

GEOLOGICAL-GEOPHYSICAL REPORT
ON
RECONNAISSANCE GEOLOGICAL MAPPING AND
ELECTROMAG (VLF-EM 16) SURVEY OF
MINERAL CLAIMS WINGDAM 1, (20 units)
No.770 (8), WINGDAM 2 (20 units) No.771 (8)
AND WINGDAM 4 (20 units) No. 772 (8)
WINGDAM-LIGHTNING CREEK AREA
CARIBOO MINING DIVISION, BRITISH COLUMBIA
Lat. 53°02'N; Long. 121°58'W
MAP M93H/4W

For

TANACANA MINES LTD.
c/o 50 Granville Square
200 Granville Street
Vancouver, B.C.
V6C 1S4

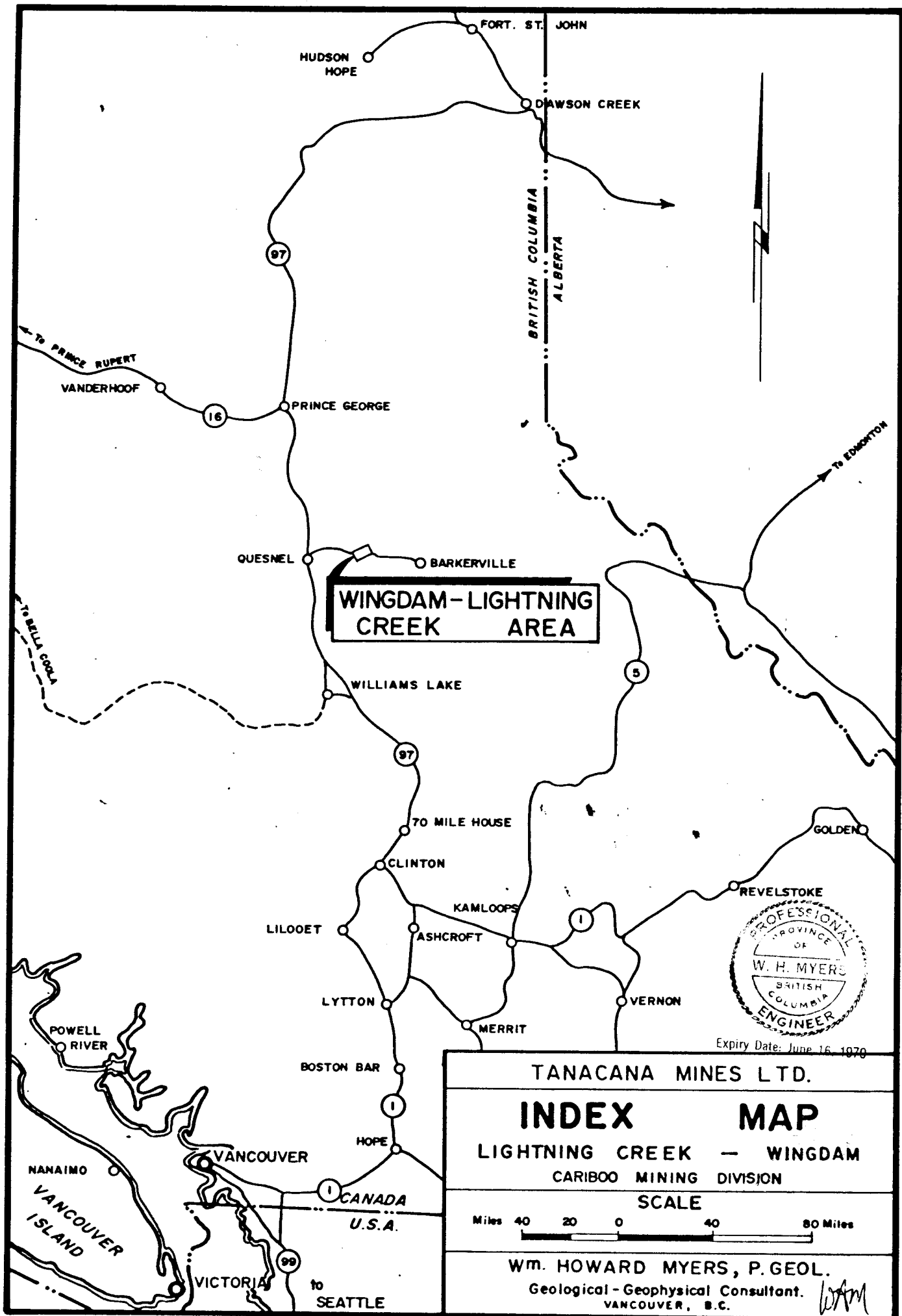
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MINERAL RESOURCES BRANCH
ASSESSMENT REPORT

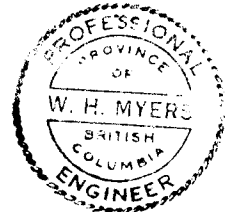
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NO.

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November 1979



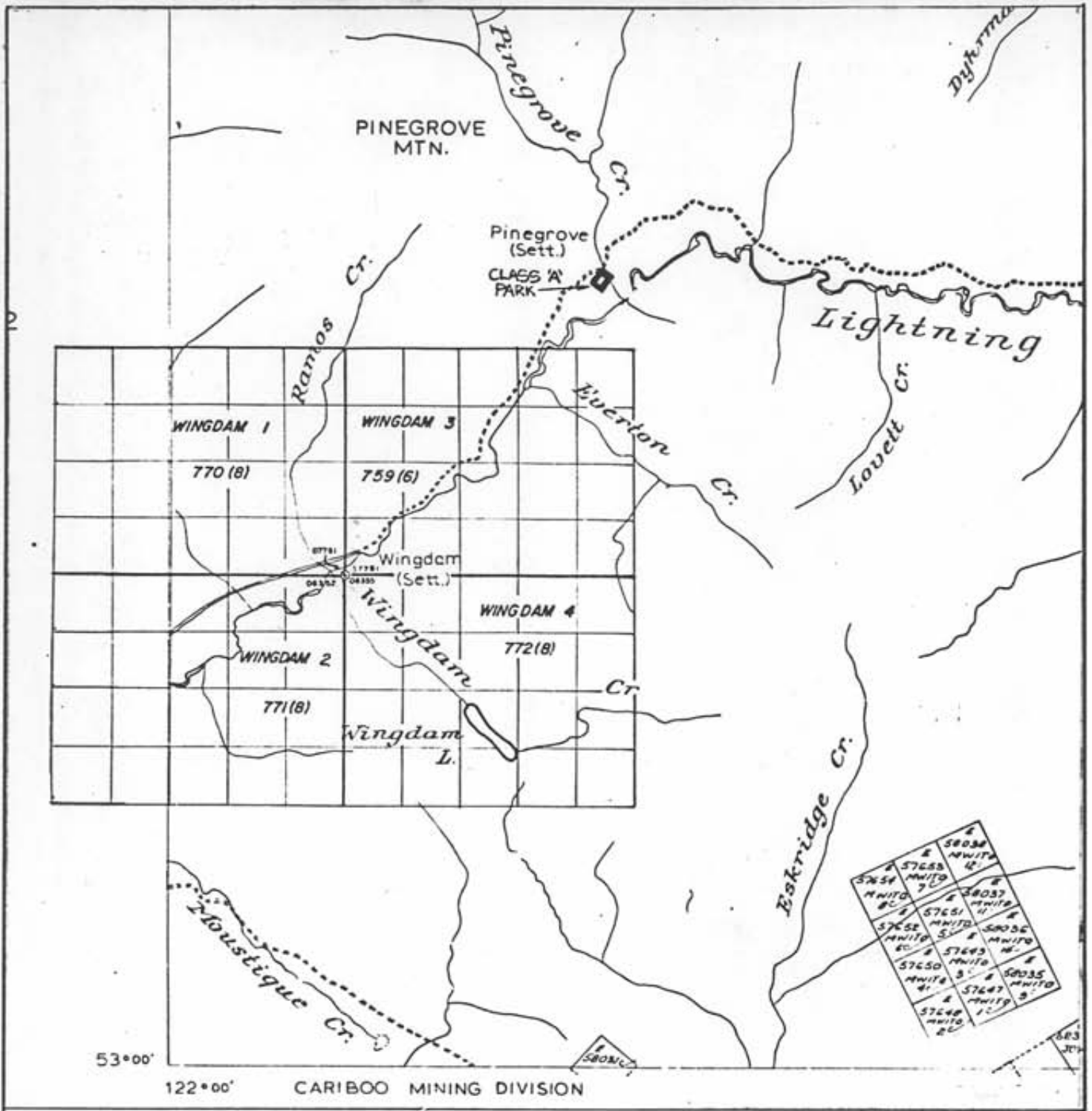
**WINGDAM - LIGHTNING
CREEK AREA**



Expiry Date: June 16, 1970

TANACANA MINES LTD.	
INDEX MAP	
LIGHTNING CREEK — WINGDAM CARIBOO MINING DIVISION	
SCALE	
WM. HOWARD MYERS, P. GEOL. Geological-Geophysical Consultant. VANCOUVER, B.C.	

WAM



53°00' 122°00' CARIBOO MINING DIVISION

57654	57655	57656	57657
57658	57659	57660	57661
57662	57663	57664	57665
57666	57667	57668	57669
57670	57671	57672	57673
57674	57675	57676	57677
57678	57679	57680	57681
57682	57683	57684	57685
57686	57687	57688	57689
57690	57691	57692	57693
57694	57695	57696	57697
57698	57699	57700	57701

TANACANA MINES LTD.
VANCOUVER, BRITISH COLUMBIA

WINGDAM - LIGHTNING CREEK AREA
CARIBOO MINING DIVISION, B.C.

CLAIM LOCATION MAP
WINGDAM 1 No 770, WINGDAM 2 No 771, WINGDAM 4 No 772



From Map M93H/4W - Sept. 1979

W^H HOWARD MYERS, P. Eng. (B.C.), P. Geol. (ALBERTA)
CONSULTANT, VANCOUVER, B.C. - OCTOBER, 1979

Expiry Date: June 16, 1979

W.H.M.

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VLF-EM 16 ELECTROMAG USE, INTERPRETATION,
CASE HISTORIES BY GEONICS LTD.

SHALLOW REFRACTION SEISMIC EXPLORATION -
THEORY INTERPRETATION AND FIELD OPERATOR
BY Wm. HOWARD MYERS, NOVEMBER 1977

CERTIFICATE

ILLUSTRATIONS

Base Map, with roads, streams, lakes prepared from photo mosaic showing location of VLF-EM 16 Profiles and structural trends	Pocket of Report
Three representative VLF-EM 16 Profiles	End of Report
Index	Front
Claim Location Map	"

ABSTRACT

A great deal of experimental work was carried out during the geophysical and geological exploration work on the sixty claims in the Wingdam Area owned by Tanacana Mines Ltd. The VLF-EM 16 electromag was used together with some shallow refraction seismic work for bedrock depth determinations. A photo mosaic map was prepared of the claim block for plotting the exploration data. Detail studies were carried out on the different rock types with special attention to characteristics which would help in the interpretation of the VLF-EM 16 electromag results. Particular attention was given to structural conditions in the outcrops related or resulting in faulting or zones of weakness. A study of the lineaments on the photo mosaic was used to indicate possible structural trends.

The results of the above studies and field exploration with the VLF-EM 16 produced some very interesting and possibly potential results which are tabulated below.

1. There appears to be a northerly trend in faulting or lines of weakness in the area of the claim block. The northerly trend varies from slightly east and west of north. Both topography and lineaments on the photo mosaic as well as possible fault zones on the VLF-EM 16 profiles confirm this possible trend. This northerly trend is also found and mapped in the Stanley and Barkerville Area to the east. This northerly trend or line of weakness could very well be related to gold mineralization in this area. These northerly trends are worth mapping in detail under the glacial drift cover.

2. On some of the VLF-EM 16 profiles which cross these northerly trends, the zone appears as an area of low or negative values on the inphase curve. In the Stanley Area a VLF-EM 16 profile was run across the three faults mapped by Stuart Holland. All three faults were recorded on the profile as zones of low or negative values on the inphase curve. The relief on both the inphase and quadrature was sharp in the fault zone but amount of relief very small on each curve.

3. The VLF-EM 16 profiles or lines can be run in the field at an oblique angle to the primary field (east-west using Seattle Station) without sacrificing too much data.

It is recommended that further VLF-EM 16 electromag work be done on the claims in the Wingdam Area. The work should be laid out to get additional detail on the northerly trending fault zones indicated to date. Detail electromag field work should be carried out in a selected area of favourable reconnaissance results using the normal grid pattern with the results corrected with the Fraser filter system for contouring data.

GEOLOGICAL-GEOPHYSICAL REPORT ON RECONNAISSANCE
GEOLOGICAL MAPPING AND ELECTROMAG (VLF-EM 16)
SURVEY OF MINERAL CLAIMS WINGDAM 1, 2 AND 4
Nos. 770, 771 AND 772.
CARIBOO MINING DIVISION, BRITISH COLUMBIA
Lat. $53^{\circ}02'N$; Long. $121^{\circ}58'W$, Map 93H/4W

INTRODUCTION

The geological-geophysical exploration work on the sixty mineral claims, in the Wingdam-Lightning Creek Area, as well as this report on the results of the survey were commissioned by Mr. Tom Boucher, officer and director of Tanacana Mines Ltd., owner of the claims. The monies spent for the field work, preparation of photo mosaic and the preparation of the report have been claimed as assessment work on the claims filed on August 8th, 1979. The delay in the preparation of the report was due to the delay in the preparation of the photo mosaic and the overlay maps to show location of the electromag profiles.

The VLF-EM 16 survey was not carried out in the normal fashion. The normal use of the EM-16 electromag is to run a grid coverage of the area with spacing of the profiles depending on detail desired. A good deal of the electromag work on the claims was experimental in nature. The object of the experimental work was to find out what subsurface information could be obtained and relative costs and reliability of the data. The station selected for the VLF-EM 16 survey was Seattle, Washington MLK/NPG-18.6 KHz. The station is located south of the area surveyed consequently the Primary Field and survey lines are in general east-west. The penetration of the EM-16 is theoretically

quite small possibly in the realm of 50 metres or less. Overburden in parts of the area is quite thick and in excess of 50 metres especially in the valley of Lightning Creek proper. Most of the survey was carried out on ridges where bedrock outcropped a great deal of the time. Some experimental work was carried out in areas of deep overburden as determined from seismic exploration. The heavy underbrush and timber in parts of the area of the claims is also a factor in the use of this type of electromag survey. This factor had to also be evaluated along with the direction (East-West) of the primary field and the oblique drainage pattern in the area of the claims. The results of the experimental work is detailed later in the report together with further recommendations.

The sixty units or claims are located in the general Wingdam area in the Cariboo Mining Division of British Columbia, some twenty four miles east of the town of Quesnel, B.C., as shown on enclosed index map. The Company, Tanacana Mines Ltd. owns a total of eighty units or claims in this area. The claims are identified as Wingdam 1 (20 units) No. 770(8), Wingdam 2 (20 units) No. 771(8), Wingdam 4 (20 units) No. 772(8) and Wingdam 3 (20 units) No. 759(6). The claims are shown on the enclosed location map with the report and is a portion of the British Columbia Titles Reference Map M93H/4W. The claims are all in good standing pending the filing and acceptance of this report on Wingdam 1, 2 and 4.

The claims are readily accessible via paved Provincial Highway #26 from Quesnel to Wells, some 24 miles east of Quesnel. The highway cuts near the center of the four claim block. Access to the outer limits of the claim block is by logging road to some cleared areas. The areas southwest of Wingdam Lake is via the Swift River logging road. The northeast portion of the claims is accessible by logging road from the top of Wingdam Hill. The intervening areas have a dense underbrush and heavy timber with access very difficult.

The terrain in the area of the claims is moderate to rugged. The terrain is quite rugged along the valley of Lightning Creek cutting through the center of the claim block. Away from the valley of Lightning Creek and along the ridges the terrain is moderate. Elevations in the area of the claims varies from just over 3000 feet above sea level along Lightning Creek to 4000 feet on the ridges above the valley.

The climate in the area of the claims is moderate to cold. This portion of British Columbia does experience Chinook conditions during the winter months and the climate becomes very moderate for brief periods. Snowfall in the area is moderate to heavy. The majority of the snow falls in January and February. Most of the snow is gone by the first week of May except for higher elevations and protected areas. Field conditions are very good, early in May, for field mapping, ground geophysical surveys and prospecting. The underbrush is less dense at this time and walking conditions are good.

The published maps and reports used in this report are listed under the Bibliography in the Appendix of the report. A photo mosaic map was prepared by McElhanney Surveying and Engineering Ltd., Vancouver, B.C. from aerial photographs flown in 1977. The mosaic showing the roads and the larger streams. This map on a scale of 1:5,000 was prepared as a base map for the plotting of the VLF-EM 16 profiles and rock outcrops studied. A copy of this map is enclosed with the report. Three VLF-EM 16 profiles are found in the back of the report. The locations of the other VLF profiles are marked on the enclosed map.

The equipment used to carry out the VLF-EM 16 survey on the claims was a VLF Electromagnetic Unit manufactured by Geonics Limited, 2 Thorncliffe Park Drive, Toronto, Ontario, Canada. The serial number of unit used is 291. The majority of the survey was carried out using the Seattle Washington Station MLK/NPG-18.6 KHz. Using this station the primary field and survey lines are in general east-west. Some work was carried out using Cutler, Maine NAA 17.8 KHz when the Seattle was off on Thursdays. The primary field using this station is in general north and south since the station is in the eastern United States. The station could only be used when the Seattle station was off the air most every Thursday due to the strength of the Seattle station and proximity to the claims. The signal from Cutler, Maine was much weaker and the quadrature quite erratic on days where the noise level was high. Station spacing

on the survey varied from 15 to 20 metres. Line or Profile spacing did not follow the normal procedure in a grid of the claims. The lines were located in areas where some data was available on the geology in an effort to evaluate the data from the VLF survey. Information on the EM-16, its use and case histories published by Geonics Limited, manufacturers of equipment used in the work, is enclosed in the Appendix of the report.

The shallow refraction seismic equipment was used in various places along the VLF profiles to determine bedrock depths and overlying material. The equipment used in the refraction survey was the Model ES-125 Signal Enchantment Seismograph manufactured by Geometrics Inc., 395 Java Drive, Sunnyvale, California. The theory, interpretation and field operations using the shallow refraction seismic method of exploration is outlined in the Appendix of the report. Part of the seismic data used along VLF Profile No.1 was done in 1978 and reported in assessment report listed in Bibliography.

The field work with the VLF-EM 16 unit was carried out on the following days tabulated below:

March 18, 1979	1 day
April 3, 1979	"
April 5, 1979	"
April 22, 1979	"
April 23, 1979	"
April 24, 1979	"
April 25, 1979	"
May 22, 1979	"
May 24, 1979	"

IN ACCOUNT
WITH

WM HOWARD MYERS, P. ENG
CONSULTANT

ELECTROMAG (VLF-EM-16) WINDAM AREA FIELD OPERATION. 20 days @ \$150.00/day	\$ 3000.00
NOTE: FIELD WORK DONE ON days of MINIMUM ELECTRICAL & MAGNETIC DISTURBANCE DURING PERIOD MARCH 10 TO AUG. 5 th 1979	
GEOLOGICAL FIELD MAPPING WINDAM AREA 10 days @ \$150.00/day	\$ 1500.00
PLOTTING VLF-EM-16 data on CROSS SECTIONS 5 days @ \$150.00/day	\$ 750.00
PHOTO MOSAIC (M. E. HANNY SURVEYING & ENGINEERING) AREA of WINDAM	\$ 425.00
PREPARATION of MAP - WITH THE SCALE FOR PLOTTING VLF & GEOLOGICAL DATA	250.00
PLOTTING + DRAFTING CROSS SECTIONS	175.00
TYPING, PRINTING, PREPARATION of REPORT on RECONNAISSANCE GEOLOGICAL - Geophysical Exploration WINDAM AREA	300.00
	<hr/>
	\$ 6400.00

TOTAL

W. H. Myers

REPORT TO FOLLOW

June 3, 1979	1 day	
June 5, 1979	"	
June 10, 1979	"	
July 7, 1979	"	
July 16, 1979	"	
July 17, 1979	"	
July 20 - 24		
1979, incl.	<u>5 "</u>	
Total	20 days @ \$150/day	\$3,000.00

Plotting Profiles		
April 8 & 19, 1979	2 days	
August 1-3, 1979	<u>3 days</u>	
	5 days	
5 days plotting @ \$150/day		750.00

Geological Field Work		
June 12-17, 1979 incl.	- 6 days	
July 25-28, 1979 incl.	- <u>4 days</u>	
Geological Field work	<u>10 days</u> @ \$150/day	\$1,500.00

The above figures together with the costs of the photo mosaic, drafting and preparations of the report were used to file assessment work of \$6,000.00 on the 60 claims on August 8, 1979.

HISTORY

The Cariboo Area of central British Columbia is well known for its production of gold. Several million ounces have been produced from both lode and placer deposits. Placer gold was discovered in the Wingdam area soon after the rush started in 1861. Gold was produced from a bench some 100 feet below the surface on Lightning Creek. Very little or no gold was produced from the deep rich channel some 160 feet below the surface. Quartz veins with pyrite and gold mineralization were prospected on the northwest section of the claim area near

Ramos Creek. There is no record of gold production but an adit was put in during the prospecting.

Lode gold was produced from two underground mines in the Wells area. The last gold produced from the underground mines at Wells was in 1967. A new mine in the same area is now being placed on production.

GEOLOGY

Bedrock, though concealed over a large portion of the claims area by rock debris and vegetation, outcrops on the ridges on steeper slopes and at various places along the stream bed. The rock debris consists mainly of morainal material and as glacial drift, landslide material on the steeper slopes of Lightning Creek. The overburden in the valley of Lightning Creek is very thick and masks completely the bedrock. Both boulder clay and hardpan together with slum are reported in the drilling on Lightning Creek. The slopes of the present valley also contain boulder clay, blue clay and hardpan indicating the entire valley of Lightning Creek was filled with glacial deposits. There is good evidence and it has been postulated that Lightning Creek flowed north into the Beaver Pass area and on to the Willow River in past geological times. The large amount of placer gold indicated in the drilling and exploration of the deep channel of Lightning Creek would have its source in the surrounding or nearby quartz veins with pyrite and gold mineralization.

Rocks in the northeastern portion of the claim block are composed of quartzite, sericite schist, argillite slate and limestone of the Cariboo Series of Precambrian age. In the southwestern portion of the area Hanson (Map 335A) maps the rocks as the Quesnel River Group consisting of shale, argillite and greenstone. The contact between the two formations could not be defined in the field by the writer. In the extreme western portion of the claim block argillites with quartz veins and limestone were mapped by the writer. The rocks are very similar to those in the Barkerville area mapped as the Basal Member of the Richfield Formation of Precambrian Age. In the extreme southwestern portion of the mapped area immediately southwest of Wingdam Lake, numerous quartz veins outcrop on the ridge. The quartz veins vary in width from an inch or fraction of an inch to over three feet. The quartz veins had a strike of north-northwest to northwest and were very abundant. There was no evidence of any gold or pyrite mineralization associated with the quartz veins. Rocks in the immediate area of the veins consisted of quartzite and sericite schist. Immediately east of the quartz veins there was evidence of faulting as shown on the enclosed map. This faulting was also indicated on the VLF profile run across the area.

The rocks of the Cariboo Series lie in the southwest limb of a broad anticlinal structure whose axis lies approximately three miles northeast of the claim block. The axis in general plunges to the northwest from 20 to 40 degrees. The strata of the Cariboo Series have a prevailing strike of north 30 to

40 degrees west and dips southwest, however, the beds are distorted in places by minor folding and faulting. Bedding planes are often distorted or obscured by shearing. In addition to the strike faults and northwest strike of the bedding there is a distinct northerly trend of faulting and topographic relief in the immediate area of the claim block. This northerly trend or line of weakness and is shown on the enclosed map is parallel to major faulting in the Barkerville Area mapped on the surface and underground. Among the well known northerly trending faults in the Barkerville area are the Lowhee Fault, Richfield Fault, Black Jack Gulch Fault, Waoming Fault and Grouse Creek Fault. Most all of these northerly trending faults were mapped by G. Hanson in Memoir 181, Canada Department of Mines 1935. In the Stanley area Stuart S Holland mapped three of these northerly trending faults as reported in Bulletin No. 26, (B.C. Department of Mines 1948. These northerly trending fault zones or lines of weakness are very significant and have a definite relationship to gold mineralization in the general Cariboo area. The VLF-EM 16 appears to be able to map these fault zones or structures.

Gold mineralization in the Wells Area east of the claim block occurs in two general types or forms namely with quartz veins and pyrite and as replacement type orebody in limestone. Mineralization occurs in fractures at or near the intersection of major structural trends in the area.

RESULTS OF RECONNAISSANCE GEOLOGICAL MAPPING AND ELECTRO-
MAG SURVEY (VLF-EM 16)

A substantial amount of time was spent in the field with the VLF-EM 16 electromag work. Profiles were duplicated using other transmitting stations and days of diurnal or magnetic disturbances. Profiles were also run at oblique angles to the primary field for different transmitting stations. The object of the experimental work was to determine the usefulness of the VLF-EM 16 electromag in this area as an efficient exploration tool. The Seattle Washington station MLK/NPG at 18.6 KHz is very strong in the area of the claim block and is located south of the claims making the primary field in general east-west. Survey lines should be run east-west in the area of the claim block. This is at an oblique angle to Lightning Creek and east-west lines would have considerable steep relief and difficult to run. Some of the lines run at oblique angle to the east-west primary field gave what appeared satisfactory results. On one profile run using the Seattle Station the line was run east-west along primary field as recommended in the operation of the equipment. The same profile (east-west) was run later on when Seattle Station was off the air (every Thursday) using Cutler Main NAA, at 17.8 KHz. The primary field using this station is north-south and survey lines should be run north-south. The above line or profile (east-west) when run using Cutler Main gave same general results as when run correctly using the Seattle Station. If this proves to be the case and the profiles can be run parallel or normal to the Lightning

Creek valley the survey progress would be very much faster. The Cutler Main station, with a north-south primary field in the area of the claims can only be used on Thursdays when Seattle Station is off the air. The Seattle Station is too strong to get Cutler Maine when on the air. The out of phase or Quadrature is not sharp using the Cutler Main Station making it slower to get correct reading. A base line or profile was along a section of logging road was established with well marked stations (15 meter interval). Every day when the VLF-EM 16 was used in the field this profile was rerun to check readings at various stations. It was found that on some days the readings were very erratic and very few checked with the normal established readings. These days of erratic readings did not check with days of storms or disturbances as reported by Victoria. Apparently the frequencies used by the VLF-EM 16 were not affected by the magnetic disturbances. It was not determined what caused the erratic readings but if a survey is run using the VLF-EM 16 a base profile should be run each day before field work is carried out. From the results of the VLF-EM 16 survey todate, it would appear that the unit can definitely be used to map structure in the Wingdam area in the form of faults, fault zones or general lines of weakness in the bedrock. At this time the structures mentioned above appear as areas of low or negative conductivity on the in-phase response. This can be due also to surface conditions however, in the Stanley area mapped, faults produced the same or similar results on the inphase curve, regardless of the

amount of overburden. The faults in the Stanley area are well established and were mapped by Stuart Holland in 1948, Bulletin No.26 B.C. Department of Mines. Two profiles were run across the three faults during the 1979 season and the response was the same each time at the two profiles. Several short profiles were run in areas of bedrock outcrop in an effort to map different formation in the field. None of the profiles showed any effects of the different types of rocks which could be definitely correlated with the different rock types. In the western portions of the claim block where the contact between the Cariboo Series and Quesnel Rivers Group is mapped by G. Hanson on map No.3354 (west half), several VLF-EM 16 profiles were run across this contact at different places on the claims. None of the profiles indicated any diagnostic correlation or relief which could be identified with the contact. In the southern portion of the area where numerous quartz veins outcrop on the ridge, the VLF-EM 16 profile (No.3) has no expression or any anomalous conditions which could be correlated with these veins. As noted earlier no mineralization was noted in the area consequently no response should be expected if there is no mineralization with depth. On this same profile where the bedrock is probably quite deep based on seismic work and hardpan velocities were recorded above bedrock there is no apparent conductivity due to the hardpan. In many areas clays at the surface produce distinct surface anomalies on the VLF-EM 16. The possible fault on the eastern part of the line

is shown on the profile.

The reconnaissance geological mapping was concerned primarily with the contacts of different types of rocks and structures rather than actual mapping of the outline of the outcrop. Local resistivity measurements were taken of the different rock types in an effort to obtain any characteristics which might be useful in the VLF-EM 16 survey. Further detail measurements should be made on the different rock types. Faults and fault zones were studied in detail in an effort to correlate these zones with possible VLF-EM 16 data. On VLF-EM 16 profile #2 both a distinct sharp fault and an inferred fault zone as observed in the bedrock outcrop could be correlated on the electromag work. The fault in outcrop, as shown on VLF Profile near station 1+50 west, shows up very distinct in the VLF-EM 16. There is no theoretical reason for a fault showing up on the electromag survey or profile, however in case histories they do. Faults with water could produce a conductive zone. Further work should be done in these anomalous areas. Northerly trending structures in the area of the claim block which produce topographic relief are probably due to faults, fault zones or old lines of weakness and should be mapped in detail where concealed by glacial drift.

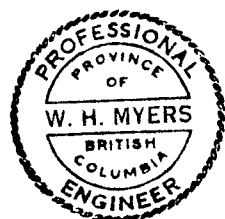
CONCLUSIONS

The VLF-EM 16 electromag probably can be used to map structures in the general Wingdam area. These fault zones appear as general areas of low or negative inphase conductivity on the profiles.

The northerly trending fault zones or lines of weakness are well concealed by glacial drift in the area of the claims. Topographic expressions of possible fault zones in the area of the claims should be checked and mapped using the VLF-EM 16 electromag.

RECOMMENDATIONS

It is recommended that further VLF-EM 16 surveys be carried out in the area of the claims in the Wingdam Area. The additional VLF-EM 16 work should be done in the form of both a detail grid pattern and as individual profiles across the northerly trending structures or fault zones in an effort to map the structures under the drift. A base line or profile should be run each day that further VLF work is to be pursued. Additional seismic surveys should be run to check bedrock depth in critical areas where bedrock is concealed.



Expiry Date: June 16, 1979

Respectfully submitted,

A handwritten signature in cursive script that reads "Wm. Howard Myers".

Wm. HOWARD MYERS
P. Eng. (B.C.), P. Geol. (Alta.)
Geophysical-Geological Consultant
Vancouver, B.C.

November 1979

A P P E N D I X

BIBLIOGRAPHY

Geological Survey of Canada Department of Mines

Memoir 181, 1935, G. Hanson

Bulletin 149, 1926, Johnson & Unglow

Map 335A (West Half) 1933, G. Hanson

Paper 72-35, 1973 J.R. Campbell, E.H. Mountjoy

British Columbia Department of Mines

Bulletin No.26 1948, Stuart S. Holland

CERTIFICATE

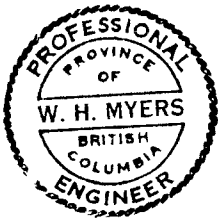
I, William Howard Myers, do hereby certify that I am an independent geological-geophysical consultant with offices at Suite 427 - 510 West Hastings Street, Vancouver, B.C. I have been actively engaged in my profession as an independent consultant in both oil and mining since 1952. I have been specializing in the exploration for and production of placer gold for the past fifteen years. I am a professional geologist member, P.Geol. #16704, for the Association of Professional Engineers, Geologists and Geophysicists of Alberta, and a non-resident member (P.Eng.) of the Professional Engineers of British Columbia.

I graduated from Fresno State College, Fresno, California, in 1930 with a B.Sc. degree in Geology. I did graduate work at Stanford University, Stanford, California, for M.Sc. degree in geology from 1939 to 1941.

Information for this report is from published and unpublished maps and reports on the general Cariboo region together with my field work and studies of the Cariboo area over the past fifteen years. The field work with the VLF-EM 16 electromag was carried out as follows: March 18, April 3, 5, 22, 23, 25, May 22,24, June 3, 5, 10, July 7, 16, 20 to 24 incl., 1979. A total of 20 days. The field geological work was carried out June 12-17 incl. and July 25-28 incl. Total of 10 days. The VLF profiles were plotted on April 8 & 9 and August 1 to 3 incl. A total of 5 days. The photo mosaaic of the claim area was prepared by McElhanney Surveying and Engineering,

Vancouver, B.C. as well as the overlay for plotting VLF data and enclosed with the report. The VLF-EM 16 profiles were plotted by the writer along with the preparation of this report.

I have no interest in the property or securities of Tanacana Mines Ltd. and do not expect to receive any interest in the property or securities of the Company to be issued as a result of writing this report.



Expiry Date: June 16, 1979

A handwritten signature in cursive script that reads "Wm. Howard Myers".

Wm. HOWARD MYERS,
P.Eng.(B.C.), P.Geol.(Alta.)
Consultant

November 1979



GEONICS LIMITED

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EM16 CASE HISTORIES

The attached case histories are examples of the capability of the VLF electromagnetic system in various conditions.

The direction in which the readings have been taken are indicated by an arrow. All VLF survey maps should be so marked as an aid to interpretation.

Figure 1 - This profile shows two conductive zones. The anomaly at the left shows a reverse quadrature slope thus also indicating the presence of conductive overburden covering the bedrock conductor. The indicated depth to the conductor is calculated at one-half the distance between the positive and negative maximums. The anomaly at the right shows some positive quadrature slope, indicating a medium conductor.

Figure 2 - This profile shows a medium conductor. The right hand positive in-phase component has a long "tail" indicating the dip direction of the conductive zone.

Figure 3 - This anomaly is caused by a vertical zone of graphitic slate covered by approximately 85 feet of conductive clay. The in-phase anomaly is considerably reduced in amplitude. The quadrature shows a typically strong reverse slope.

Figure 4 - This anomaly is the result of a weak conductor. The location of the conductor is at the center of the slope, not at the actual zero-crossing.

Figure 5 - This shows a simplified example of EM16 used underground. By taking readings in two directions, using different primary field sources, one can locate ore pockets precisely. Only the in-phase profiles are shown in this figure.

PRINGIPLE OF OPERATION

The VLF-transmitting stations operating for communications with submarines have a vertical antenna. The antenna current is thus vertical, creating a concentric horizontal magnetic field around them. When these magnetic fields meet conductive bodies in the ground, there will be secondary fields radiating from these bodies. This equipment measures the vertical components of these secondary fields.

The EM16 is simply a sensitive receiver covering the frequency band of the new VLF-transmitting stations with means of measuring the vertical field components.

The receiver has two inputs, with two receiving coils built into the instrument. One coil has normally vertical axis and the other is horizontal.

The signal from one of the coils (vertical axis) is first minimized by tilting the instrument. The tilt-angle is calibrated in percentage. The remaining signal in this coil is finally balanced out by a measured percentage of a signal from the other coil, after being shifted by 90° . This coil is normally parallel to the primary field.

Thus, if the secondary signals are small compared to the primary horizontal field, the mechanical tilt-angle is an accurate measure of the vertical real-component, and the compensation $\sqrt{2}$ -signal from the horizontal coil is a measure of the quadrature vertical signal.

SELECTION OF THE STATION

The magnetic field lines from the station are at right angles to the direction of the station. Always select a station which gives the field approximately at right angles to the main strike of the ore bodies or geological structure of the area you are presently working on. In other words, the strike of geology should point to the transmitter. Of course, $\pm 45^{\circ}$ variations are quite tolerable in practice.

The selection of the proper transmitting station is done by plug-in units inside the receiver. The equipment takes two selector-units simultaneously. A switch is provided for quick switching between these two stations.

To change a plug-in unit, open the cover on top of the instrument, and insert the proper plug. Then close the cover again.

Here is a list of some of the stations useful in Canada and United States.

Station NAA:	Cutler, Maine	Freq. 17.8 kHz
Station NPG:	Seattle, Washington	Freq. 18.6 kHz
Station NSS:	Annapolis, Maryland	Freq. 21.4 kHz
Station NBA:	Panama	Freq. 24.0 kHz
For European use GBR:	Rugby, England	Freq. 16.0 kHz
	NWC: Australia	Freq. 22.3 kHz

When ordering an instrument, consult Geonics for latest information for best selection of stations.

TAKING A READING

The direction of the survey lines should be selected approximately along the lines of the primary magnetic field, at right angles to the direction to the station being used. Before starting the survey, the instrument can be used to orient oneself in that respect. By turning the instrument sideways, the signal is minimum when the instrument is pointing towards the station, thus indicating that the magnetic field is at right angles to the receiving coil inside the handle.

To take a reading, first orient the reference coil (in the lower end of the handle) along the magnetic lines. Swing the instrument back and forth for minimum sound intensity in the speaker. Use the volume control to set the sound level for comfortable listening. Then use your left hand to adjust the quadrature component dial on the front left corner of the instrument to further minimize the sound. After finding the minimum signal strength on both adjustments, read the inclinometer by looking into the small lens. Also, mark down the quadrature reading.

While travelling to the next location you can, if you wish, keep the instrument in operating position. If fast changes in the readings occur, you might take extra stations to pinpoint accurately the details of anomaly.

The dials inside the inclinometer are calibrated in positive and negative percentages. If the instrument is facing 180° from the original direction of travel, the polarities of the readings will be reversed. Therefore, in the same area take the readings always facing in the same direction even when travelling in opposite way along the lines.

The lower end of the handle, will as a rule, point towards the conductor. The instrument is so calibrated that when approaching the conductor, the angles are positive in the in-phase component. Turn always in the same direction for readings and mark all this on your notes, maps, etc.

THE INCLINOMETER DIALS

The in-phase percentage scale is on the right. The left scale is the secant of the slope of the ground surface. You can use it to "calculate" your distance to the next station along the slope of the mountain.

- (1) Open both eyes
- (2) Aim the hairline along the slope to the next station to about your eye level height above ground
- (3) Read on the left scale directly the distance necessary to measure along the slope to advance 100 (ft) horizontally

We feel that this will make your reconnaissance work easier. The outside scale on the inclinometer is calibrated in degrees just in case you have use for it.

PLOTTING THE RESULTS

For easy interpretation of the results, it is good practice to plot the actual curves directly on the survey line map using suitable scales for the percentage readings. The horizontal scale should be the same as your other maps on the area for convenience.

INTERPRETATION

The VLF primary field's magnetic component is horizontal. Local conductivity inhomogeneties will add vertical components. The total field is then tilted locally on both sides of a local conductor. This local vertical field is not always in the same phase as the primary field on the ground surface. The EM16 measures the in-phase and quadrature components of the vertical field.

When the primary field penetrates the conductive ground and rock, the wave length of the wave becomes very short, maybe only few tens of meters, depending on conductivity and frequency.

At the same time the wave travels practically directly downwards. The amplitude of the field also decreases very fast, completely disappearing within one wavelength. The magnetic field remains, however, horizontal.

Figure 7 shows graphically the length and phase angle of the primary field penetrating into a conductive material.

The phase shift in radians per meter and the attenuation in nepers per meter ($1/e$) is:

$$\beta = \alpha = \left(\frac{\omega \mu \sigma}{2} \right)^{\frac{1}{2}} \text{ where } \omega = 2\pi f$$

$$\mu = \mu_0 \mu_r = 4\pi \times 10^{-7}$$

$$\sigma = \text{conductivity mho/m}$$

Figure 7 also reminds of the fact that all secondary fields have a small (or large in poor conductors) positive phase shift in the target itself due to its resistive component, and that the secondary fields have another negative phase shift while penetrating back to surface from the upper edge of the target.

The targets are located somewhere in the depth scale (phase shift scale in this case). Suppose we have semi-infinite vertical sheet target starting from the surface. Figure 8 shows that the total integrated primary field inphase and quadrature flux has a value of + 0.5 and - 0.5 respectively.

These two charts can be used to analyze the inphase and quadrature readings taken on both sides of the target. If one knows the actual conductivity of the overburden and the rock, the task is easier. Because of the many variables involved the precise analysis is usually impossible.

Mostly encountered and easily solved problem is, however, the separation of surface conductors from the more interesting ones at depth. This is easily done by observing the negative quadrature signals compared to the usually positive or zero ones from the surface targets. See the sample profiles 9 and 10. This way we can often tell if we have a more interesting sulfide target under a swamp for example.

Another use for the quadrature polarity is in the following a fault or a shear zone. Normally these weak conductors give a fair amount of positive (the quadrature follows the in-phase polarity) quadrature. When we have a local sulfide concentration in these structures, we get a negative quadrature response.

All the interpretation is made easier by other indication of the depth to the target. The horizontal distance between the maximum positive and negative readings is about the same as the actual depth from the ground surface to the centre of the effective area of the conductive body. This point is not the centre of the body, but somewhat closer to the upper edge.

Theoretically for spherical conductor, the depth

$$h = \Delta X \quad \text{where } \Delta X \text{ is the horizontal distance between the max. points of the vertical field } H_z.$$

$$\text{The radius } a = 1.3 h \sqrt[3]{H_z(\text{max})}.$$

$$\text{For cylindrical body } h = 0.86 \Delta X$$

$$\text{The radius } a = 1.22 h \sqrt{H_z(\text{max})}.$$

In these equations $H_z = 1$ means 100% on the equipment dial.

The determination of the depth is generally more reliable than the estimation of the actual dimension a . The real component of H_z , which we should use in these calculations, decreases proportionally for a poorer conductor and with the depth in conductive material.

One can also draw some conclusions about the dip and shape of the upper area of the conductor by observing the smaller details of the profile. See the modelling curves.

A vertical sheet type conductor, if it comes close to the surface, gives a sharp gradient of large amplitude and slow roll-off on both sides.

Horizontal sheet should give a single polarity on the edge of it, and again the opposite way on the other edge.

When looking at the plotted curves, one notices that two adjacent conductors may modify the shape of the anomalies for each one. In cases like this, one has to look for the steepest gradients of the vertical (plotted) field, rather than for the actual zero-crossings. Forget the word "cross-over". Look for the centres of slopes on the in-phase for location of targets.

As with any EM, the largest and best conductors give the highest ratio of in-phase to quadrature components. In VLF however, the surrounding conductive material influences the results so much that it is almost an irrelevant statement except in a few cases. Also in practice most of the ore bodies are composed of different individual sections, and therefore one cannot use the in-phase/quadrature ratio as the sole indicator of the conductivity-size factor. In other words the characteristic response curves are flat, much flatter than with modelling.

SOME NOTES FROM THE FIELD

It has been shown in practice that this instrument can be used (in proper areas) also underground in mines. The rails and pipes may cause background variations. It was found in one mine even at 1400 foot level, that the signal strength was good. By taking readings at two directions at each station, one could obtain a very good indication about the location of the ore pockets in otherwise difficult geology.

On the other hand a thick layer of conductive clay can suppress the secondary field to a negligibly small value.

In mountainous areas one can expect a smooth rolling background variation. However, the actual sharper anomalies induced by conductive mineral zones can be usually easily recognized.

Faults and shear-zones can give anomalies, but not without a reason. There must be conductivity associated with them. Reverse quadrature may indicate sulfide deposits in these structures.

Geonics invites any comments and interesting observations with the EM16 for the benefit of all users. These can be kept confidential if so desired.

SERVICING

Changing the batteries is done by removing the cover and changing the penlight batteries one by one. Please notice the polarities marked on each individual cell. To test the condition of the batteries, turn the instrument on, press the push-button on the front panel. There should be a whistling sound in the loudspeaker if the batteries are in useable condition. If the sound is not heard, the battery voltage may be low.

It may be occasionally necessary to clean the contacts of the plug-in unit. For this, use a clean rag that is very slightly moistened with oil. The oily rag is good also for the battery terminals.

If any repairs are necessary, we recommend that the instrument be shipped to Geonics Limited for a thorough check-up and testing with proper measuring instruments.

PHOTOGRAPHS

- Figure 1 shows the insertion of the station selector plug-in units in the EM16.
- Figure 2 shows how to use the instrument to find the direction of the primary field. Swing the instrument horizontally for minimum signal.
- Figure 3 shows that you are now facing in the survey line direction along the primary field. The transmitter is on your left or right.
- Figure 4 shows that you are approaching a conductor. In-phase readings are positive. Quadrature may be negative if target is deeper.
- Figure 5 you have passed over the conductor already. In-phase dial shows negative value. Quadrature could be positive if deeper target was behind you.
- Figure 6 shows a sample profile over a massive sulfide target.

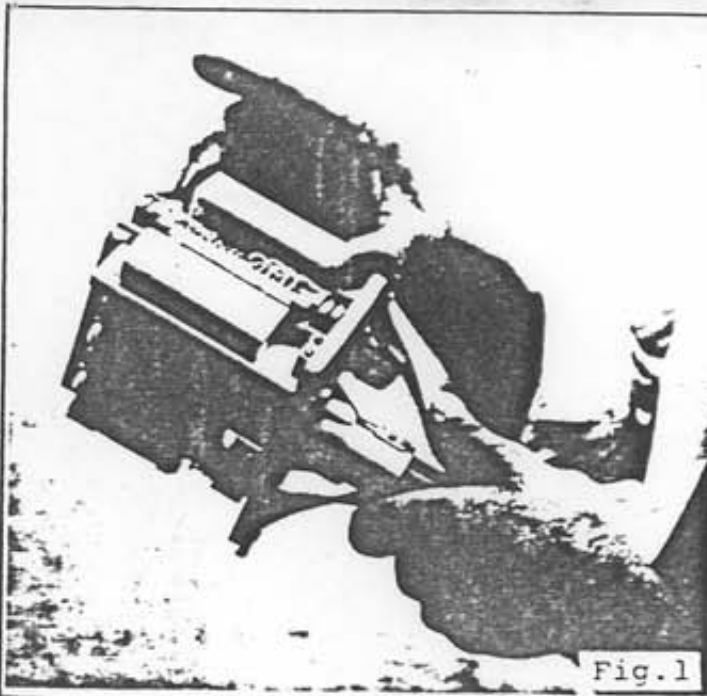


Fig. 1

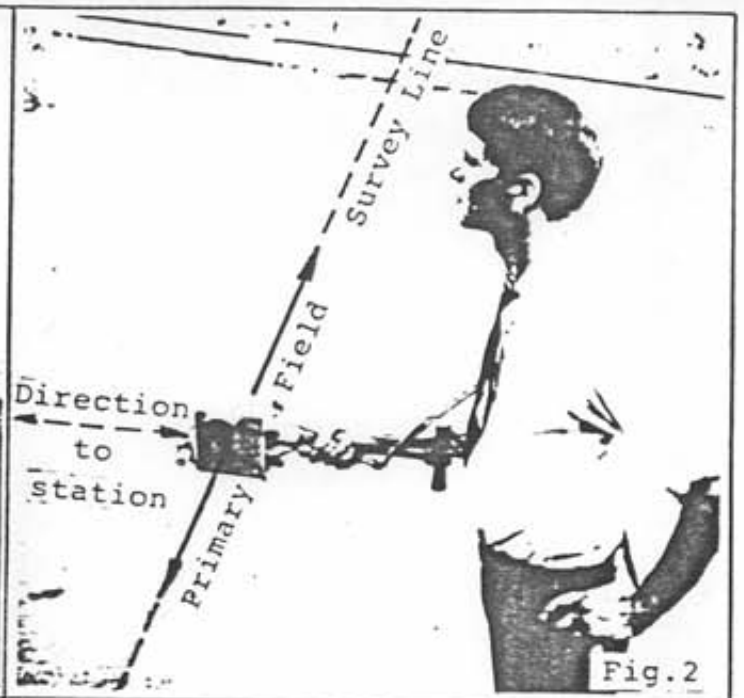


Fig. 2

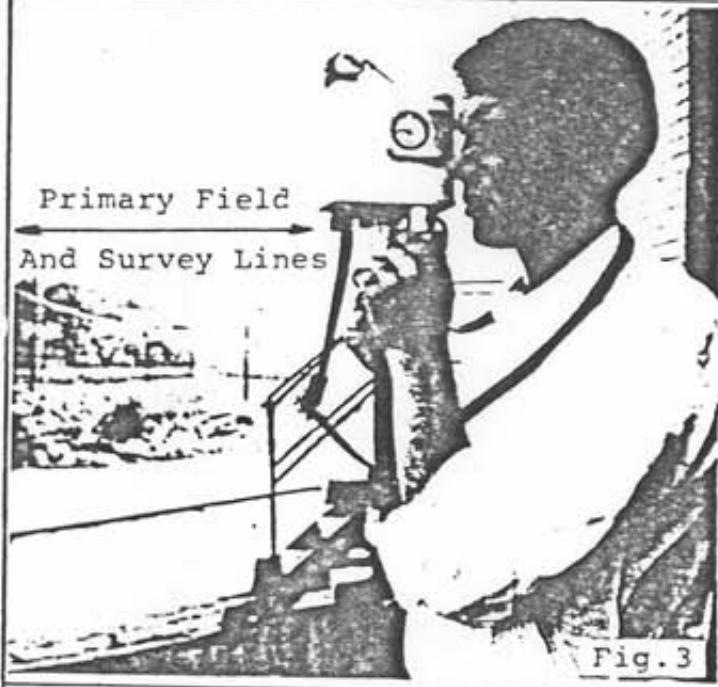


Fig. 3

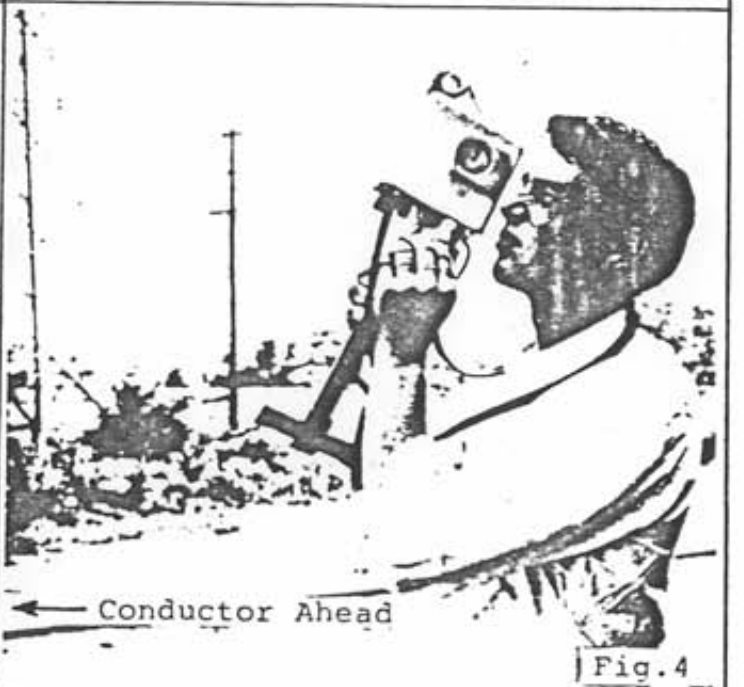


Fig. 4

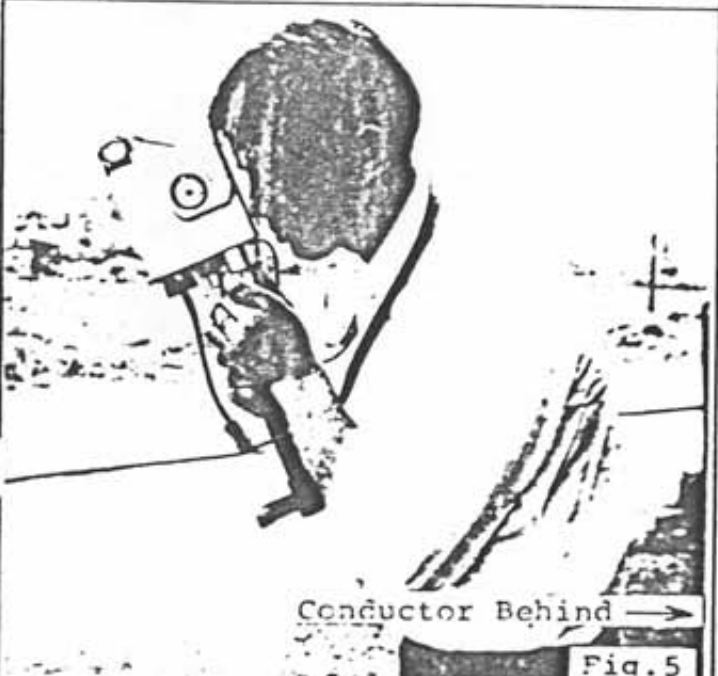


Fig. 5



Fig. 6

SHALLOW REFRACTION SEISMIC EXPLORATION

BY

Mr. Howard Myers, P.Eng. (B.C.), P.Geol. (Alta.)

November, 1977

THEORY

The quantity that is observed in the refraction method of seismic exploration is the time between the initiation of the shock wave at the shot point by hammer blow on a steel plate or explosion and its first arrival at the detector placed at a measured distance from the shot or impact point. As the first arrivals only are usually considered in the analysis, the wave arriving at the detector first must be the one which has travelled the minimum time path between shot point and detector. By observing first arrivals for different separation distance of source and receiver, a time distance curve can be constructed representing variations of minimum time path with distance, (see figure 1 at end of text). From these variations, the nature and depth of the elastic discontinuities can be determined.

The shock waves travel through earth materials as through air, with a definite velocity and along a definite path. The velocity depends primarily upon the degree of consolidation. The travel path of the seismic waves, like the path of light waves, follows whatever course that will require the least amount of time between the source and the detector.

The travel path of shock waves for minimum travel time can be traced out by a simple relationship from a familiar law of optics known as Snell's law where $\frac{\sin i}{\sin r} = \frac{V_1}{V_2}$. In the equation i is the angle of incidence and r is the angle of refraction. A shock wave will travel in a straight line through any material which has a constant velocity but will be bent if it passes through a discontinuity where there is an

abrupt change in elastic properties. In refraction seismic work, we are interested only in the rays which go down at the critical angle, become refracted parallel to the boundary and are refracted back to the detector (surface) at the critical angle. When $r = 90^\circ$ then the above equation (Snell's law) becomes $\sin i_c = \frac{V_1}{V_2}$.

Interpretation:

The process of refraction seismic interpretation can be illustrated by a simple case of the single horizontal discontinuity as shown in Figure 2 at end of text. Any number of discontinuities can be recorded as long as there is sufficient thickness and velocity contrast. In the ideal case and for simple interpretation of the refraction data the velocities will be higher in succeeding layers from surface down and the thickness will be greater than the overlying layer. This is not always the case and in such instances where deeper layers are thinner and velocities lower the interpretation becomes complex and experience is necessary for accurate and definitive interpretation of the refraction data.

The field data consisting of times recorded in milliseconds and distances measured from shot point to detector are plotted on a time distance graph. A line is drawn through the points that line up in a straight line. The velocity on each segment of straight line is computed from the basic formula $V = \frac{D}{T}$. Overlays with velocity scales computed from the above formula can be made up so that a direct read out can be obtained for each segment representing different velocity layers (see figure 1 at end of text).

The thickness of a layer is computed by the means of the formula $\text{Thickness} = \frac{XV_1}{2} \sqrt{\frac{V_2 - V_1}{V_2 + V_1}}$, where XV_1 is the horizontal distance from the zero point or detector to the change from velocity one to velocity two. The function $\sqrt{\frac{V_2 - V_1}{V_2 + V_1}}$ for the different velocities can be plotted on a graph so that a direct read out can be determined for

rapid computation. In the simple two layer case where bedrock is covered with one layer of low velocity material then the depth to bedrock is the same as the thickness of the layer. In the three or more layer case the depth calculation is made with the formula $D_2 = 0.8D_1 + \frac{XV-2}{2} \sqrt{\frac{V_3-V_2}{V_3+V_2}}$ (See figure 1 at end of text).

Additional information and greater accuracy can be obtained by reversing each profile in the field. When the profile is reversed dip calculations can be made on the various interphases. The length of the profile (distance from detector to shot point) depends on the depth of penetration desired. As a rule of thumb the depth penetration is roughly one quarter of the horizontal separation. A separation of 100 feet gives 25 feet penetration. This rule is only approximate and depends on velocity of the near surface layers.

Field Operations:

The operation of the shallow refraction seismic survey in the field is relatively simple and can be done by one or two men. The horizontal distance, with ten foot intervals moves down the line and strikes a steel plate with a sledge hammer at each 10 foot interval and records the time in milliseconds on the seismic timer. The time and distance is written down with notes on changes in surface conditions and terrain for different hammer points. If the readings are anomalous then a time-distance plot is made in the field to check data. With two men in the field, one on hammer and the other recording data, progress is much more rapid. Two men can run up to twenty profiles a day where conditions are favourable along logging roads or good trails. The plotting and interpretation of the data requires almost as much time as the field work.

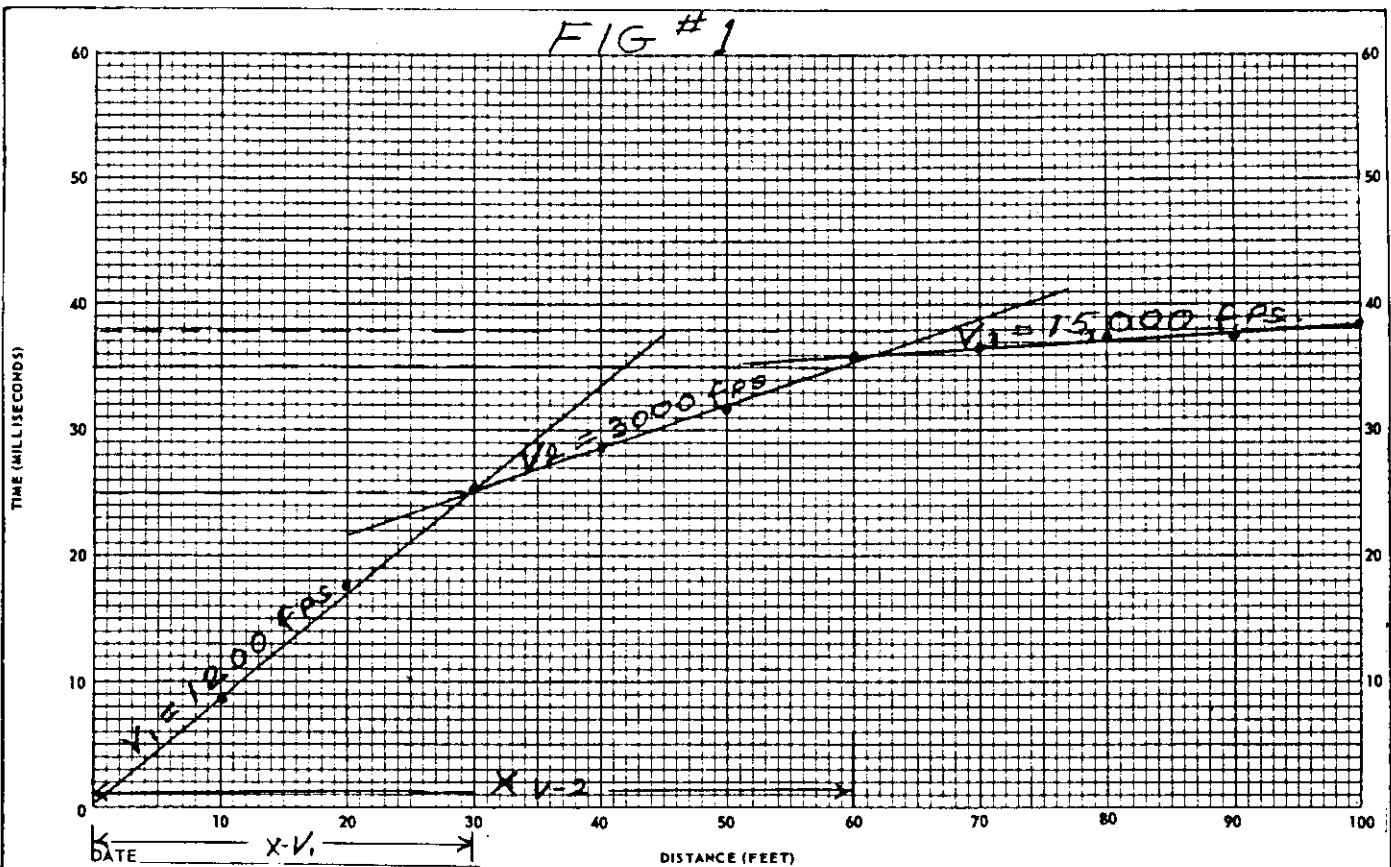
The equipment, consisting of two cables, geophone and sledge hammer and small steel plate and seismic timer can easily be carried by one man.

Applications:

Some of the applications or cases of the refraction seismic method of subsurface exploration are:

- (a) Depth of Alluvium (Depth to Bedrock)
- (b) Relief on Bedrock (Dip or irregularities)
- (c) Identification of material below the surface for excavation purposes such as gravels, clays and hard pan.
- (d) Type of bedrock and possible weathering or faulting.
- (e) Geological mapping for mineral and ground water.

The refraction seismograph is an excellent method for placer gold exploration in that all of the applicaitons listed above are useful.



Velocity Computation - $V = \frac{D}{T}$

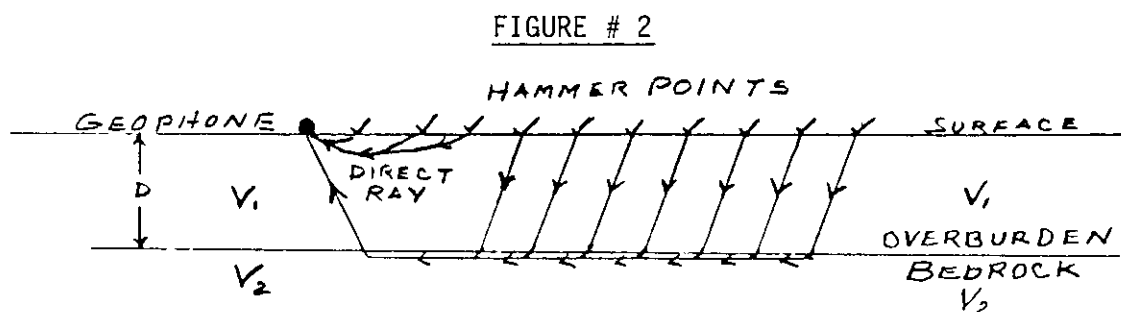
$$v_1 = \frac{30}{.025} = 1200 \text{ FPS} - v_2 = \frac{30}{.010} = 3000 \text{ FPS} - v_3 = \frac{40}{.0027} = 15,000 \text{ FPS}$$

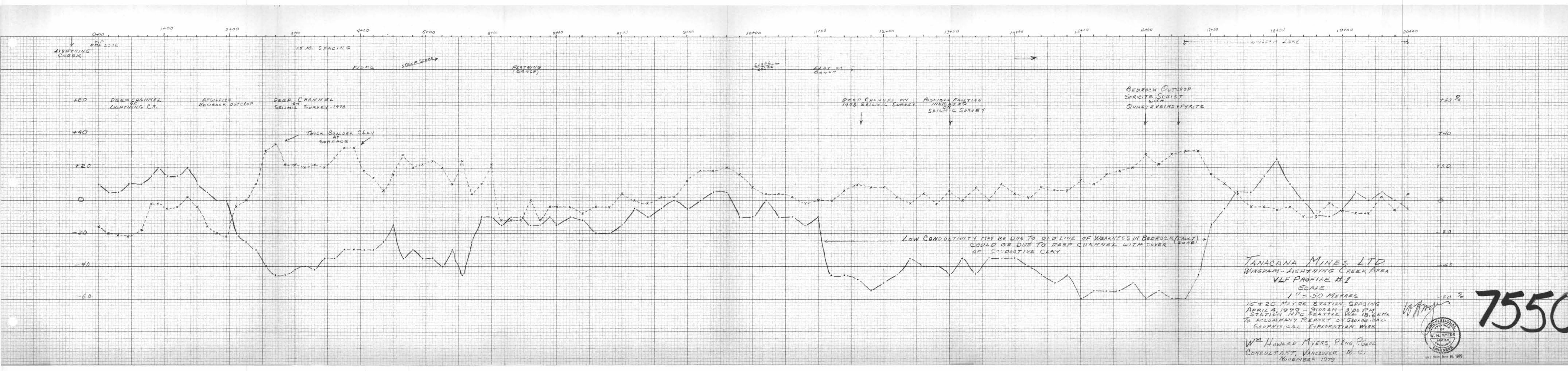
Depth Calculation - $D_1 = \frac{XV-1}{2} \sqrt{\frac{V_2-V_1}{V_2+V_1}}$ - $D_2 = \frac{XV-2}{2} \sqrt{\frac{V_3-V_2}{V_3+V_2}} + 0.8 D_1$

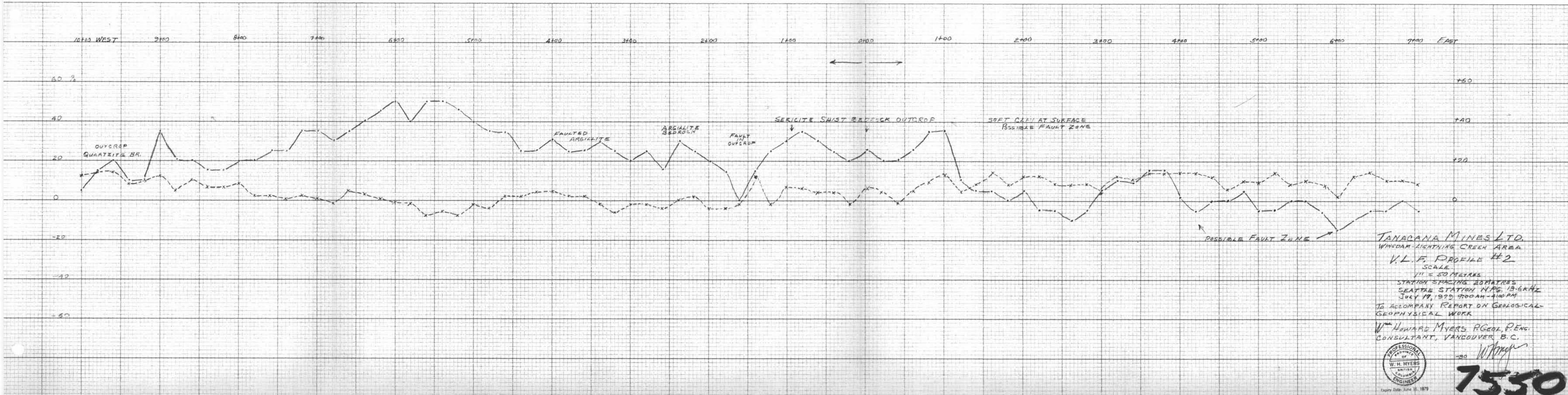
$$D_1 = \frac{30}{2} \sqrt{\frac{3000-1200}{3000+1200}} = 9.8' : D_2 = \frac{60}{2} \sqrt{\frac{15000-3000}{15000+3000}} + 0.8 \times 9.8 = 32.33$$

Results:

0 - 9.8' soil: Gravel @ 9.8' Bedrock @ 32.33







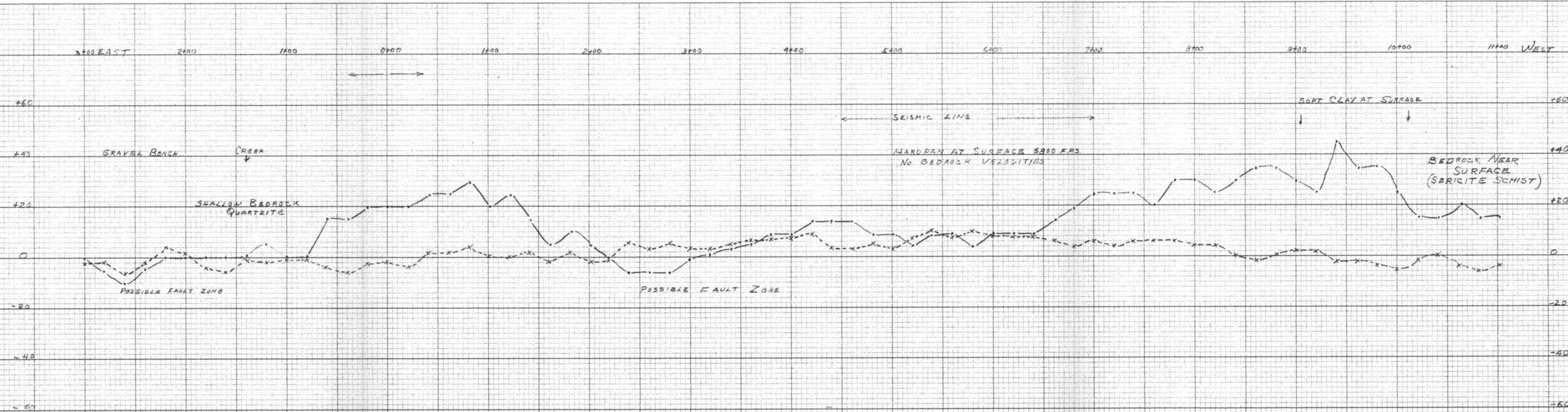
TANARANA MINES LTD.
WINDAM-LIGHTNING CREEK AREA
V.L.F. PROFILE #2
SCALE
1" = 50 METRES
STATION SPACING 20 METRES
SEATTLE STATION N.P.G. 13.6 KHZ
JULY 19, 1979 7:00 AM - 4:00 PM
TO ACCOMPANY REPORT ON GEOLOGICAL-
GEOPHYSICAL WORK

W. HOWARD MYERS P.GEOL. P. ENG.
CONSULTANT, VANCOUVER, B.C.



W. H. Myers

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TANACANA MINES LTD
 WINGDAM-LIGHTNING CREEK
 V.L.F. PROFILE # 3
 SCALE:
 1" = 50 METRES
 STATION SPACING 20M.
 SEATTLE STATION N.P.C. 18.6KHz
 APRIL 5, 1979 - 9:00 AM - 3:00 PM
 TO ACCOMPANY REPORT ON GEOLOGICAL
 GEOPHYSICAL WORK

W. HOWARD MYERS, P. ENG. (GEO.)
 CONSULTANT, VANCOUVER B.C.



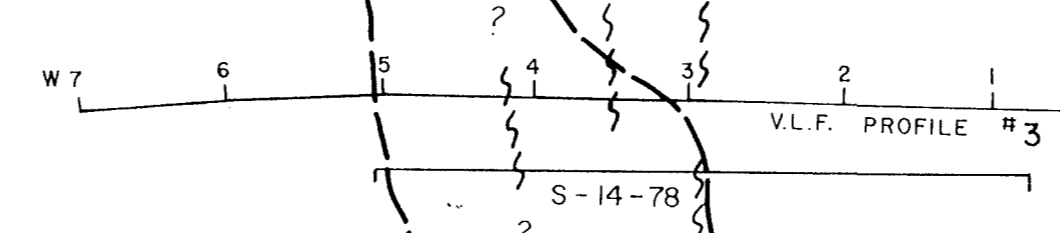
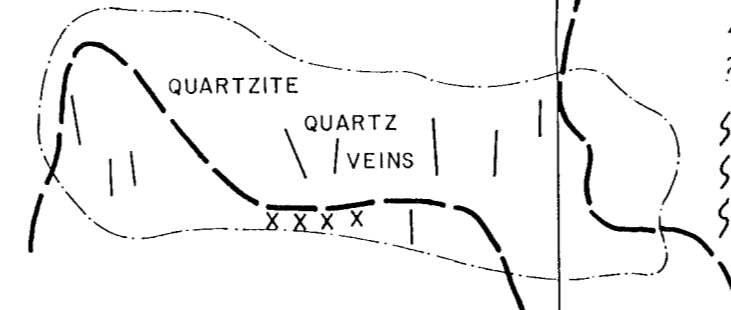
W. H. Myers

7550



- LEGEND**
- BEDROCK OUTCROP
 - V.L.F. -EM-16 PROFILE AND NUMBER
 - SHALLOW REFRACTION SEISMIC PROFILE AND NUMBER
 - OLD LINE OF WEAKNESS IN BEDROCK FAULTING IN OUTCROP LOW CONDUCTIVITY OR V.L.F.
 - LOCAL V.L.F. -EM-16 TESTING

NOTE:
 TO ACCOMPANY REPORT ON GEOPHYSICAL-
 GEOLOGICAL EXPLORATION SURVEY
 NOVEMBER, 1979.
 BY HOWARD MYERS P. ENG. (B.C.) P. GEOL.
 GEOPHYSICAL-GEOLOGICAL CONSULTANT
 VANCOUVER, B.C.



TANACANA MINES LTD.
WINGDAM CREEK

SCALE - 1:5000

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