option on more ground in that direction, and possibly some open ground exists that can be located.

I did not investigate the Simon mine, but it has produced good ore, and its position suggests that it may have an important downward extension. It should be acquired by your Company if further investigation shows it to be desirable.

Ore of considerable importance has been found by sampling in the Argentum and Mt. Diablo mines. It consists of ore that was of too low grade to work by the old-time processes.

July 24, 1922.

Mr. C. D. Kaeding, General Manager,
Candelaria Mines Company,
648 Mills Building,
San Francisco, California

Dear Sir:

Geological Report

I hand you herewith a report on the general geology of the Candelaria district, and a brief advance report on the Northern Belle mine. The completion of my field work in the mine will be delayed until the transit survey of the workings is finished, which will probably be within three or four weeks. I shall then proceed to finish my work and to prepare a complete report. The work, as far as it has progressed, has covered all levels below the 9th, with the exception of the 12th level.

In the report now submitted, you will note that the description of the veins is brief and general. The reason for this is that the unfinished work will have a bearing on this subject, and I prefer not to write on it until I have all the data in hand. At the same time, my work below the 9th level is sufficiently advanced, so that I can now outline a good deal of development work, and express an opinion as to probable results.

I am submitting this advance report to meet your immediate requirements for an outline of the general geological situation, and for advice regarding early mining operations. The principal information that you require is embodied in the geological maps that I am turning over to you, and to which this written report is supplementary. I expect to give you a complete report in about two months.

Very truly yours,

John A. Burgess.

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SUMMARY OF GEOLOGICAL HISTORY

The formation at Candelaria consists of both sedimentary and igneous rocks. The sedimentary rocks are the oldest. They were intruded by dikes of various igneous rocks, and were finally covered with surface flows of Tertiary rhyolite and basalt.

The geological history is complex. The earliest rock, the Columbus chert, of Ordovician age, was formed under deep sea conditions. It was then elevated above sea level and in that position underwent erosion. It was again depressed below sea level and the next formation, the Candelaria shales, of Triassic age, were deposited. Subsequent ot this, an uplift occurred, which resulted in the formation of a huge east-west anticline, of which the Candelaria mountain forms part of the north limb. No search was made for the south limb by the writer but from a distance, the rock starta of Miller mountain can be seen dipping to the south some six miles away, and possibly if ofms the southern slope. Erosion has carved out the center of the anticline leaving the upturned edges exposed. Before erosion was completed, an intrusive mass of basic rock, that has since altered to serpentine, was injected into the Candelaria shales; and this was followed by the intrusion of granodiorite and andesite. Narrow dikes of andesite prophyry were injected along the position now occupied by the veins.

The deposition of the veins near the base of the shale formation was the next event. At this tage, erosion had not proceeded to its present extent, but was in progress. Faulting, of considerable movement, followed the deposition of the veins; and after further erosion, outpourings of rhyolite, followed by basalt, covered the surface with cappings of these rocks. Later faulting and erosion brought the surface to its present condition.

SEDIMENTARY FORMATIONS

Columbus Chert

This is the oldest formation exposed in the district. It consists of strata of white or black flinty chert, one to three inches thick, usually with a thin parting of softer material between the strata. The individual strata have a knotted or lumpy appearance. The general strike is easterly, with a dip of 45 to 65 degrees to the north; but in many places the strata are bent and intricately contorted, and generally they show signs of having been subjected to great pressure. The thickness of the formation is to be measured in thousands of feet; not less than half a mile and probably a good deal more. It extends from about 500 yards south of the Mt. Diablo mine to the edge of the Columbus Marsh valley. The chert has been traced west to the R. R. station of Basalt and east to the old town of Columbus. To the south, it is found at Emigrant Gap at the entrance to Fish Lake Valley.

The formation contains a few small interbedded strata of limestone, one of which can be seen south of the Potosi Mine; and it is intruded by andesite dikes. It is not, so far as known, an ore bearing formation. Mr. Henry G. Ferguson, of the U.S.G.S. informed the writer verbally, that his recent investigation of fossils from this formation fixes its age as Ordovician.

Candelaria Shale

The Candelaria shale formation is also sedimentary. Although it rests on the Columbus chert and has the same general strike and steep dip to the north, nevertheless, there is an unconformity between the two. The unconformity is well shown on the hillside a few hundred yards east of the Potosi mine, where the chert strata approach the contact at an angle and end there; or in other places in the same locality where the chert strata are highly contorted, in contrast to the flat undisturbed shale beds of the overlying formation. Ferguson states that this formation is Triassic and that the unconformity between the Columbus and the Candelaria formations represents the upper Paleozoic. During the upper Paleozoic era, thereofre, the Columbus formation was a dry land area in a state of erosion.

The lowest member of the Candelaria formation is a bed of greywacke ten to fifty feet thick. It lies directly on the cherts, and consists of a coarse sand of chert particles, with a subordinate amount of rounded quartz grains, and an occasional fragment of other rock; all cemented by silica into an exceedingly hard, massive rock. The chert fragments are angular, and run 1/10 to 1/8 inch in size. The grain is very uniform, but in some places inclusions of larger chert fragments an inch or two in diameter, or an agglomerate of large angular chert fragments, occurs within the graywacke at its base. This can be seen a short distance east of the Potosi mine. This stratum was simply a coarse sand formed near the shor of a land surface composed of the Columbus cherts. It is made up of chert particles eroded from what was then the nearby land. The bed has been traced for a distance of 4 or 5 miles, but it is doubtless far more extensive. Two thin strata of this type of rock 18 inches wide, occur interbedded with the later shales. They can be seen near the face of the Columbus tunnel, and on the 11th level in cross-cut 1101, 50 feet south of cross-cut 1125.

Resting conformably on the graywacke, but with a sharp separating surface, are beds of red, black, or gray sandy shale, some 20 feet thigh. They are flat, and fissile, cleaving readily into thin slabs in some places. The material composing them is principally a fine sand, the separate particles only distinguishable under the microscope, or a high power hand lens.

These shales give way rather quickly, but still with some gradation, into the next high member, the striped shale, a fine black or grey sandy shale of denser consistency, but with well defined diffility on the bedding planes. The microscope shows a sandy shale not so much metamorphosed as the other sediments and made up of small rounded quartz grains in a matrix of clay, with some mica and secondary sericite. The thickness is not uniform, but may be from 100 to 300 feet. In the lower part of these shales, there are peculiar spherical or flattened spheroidal bodies, 1/2 inch to 1 inch in diameter, which are thought to be of concretionary origin, although they strongly suggest fossils. Some of them are solid black chert, and some are of a softer, light-colored material, occasionally of concentric structure. Much of this shale is marked by thin bands or stripes of lighter color than the body of the rock, and almost unrecognizable metamorphic forms occur. In the Northern Belle mine, particularly on the 13th level, there is a large area of black dense rock, shattered into small fragments by a network of fine cracks, which have been recemented by dolomite; and the rock is, in places, largely replaced by the same mineral. Fine grained cubes of pyrite are liberally disseminated through the mass. The bedding planes have been destroyed, except in an occasional spot where stratification, and in one instance, a spherical concretion, give a clue to its identity. The shattering is thought to have been caused by the oxidation of a pyritiferous phase of the rock. A similar fissuring is seen in the west drifts on the 13th and 10th levels, where the black pyrite-bearing shale has slacked like coal and has lost its original structure. The resulting fine network of fissures is similar to that in the black metamorphic shale, except that they are uncemented.

Another rock of puzzling character is thought to be a metamorphic form of the shale. It has no stratification, is hard, and light in color, but is clearly of crystalline structure. Under the microscope it is seen to consist principally of an aggregate of crystalline quartz and dolomite. The quartz is probably to a great extent a re-crystallization of the original detrital silica of the shale. Neither its appearance to the naked eye, nor under the microscope, give any clew as to its origin, but is is ascribed to the shale because of its position with reference to the other rocks. It is usually found within the influence of intense vein formation. This is the rock that was called "silicified limestone" in the Lucky Hill report. At the Lucky Hill mine on the adit level, this rock occupies the area between the Main vein and the Baldwin vein. It is found in considerable quantity from the 11th to the 14th levels of the Northern Belle mine, but is is less common at greater depth, and none is found on the 1500 or lower levels. When examining the limited area of Lucky Hill, it seemed reasonable to regard the rock as silicified limestone; but although limestone is found in narrow strata, interbedded with the shale, there are no beds large enough to account for this occurrence; and as observations were extended laterally and in depth, it was seen that there is no large body of limestone in this position. It was, therefore, necessary to revise its classification.

The well bedded shales give way gradually to more massive, non-fissile, types in which bedding although present is inconspicuous, and in which there is usually no parting along bedding planes. The fracture generally forms plane surfaces, but not parallel to the bedding. The best exposure of these rocks, unaffected by weathering, is in the Columbus tunnel. The tunnel, 900 ft. long, crosses the bedding and shows the following column of rocks, omitting veins and intrusive andesite dikes. The face of the tunnel is probably not far from the bottom of the Candelaria formation.

Portal of Tunnel

Basalt (Youngest rock exposed)

(Candelaria Fault)

Exceedingly fine-grained, light colored, non-fissile sediment; 150 ft.

Fine-grained, non-fissile sandstone; 200 ft.

White, fine-grained, non-fissile shale; 50 ft.

Bedded shale, including 18-inch interbed of graywacke; 100 ft. (oldest rock)

Face of Tunnel

Taking these rocks in order from face to portal of the tunnel, the 100 ft. of gray, bedded shale is well marked by thin white bands, and by cleavage along the bedding planes. The 50 ft. of white shale is fine grained and gritty. The bedding planes are faintly marked but are not planes of fracture. The 100 ft. of sandstone is hard, gray, and fine-grained, but the sand grains can be distinguished by a high power hand lens. At 615 ft. from the portal, this sandstone contains numerous fossils consisting of broken fragments of small shells. White crescent-shaped forms, and black fluted surfaces are distinguishable. Small black spots and black streaks of fragmental shape are thought to be of organic origin.

The exceedingly fine-grained, light-colored sediment that follows for 150 ft. is sandy shale. Under the microscope, specimens of similar rock from the 11th level of the Northern Belle mine showed sandy shale more or less metamorphosed, containing quartz particles, kaolin, and secondary sericite. The color of the rock runs from white to gray, often with a pale green cast. Its texture may be as fine as that of the broken surface of porcelain, which in fact, some phases of the rock closely resemble. It usually fractures with smooth flat surfaces, not parallel to the bedding planes. Little cavities, cubical or irregular in form, mark the position of leached pyrite crystals, which in other specimens are found unaltered. Jarosite in small amount is of common occurrence. Considerable secondary sericite also occurs in the rock, which is frequently much metamorphosed. The rock is exposed for over 300 ft. in thickness in the Columbus Tunnel to where it is cut off by the Candelaria Fault; and at the Potosi mine and east of the Diablo mine it shows a still greater thickness, but its full width is not known.

At 300 ft. from the portal of the tunnel, the shale formation is cut by the Candelaria Fault and thrown downward on the north side for an unknown distance. The amount of displacement is known to be at least 300 ft. plus the unknown thickness of the basalt at the tunnel entrance.

Mr. Adolph Knopf, U.S.G.S. Bul. No. 735, designated the Candelaria shales as argillite. The term implies a rock composed essentially of argillaceous material, or clay. Of the rock under consideration, some parts are almost entirely composed of sand; other parts, the striped shale for example, are made up of sand and clay; and the finest grained shale, although it is too fine to be resolved under the microscope and probably contains much clay, is known to contain a considerable proportion of fine siliceous grit. It is because of its being composed of sand and clay, which are the ingredientsof ordinary shale, and because its lower parts have the bedded shale structure that the term shale is here used for this formation as a whole. However, the term argillite is retained as a convenient term to designate the very fine grained, non-fissile, upper portions of the shale formation.

Knopf regards much of this fine grained shale as being of igneous origin, and calls it felsite. He mentions the felsite as being 500 ft. thick at the Lucky Hill mine. The rocks in the Lucky Hill mine belong to the same geological horizon as those of the Columbus tunnel, and, as previously stated, there is good reason to believe that the latter are sedimentary. An examination of the rock in the corresponding geological horizon about one mile east of the Diablo mine, where it is more free from the influence of large intrusive bodies, and of vein forming solutions, leaves no doubt of its origin. It is there seen to be a typical fine-grained shale of uniform character through a thickness of hundreds of feet. Knopf describes a felsitic rock on the ridge east of the Diablo mine that resembles a white chert, but shows a few exceedingly inconspicuous feldspars. This rock, if the writer identifies its location correctly, is a higly altered form of the Diablo andesite, and can be traced into unquestionable andesite. No rock was found in the locality described that, after being followed through its various alteration phases, cast any doubt on the sedimentary character of the fine-grained rocks.

No later types of the Candelaria shale have been observed in place wit in the area examined, their exposure being prevented by covering of detritus and lava flows. There are, however, in Pickhandle Gulch, large masses of black quartzite included in the serpentine, which do not belong to any of the formations exposed in the district. One of these can be seen just northeast of the sharp bend in the road below the Holmes lower tunnel. It is a typical dense black quartzite, though to have been floated into this position by the serpentine intrusion. The rock can also be seen on the 13th level in the cross-cut to the Belle shaft.

The Candelaria shale formation is exposed for a considerable width on the road leading north from the Sheep Corral to the railroad. It here shows the greywacke resting unconformably on the Columbus chert; and above this several hundred feet of dense, fine, brown, sandstone. In this position the shale has changed in character. It still shows the bedding, and occasional spherical concretions, but it has become more sandy and more uniform in character through a greater thickness. The formation is downthrown to the north by the Candelaria fault, and has not been found north of the fault in the Candelaria district because of being covered by later lava flows.

PICKHANDLE GULCH INTRUSIVE ROCKS

Serpentine

Under this heading are grouped a series of intrusive igneous rocks all of which can be seen along Pickhandle Gulch. The oldest and by far the most voluminous is the Pickhandle Serpentine, which occurs in great masses along the gulch. It is also found on the 11th level of the Northern Belle mine, and on the 13th, 15th and 17th levels in the cross-cuts leading to the Belle shaft, and there is a patch of it on the surface on the north side of Candelaria mountain above the Columbus tunnel. It varies from a pure serpentine rock, to one in which there is comparatively little serpentine. This variation in type suggests that more than one kind of serpentine-forming rock was present, but no special investigation of the origin of the rock was undertaken. Large bodies of sedimentary rocks are included in the serpentine. These are well exposed in Pickhandle Gulch.

Granodiorite porphyry

This is the rock called quartz monzonite in Knopf's Bulletin. In monzonite the plagioclase and orthoclase feldspars are in equal proportion, but in the specimen examined orthoclase predominates, and its designation as granodiorite is based on this difference, which, however, is too slight to be a matter of importance. The rock is found sparingly in Pickhandle Gulch and in the mines. It is exposed on the 11th level of the Northern Belle. Further study may identify it with bodies of altered rock not now classified.

Andesite

Andesite, always in the form of intrusive dikes, occurs plentifully throughout the mines. It is particularly common around the Diablo mine where large dikes of it are visible on the surface, and it is also seen throughout the Northern Belle mine. It is invariably altered. In the freshest specimens, remnants of biotite and plagioclase feldspars can be identified, but usually the altered feldspars are detected only by their outline, and the ferro-magnesian minerals are entirely destroyed. In some places alteration has destroyed even the outline of the feldspars, making the rock very difficult to recognize. There are undoubtedly several kinds of andesite represented in the district, but no attempt has been made to map them separately, because of their extreme alteration.

There is an altered rock of uncertain species that occurs persistently through the mine, though not in important amounts. It is of igneous character, but no specimen sufficiently fresh for accurate determination was secured. Its constant association with the andesite and the difficulty in distinguishing the two in their altered forms led to its being mapped with the andesite.

Porphyry Dike

Another altered dike-rock is found most frequently as an intrusive along or near the vein fissures. It is now, in its altered form, chiefly quartz and sericite, in fine silky texture. Its color is usually white. It may have been a form of the granodiorite, but the specimen taken on the 11th level was too much altered for definite determination under the microscope, and it is, therefore, mapped simply as a "porphyry dike".

TERTIARY LAVA FLOWS

The Tertiary lava flows are represented on Candelaria mountain only by remnants that have escaped erosion, but they cover large areas north of the Candelaria fault and south of the Alpha fault. Only brief mention will be made of these rocks because of their unimportance as concerns the mining situation. Knopf has described them in some detail in his bulletin.

Rhyolite

A light-colored rhyolite, well sprinkled with fine, black biotite, can be seen in Pickhandle Gulch at an old tunnel 500 ft. west of the Bi-Metallic shaft and along the tramway cut, 500 ft. east of the old Bi-Metallic office. It is underlaid with tuff, and, with the tuff, it forms a capping over the underlying shale. Other types of rhyolite are found on the surface and in small amounts in the mines, but they are not of sufficient importance for further description.

<u>Basalt</u>

Above the rhyolite, there was an extensive basalt flow. Erosion has removed an unknown thickness, leaving only remnants 50 to 100 ft. thick in isolated patches on Candelaria mountain. North of Candelaria fault, there is a large area of basalt that has been protected from erosion by its low relative elevation.

The basalt that is seen in spots on the 10th and 11th levels of the Northern Belle mine are parts of this flow, that are found where the workings break through the pre- Tertiary surface of the shale. A specimen from the 11th level was determined to be olivine basalt.

FAULTS

<u>Candelaria Fault</u>

The Candelaria fault strikes approximately east, and dips 45° - 75° north. It can be seen in the Columbus tunnel 500 ft. from the portal, where it has a strong wide gouge; and its scarp is plainly seen along the north side of Candelaria mountain. It cuts the No. 10 and 11 tunnels, and its strike would take it a short distance north of the Northern Belle shaft. The fault is normal, and the downthrow on its north side has let the basalt capping down opposite the shale. It was the action of this fault that determined the position of the valley that runs westward through the town of Candelaria.

along the railroad, and easterly toward the Soda Lake Valley at Rodlick. The extent of the movement is not known, but it is probably not less than 1000 ft.

Alpha fault

The Alpha fault is best exposed in the bottom level of the Lucky Hill mine, and on the surface in the gulch, opposite the Lucky Hill tunnel, that leads northward up the side of Candelaria mountain. The fault at this point is about 1000 ft. south of the Candelaria fault. Its strike is a little south of west, sothat on its westward course it diverges from the Candelaria fault. The dip is 80° south and the throw was normal, downward to the south. The amount of movement was 1200 ft. as measured by the displacement of the graywacke bed. There is no direct evidence to show that there was any horizontal component of the movement along the fault and it must, therefore, be regarded simply as a normal post mineral fault.

The action of the Alpha fault and the Candelaria fault, with their great movements and opposite dips, formed the broad wedge of chert and shale that now comprises Candelaria mountain. The Alpha fault intersected the Northern Belle vein-system and threw it downward and to the south, so that the Lucky Hill-Diablo vein system is the faulted continuation of the Northern Belle vein-system. The Alpha fault is consequently post-mineral in age.

The scarp of this fault is evident along the

the mouth of the tunnels

south side of Candelaria mountain. The fault cuts through Diablo mountain near the Princess shaft and just north of the sharp rhyolite peak, and it extends westward along the south side of Candelaria mountain, thus forming the little valley through which the pipe line runs.

Almost the entire movement on the fault occurred before the eruption of the rhyolite and basalt cappings, though there was a small subsequent throw of less than 100 ft. This is shown by the basalt capping on the shoulder of Candelaria mountain, above the Bi-Metallic office, which lies over the fault but is thrown only a short distance by it. The Alpha fault is thus shown to be older than the Candelaria fault.

Amastilla Fault

This fault is seen at the mouth of the tunnels on the Amastilla No. 1 claim, just north of the road. It passes easterly near the Bi-Metallic shaft and east just south of the rhyolite peak. Its dip varies from 60° south to vertical. It is one of the lesser faults supplementary to the Alpha fault, and its throw was in the same direction but of less extent.

Belle Fault

This is a steep, east-striking fault that is seen throughout the Northern Belle mine from the 10th level to the 13th level. It was formed by the same forces that caused the Candelaria fault, with which it is parallel in strike and dip. The movement was normal and not large, probably not more than 100 ft. Its intersection with the ore bodies will be described under a later heading.

MINERAL VEINS.

The productive orebodies of the Candelaria district occur in the Candelaria shale, most of them near its lower border. This is the case at the Potosi, Northern Belle, Lucky Hill, and Diablo mines, and in other prospects farther to the east.

The vein system consists of a zone of fissuring 100 ft. to 150 ft. wide, with a general east-west strike, and roughly parallel to the bedding of the shale. The main productive zone extends through the Northern Belle mines and then, south of its interruption by the Alpha fault, it continues eastward through the Lucky Hill mine and the Diablo mine. While the main zone is long and continuous, the fissures within it, as exemplified, in the Northern Belle mine, were less continuous. They were rather in the nature of an overlapping, more or less parallel, system of sheeting, and frequently their disposition was across the zone or at random. This resulted in the formation of parallel, overlapping orebodies in cross-section; and sometimes, as in parts of the Yankee stope, in streaks of ore in a complex system of fractures.

In the Northern Belle mine, the shale strata and the vein system have a southeasterly strike, and dip about 45° northeast. This variation from the general easterly strike of the shale formation is due to local disturbance caused primarily by the injection of the Pickhandle Gulch intrusives.

The most productive mines are in the vicinity of the large intrusive masses of igneous rock which are undoubtedly connected with the origin of the orebodies. Some veins are found in the serpentines, but they have not proved profitable to work.

Within the vein-system, channels were opened that permitted the circulation of mineralizing solutions. The effect of these was to replace much of the shale with dolomite, and eventually to deposit large bodies of silver-bearing sulphide ore. Dolomite not only forms the gangue of much of the ore, but also is found replacing the wall-rocks throughout considerable widths; as for example, at the Lucky Hill mine, where the shale, between the Main vein and the Baldwin vein, a distance of 200 ft., is so completely altered to quartz and dolomite that there is no internal evidence of its original character. It is thought that most of this dolomitization occurred before the deposition of the ore, and that the ore was deposited largely as a replacement of the dolomite veins.

The primary ore consisted principally of iron sulphide, with minor amounts of the sulphides of lead, copper and zinc. The form in which silver originally existed is uncertain, but it was probably a constituent of the baser sulphides. Knopf identified jamesonite in remnants of unoxidized ore. Silver formed a far less percentage of the total weight of the primary ore than its [illegible] of the oxidized ore, the difference being due to the oxidation of the sulphides and to the removal by leaching of many of its base constituents.

The principal orebodies are from 10 to 20 ft. wide, and stopes of these widths are common. Narrow veins also occur, but the bulk of the ore came from wide veins. Within the wider veins, there appear to have been streaks and bunches of the high-grade ore that was required by early-day operations, and mining was directed toward recovering these streaks, leaving the intervening lower grade ore in the stope as filling. It is this rejected ore, of 10 or 15 oz. silver content, that will furnish a very considerable tonnage for the new mill.

In its present condition, the ore consists of the thoroughly oxidized residue of the original sulphide minerals. Limonite, oxides of manganese, dolomite, and a minor amount of quartz from the bulk of the ore. No silver minerals such as the sulphides or horn-silver can be [illegible] by the naked eye in the oxidized ore, even in that assaying 75 oz. per ton. The silver content appears to be finely divided and probably is combined with other minerals in an unknown form. Knopf recognized bindheimite in the oxidized ore.

The primary ore consisted principally of iron sulphide with minor amounts of the sulphides and probably antimonides of lead, copper, and zinc. Silver formed a far less percentage of the primary ore than of the oxidized ore, the difference being due to the oxidation of the sulphides, and to the removal by leaching of base constituents.

Samples of the oxidized ore were sent to the Intermountain Station of the U. S. Bureau of Mines for microscopic examination, and were reported on as follows by R. E. Head, Mineralogist.

Whether secondary enrichment was of importance in forming the oreshoots is a point not yet determined.

The ore is completely oxidized in the upper levels, but while oxidation extends to the bottom of the mine, remnants of low-grade sulphide ore are plentiful on the 18th, 19th and 20th levels. Some stoping was done on the oxidized ore of these lower levels, but the sulphide ore appears to have been unprofitable. There are exposures of ore above the 18th level, from which ore of 18 oz., or better, average grade, can be produced by lessees, and in some instances by company work. I have inspected these exposures with a sample record in hand, and feel quite satisfied that a very considerable tonnage of profitable ore can be taken from the ground within the range of the old workings. The most favorable areas for high-grade ore are in the Yankee stopes below the 11th level, and in the various workings of the 14th level. In these workings, there are exposures of ore twelve inches to eighteen inches wide, which range in assay value from 20 to 50 oz. silver, and there are also good chances on the other levels. Naturally prospecting has been most intensive in the most easily accessible places, and it is on the less accessible levels, and in the old stopes, where the most favorable points of attack will be found.

DEVELOPMENT PLANS; NORTHERN BELLE MINE

These plans are confined to the levels that have been studied to date; namely, from the 10th to the 20th levels, inclusive, with the exception of the 18th level. The most favorable ground for immediate work is from the 15th level upward. Below the 15th level, comparatively small amounts of ore were found by the early operators, and the prospect of finding profitable ore is less favorable for the immediate future. However, it must be recognized that the Candelaria veins are of a deep seated type, entirely different from the comparatively shallow-seated veins so common in the Tertiary lavas of Nevada, and they may be expected to continue to a great depth. It is practically certain that the continuation of the veins could be found north of the Candelaria fault; but the depth at which it might be necessary to work, the unknown character of the

"GREY DAWN"

ore as regards oxidation and value, and the expense of finding them, makes it inadvisable to do anything in this direction now. However, while results of mining below the 15th level were not encouraging, there is still a possibility that profitable ore exists at a greater depth.

It is noticeable that no orebodies of first importance have been found north of the Bello fault, and that practically no exploratory work was done on the vein system in this direction above the 15th level. There are, however, some indications that point to the possibility of ore in this area. They are: The existence of three small stopes in D 1505 on the 15th level, in which there was evidently some workable ore; the presence north of the fault on the 14th level of 14, 18 and 22 oz. ore as shown by samples in X-C 1404 and D 1405; the existence of a fairly strong vein in the Mule Stable drift on the 13th level, from which specimens from a streak a few inches wide assayed 7.60 oz. silver. These data, together with the known tendency of the ore to be richer in the upper levels will justify further exploration of the vein north of the Bello fault, on the 13th and 14th levels, and work for this purpose will be advised. The old surface outcrop of this part of the vein, where it is now covered by basalt, is at the 11th level.

[illegible]

10th LEVEL:

1000 - 1

In D 1003, there is ore on the east side, 20 ft. south of station D 7, that assays 5.77 oz. silver. It is uncertain whether it is on a vein in the hanging wall of D 1003, or in the footwall of the Yankee vein. It is near enough to good stopes, and of sufficiently good appearance to justify development. Drive a short drift on it. See Rec. 4 - 1200.

1000 - 2

The Yankee drift should be extended 100 ft. southeast from station 10.06.

1000 - 3

Drive cross cuts into foot and hanging walls from Yankee drift at station 10.04.

1000 - 4

Drive cross-cut S 70W from face of 1009.

1000 - 5

Cross-cut N85W from station 10.03.

1000 - 6

At station U1 drive X-C southwest 25 ft.

1000 - 7

Continue D 1003 to west 100 ft. The face is filled and total extent unknown.

1000 - 8

From face of 15 ft. drift at station E 1 in 1003, drive N 70 W 65 ft.

10th LEVEL:

1000 - 9

From point P. 11 drive N 70 E 100 ft.

1000 - 10

At east face of D 1001, 60 ft. east of station D 17, drive cross-cut south 50 ft.

1000 - 11

Continue D 1001 easterly 200 ft.

11th LEVEL:

1100 - 1

In stub south of station 11.26, (in D 1101) drift easterly on vein.

1100 - 2

In drift south from 1101 at station 11.27, clean out fill and drift on vein.

1100 - 3

Drift southeasterly on vein that goes into foot-wall from stub 30 ft. east of station 11.28.

1100 - 4

Drift easterly from station K 11 at junction of 11-1 and 1112.

1100 - 5

Cross-cut south from station N 5, 100 ft. (about 100 ft. from face of D 1002)

1100 - 6

Continue D 1102 southeasterly on vein from N 9.

11th LEVEL:
1100 - 7

Cross-cut N 40 E from station N 10 in D 1100.

1100 - 8

Cross-cut N 30 E from station L 6 at face of X-C 1114. This X-C is of secondary importance.

12th LEVEL:
1200 - 1

Extend D 1202 northwesterly, west of station D 15. There should be a vein at the contact of the andesitic rock and the shale north of the Belle fault, and the drift should follow the vein that shows in the present face. A cross-cut from the north face of D 1200 would prove this point, but 1202 is easier of access and will have the advantage of exploring the vein as it progresses. Vein material in the face of 1202 assays 4 oz. silver.

1200 - 2

Resume work to the northwest in the face of the drift from 1201 known as the Mule Stable. Turn sufficiently to the right to get on the vein and drift to the northwest following the vein. A selected sample from this vein near station D 20 assayed 7.62 oz. These two drifts will explore the main vein zone north of the Belle fault.

1200 - 3

Start a cross-cut at the southeast end of drift 1200 and drive S 35° W 150 ft.

1200 - 4

Start a cross-cut at the southeast end of X-C

1503 and drive S 50 W for about 100 ft., keeping on the northwest side of the 50° fault. The cross-cut was driven some distance in this direction but the face is now filled.

1500 - 5

Start a hanging wall X-C from D 1500 100 ft. southeast of X-C 1501, and drive 100 ft. N. 50 E.

1500 - 6

Continue X-C 1511 65 ft. farther to the northeast. The face is now filled.

1500 - 7

20 ft. southeast of station 15.17, in D 1500, a short drift starts to the north and then bends southeast. The face gives assays of 14.0 and 23.0 oz. and work to the southeast should be resumed.

1500 - 8

Resume work in the face of X-C 1502 and drive N 40 E 100 ft.

1500 - 9

Resume work in the east face of D 1500. Drive east 70 ft. and then cross-cut north 120 ft. and south 50 ft.

14th LEVEL:

There are excellent opportunities for successful development on this level, but complete recommendations will be deferred until the 15th level has been examined.

1400 - 1

At the west end of 1405 drift on mineralized belt

N 40 W.

1400 - 2

Resume drifting to the west from face of drift that extends 33 ft. west from station 14.46.

1400 - 3

Resume drifting N 65 W from west end of D 1400 at station 14.32.

1400 - 4

From station near the southwest end of D 1412 start a drift to the southeast, as shown on map, hunting for the vein that was stoped 120 ft. farther west.

1400 - 5

From station 14.37 in D 1411, drive cross-cut northeast 75 ft.

1400 - 6

From point 12 ft. south of station 14.60 drift southeast on vein.

1400 - 7

From a point 13 ft. east of station 14.13, drift southeasterly on vein.

1500 LEVEL

1500 - 1

From a point 15 ft. north of station C 6 in X-C 1500, drive a drift on the vein to the northeast.

1500 - 2

From station E 6 in X-C 1525 drive west on vein. In the east drift from this point there is a 23.30 oz. assay which should be investigated. The ore in this vicinity has a favorable appearance. The east drift should be extended, and the upward continuation of the vein should be investigated.

1500 - 3

Drive west on vein from point D 1. Samples 706 and 727 assayed 14.60 and 41.20 oz. Attention is called to a 53.0 oz. sample 15 ft. west of station 15.31 in D 1530; a 10 oz. sample at station 15.33; and 8.00, 15.20 oz. samples in the stope from 1530 X-C. These showings are worth further investigation, especially so, as they are in the extreme easterly workings on the vein. It may prove advisable to extend exploration further east on the vein system, but this point will be reserved for later discussion.

MICROSCOPIC EXAMINATION OF SPECIMENS

Specimens of the various types of rocks found on the 11th level were submitted for microscopic examination to a highly competent authority on this subject, whose report follows. The subdivision headings, giving the classification used in this report are mine.

Candelaria Shale

A-17. An altered fine-textured sediment. A very fine-textured aggregate of quartz and sericite with some titanite (?) dolomite, and brown carbonate.

A-10. An altered fine-textured sediment.

Similar to AA-17. Mostly quartz and sericite. Some jarosite in veinlets and aggregates replacing another mineral.

A-23. A sandy shale not so much metamorphosed as the other sediments. Made up of small rounded quartz grains in matrix of clay with some mica. There is considerable secondary sericite and veinlets of quartz, sericite, and an opaque mineral. Some jarosite. Another piece is similar but has small pebbles.

A-25. Similar to 23, but more metamorphosed and has more sericite and considerable dolomite. Some pyrrhotite and some gypsum along fractures.

A-32. Similar to 23. A few grains of zircon.

A-33. Similar to 23.

A-37. Uncertain origin. Mostly quartz, sericite, and dolomite in fine-grained aggregates. A little tourmaline. The arrangement of the quartz grains looks like a sediment but some of the dolomite aggregates suggest phenocrysts in a volcanic rock.

A-10. This is also of uncertain origin. It is a fine-grained aggregate of quartz, and dolomite, with some tourmaline, chlorite, and an opaque mineral.

[illegible] Andesite

A-2. A peculiar rock of uncertain origin but probably an altered granitic rock. It is made up mostly of quartz of secondary origin in grains about a millimeter across that have very ragged boundaries and carry inclusions of quartz, calcite, albite, kaolinite, chlorite, actinolite (?) titanite, and iron oxide.

<u>Remnant of Sulphide Ore 11th Level</u>

A-10. Ore. The black mineral is in needles and is probably the mineral that has been called jamesonite. Tsh yellow secondary material is mostly carbonate. I could not certainly determine either on the sample submitted.

mixed mineral and some jarosite.

Granodiorite

A-7. An altered granodiorite porphyry. (Knopf calls this a quartz monzonite porphyry, but it has more plagioclase than orthoclase). Originally made up mostly of stout millimeter plagioclase tablets with considerable biotite and another dark mineral and some interstitial biotite and another dark mineral and some interstitial fine-grained quartz, orthoclase, and plagioclase. There is some apatite, titanite, and magnetite. The rock is considerably altered, the plagioclase to albite and sericite and perhaps zoisite. The dark minerals are altered to chlorite and titanite. There is some calcite.

Basalt

A-16. A rather fresh basalt. The chief mineral is labradorite feldspar in small tabular crystals; olivine is present in large amount; some augite is present between the feldspars; and magnetite is in small amount. There is a little interstitial glass. The olivine shows incipient alteration to iddingsite and there is a little secondary calcite.

Old Surface Breccia between
[illegible]

A-13. An altered rock made up of fragments of different kinds. May have been a tuff or a breccia of some kind. Some fragments were porphyritic volcanic rocks. Some were fine-grained sediments or felsites. Made up chiefly mineral. The groundmass is made up of stout feldspar laths with magnetite and dark mineral. Feldspar is now altered to sericite and albite, and the dark minerals to chlorite. There is some quartz, calcite, leucoxene, and iron oxide.

A-13. An altered andesitic rock. Now made up mostly of sericite and chlorite.

A-14. Altered volcanic, probably a pyroxene andesite. Originally a porphyritic rock with scattered millimeter phenocrysts or plagioclase and some dark mineral in a crystalline groundmass made up of plagioclase laths and pyroxene (?). There may have been a little orthoclase. The feldspar is now altered to albite and sericite and the dark mineral (pyroxene?) to chlorite and uralite. There is secondary calcite, tourmaline, titanite, and an opaque mineral, and veinlets of quartz and calcite.

A-34. Probably an altered andesite but uncertain. Made up of quartz and dolomite with considerable tourmaline and some ore minerals. Tourmaline has a light blue core and darker border. Some large apatite crystals. In places a remnant of a porphyritic texture is suggested, and that, together with the apatite, indicates a volcanic rock. Some aragonite along the fracture.

PORPHYRY DIKE

A-54. This is probably a completely altered porphyry (resembling A-7). It is now chiefly quartz and sericite with some minute irregular needles of an undeterof sericite, orthoclase, and albite in small irregular bodies. These intergrowths have some slight resemblance to micropegmatite but with a large predominance of quartz. There is some iron oxide and a few flakes that look like bleached biotite. It was probably derived from a granite rock or possibly a rhyolite or other rock.

A-2. Andesite porphyry, near quartz latite porphyry. It has some similarity to A-7, but is considerably finer-grained. Phenocrysts of plagioclase and ragged biotite and probably another dark mineral make up nearly half the rock. The ground-mass is holocrystalline, rather fine, equant grained, and is made up of orthoclase plagioclase and quartz, with some magnetite and augite. There are a few quartz crystals much resorbed. The plagioclase is altered to sericite and albite. The biotite is partly altered to chlorite, and the augite to chlorite. There are some veinlets of calcite.

A-3. An altered volcanic rock now made up of interlocking grains of quartz with considerable sericite. Teh rock originally had some feldspar phenocrysts which are now sericite and carbonate. It had some similarity to specimen A-2.

A03. Similar to A-3, but the altered phenocrysts are less easily recognized. It has a few grains of bleached biotite.

A-11. Altered andesite. A porphyritic rock that had phenocrysts of plagioclase, biotite, and another dark