ORIGINAL

GEOPHYSICAL REPORT

ON

DETAIL REFRACTION SEISMIC SURVEY
OF
PLACER MINING LEASES NOS. 5332, 6106
7067, 7074, 7092, 7117 AND 852
CARIBOO MINING DIVISION, BRITISH COLUMBIA
BARKERVILLE DESIGNATED PLACER AREA
(LAT. 53°02'N. LONG. 121°58'W.)
MAP P.93H/4W

FOR

TANACANA MINES LTD.
2780C Granville Street
Vancouver, B. C.
V6H 3J3

BY

WM. HOWARD MYERS, P.Eng. (B.C.), P.Geol. (Alberta)
GEOLOGICAL-GEOPHYSICAL CONSULTANT
427 - 510 West Hastings Street
Vancouver, B. C.
V6B 1L8

December 29, 1978

7094

WHM

TABLE OF CONTENTS

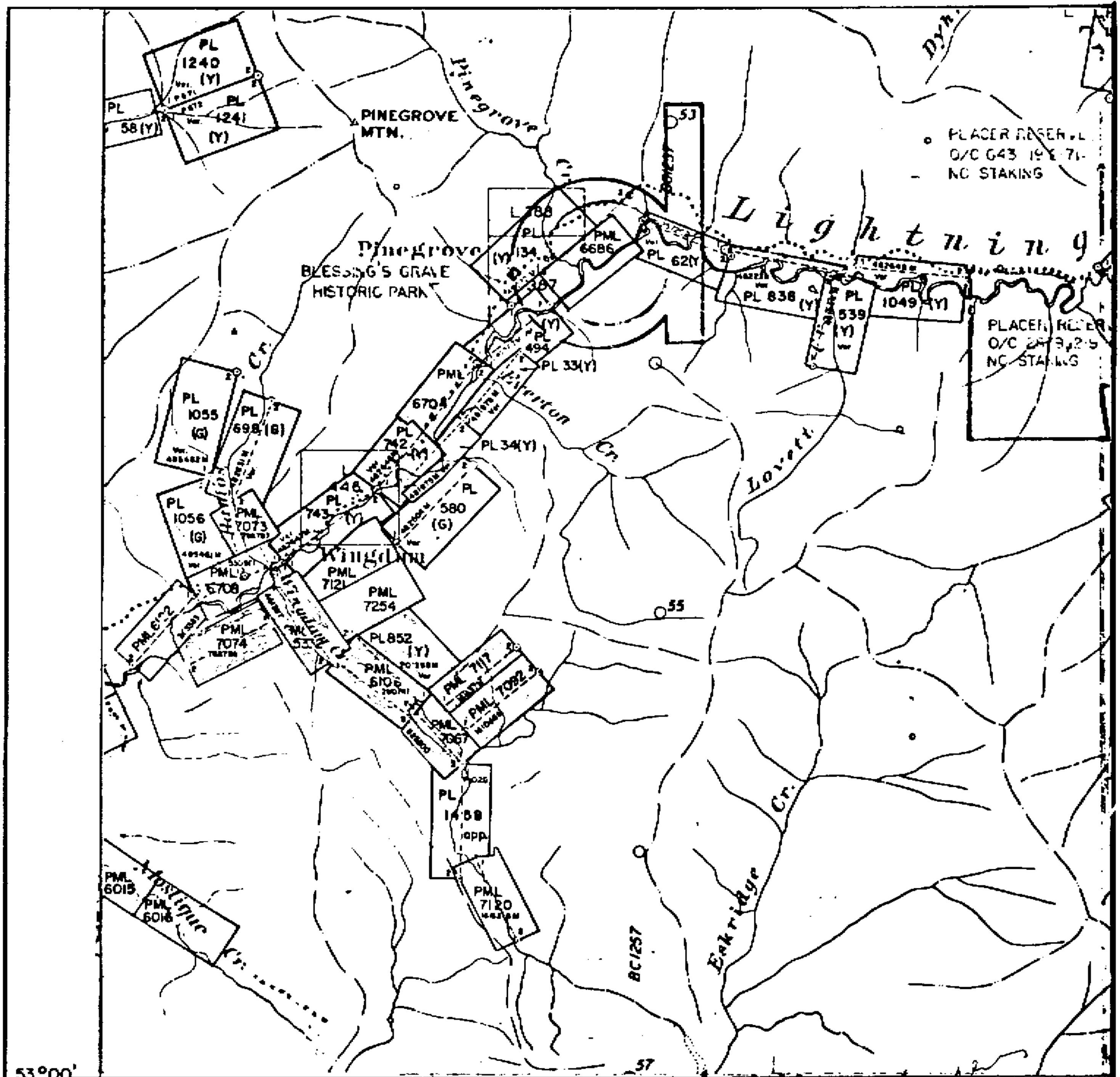
APPENDIX

.../2

TABLE OF CONTENTS

ILLUSTRATIONS

WHM



TANACANA MINES LTD.

VANCOUVER, BRITISH COLUMBIA

WINGDAM – LIGHTNING CREEK AREA

CARIBOO MINING DIVISION, B.C.

CLAIM LOCATION MAP OF PLACER LEASES No.'s

5332, 6106, 7067, 7074, 7092, 7117, 852

SCALE

1000 500 0 1000 2000 METRES

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — W. H. MYERS

Expiry Date: June 16, 1979

From Map P93H/4W — Nov. 1978

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

CONSULTANT, VANCOUVER, B.C. – DECEMBER 1978

ABSTRACT

The detailed shallow refraction seismic survey on the placer mining leases owned by Tanacana Mines Ltd., located in the general Wingdam Area, identified three possible deep channels on the leases. The actual depth and the trend of these channels could not be determined due primarily to surface conditions. Thick underbrush and soft surface over most of the leases restricts the seismic survey to cleared areas on the bench near the confluence of Wingdam and Lightning Creeks and the bulldozed trail from Lightning Creek to Wingdam Lake. The refraction seismic method can be used to establish the trend of these indicated deep channels when additional trails have been bulldozed. As soon as the trend is established on the possible deep channel located northwest of Wingdam Lake on placer mining leases 6106 and 852, it may be possible to test the channel with a backhoe if it is cut by Wingdam Creek at a lower elevation. If this is not possible then all three indicated channels will have to be drilled to test for possible placer gold.

The seismic survey across the upper channel on placer lease 6106 indicates possible faulting and a steep bedrock interphase on both sides of the channel. Bedrock drops off very rapidly in both instances. No bedrock velocities were recorded near the center of the channel. Bedrock would be deeper than 42 feet below the surface. No hard pan or boulder clay velocities were recorded in the channel. Near the northwest rim of the channel a low velocity layer of soft material, probably blue clay, was recorded above bedrock. The material filling the channel has an average velocity of 4000 feet per second

WHM

which is normal for gravel and clay or fill material.

The indicated deep channel near the confluence of Lightning and Wingdam Creeks is located immediately northeast of the area where placer gold production was carried out by Tanacana Mines a few years ago. The channel was identified on two seismic lines which were run during the 1978 season. A very steep bedrock interphase was recorded on the northeast run where bedrock outcrops at the surface a short distance northeast of the line. Normal gravel velocities were recorded near the surface in the area, however, typical hard pan or boulder clay velocities (6000-6800 f.p.s.) were recorded in the deeper part of the channel. The channel is over 75 feet deep on both lines. A trend could not be established with the seismic work due to surface terrain. The third possible deep channel identified by the seismic work is located up Wingdam Creek some 1000 feet from its confluence with Lightning Creek. The depth and possible trend of the indicated channel could not be determined with the seismic survey due primarily to surface conditions. A steep bedrock interphase was recorded near the southeast end of the line. Possible bedrock faulting was also indicated on this end of the line. Normal boulder clay or hard pan velocities (6100 f.p.s.) were recorded on the seismic work above bedrock. Surface velocities on this end of the line were quite high due probably to large rocks and clay at the surface. Near the northwest end of the line bedrock appears to come up fairly sharply and bedrock outcrops at the surface some 250 feet northwest of the line. Near station 1+00 near the northwest end of the line fairly high velocities (8000 f.p.s.) were recorded at 14 feet below the surface. This could be an apparent hard pan velocity (dipping hard pan) or possible broken bedrock slide material. Lower velocities (3000 f.p.s.) were recorded below the higher velocities at 14 feet. The lower velocity of 3000 f.p.s. is fairly low for this depth and probably represents a soft clay with some sand or gravel.

The detailed seismic survey on the bench just above Lightning Creek, where production testing for placer gold was carried out by Tanacana Mines Ltd., a few years ago, indicates fairly definitely that this is not a bench in the subsurface as previously determined by churn drill holes and reconnaissance type seismic survey. All of the seismic lines across this bench show low velocity layer below the bedrock some 10 to 20 feet below the surface. The seismic lines along or parallel to the bench indicate considerable relief on the shallow bedrock surface. The sharp relief on bedrock and lower velocities recorded below the shallow bedrock are interpreted as a bedrock slide from the steep slope of the main Lightning Creek valley.

WHM

RESULTS OF DETAIL REFRACTION SEISMIC SURVEY OF PLACER MINING LEASES NOS. 5332, 6106, 7067, 7074, 7117 AND 852. LOCATED IN THE WINGDAM-LIGHTNING CREEK AREA, CARIBOO MINING DIVISION, BRITISH COLUMBIA. LAT. 53°02'N. AND LONG. 121°53'W. MAP 93H/4W. (PLACER).

INTRODUCTION

The detail refraction seismic survey of the placer leases as well as this report on the results of the survey were commisioned by Mr. Tom Boucher, Vice-President of Tanacana Mines Ltd., owner of the seven placer mining leases. The monies spent for the field work and report have been claimed as assessment work on the leases filed on December 29, 1978. Permission was obtained from the gold Commissioner to file the report in early 1979 when drafting is completed on cross sections and maps.

The seven placer leases are located in the general Wingdam area in the Cariboo Mining Division of British Columbia, some 24 miles east of the town of Quesnel, B. C. The leases are along or adjacent to Wingdam Creek, a tributary flowing into Lightning Creek near the old Wingdam town site. The leases are shown on the index maps enclosed with the report which is a portion of the British Columbia Titles Reference Map 93H/4W (Placer). The seven leases are identified as Placer Mining Leases Nos. 5332, 6106, 7067, 7074, 7092, 7117 and Placer Lease No. 852. The anniversary date on the first six leases is May and December for placer lease 852. All seven leases are in good standing and were grouped on December 29, 1978.

The leases are readily accessible via paved Provincial Highway #26 from Quesnel to Wells some 24 miles east of Quesnel. The leases south of Lightning Creek are accessible by a bulldozed trail and road running up the right bank of Wingdam Creek from Lightning Creek to Wingdam Lake.

WHm

The trail or road is quite steep in places and will have to be relocated before it can be used as an access road for equipment. The existing trail or road is shown on the enclosed topographic map together with the proposed new access road. The timber in the area of the leases is quite heavy and very little or none of the area has been logged. There are local areas, however which are void of trees and these areas are shown on the topographic map.

The terrain in the area of the leases which cover the Lightning Creek valley is quite rugged. The terrain in the vicinity of Wingdam Lake near the south central portion of the area is moderate. The underbrush is quite dense over most of the leases even in the stream beds. Elevations in the area of the leases varies from just over 3000 feet above sea level on Lightning Creek to 3673 at Wingdam Lake in the southern portion of the lease area.

The climate in the area of the leases 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 1st of May, except for the higher elevations and shaded areas. Field conditions are very good in early May for field mapping and prospecting.

The published maps and reports used in this report are listed under the Bibliography in the Appendix of the report. The topographic map enclosed with the report was prepared by McElhanney Surveying and Engineering Ltd., Vancouver, B. C. from aerial photographs flown in 1977. The area of the

WHM

topographic map covers the central portion of the leases and the area of the detailed refraction seismic survey. The leases and the location of the seismic survey are shown on the topographic map. Cross sections were prepared to show the detail subsurface data obtained on the seismic survey. A cross section was also prepared across the area of the leases from Lightning Creek to Wingdam Lake using subsurface data existing from churn drill holes on Lightning Creek and results of the detail refraction seismic survey. All cross sections are enclosed in the Appendix of the report.

The theory, interpretation and field operations using the shallow refraction seismic method of exploration is outlined under "Shallow Refraction Seismic Exploration by Wm. Howard Myers, Consultant, November 1977" enclosed in the appendix of this report.

The classification and description of the various types of placer deposits found in the Cariboo is outlined under "Placer Golds Deposits in the Cariboo by Wm. Howard Myers, Consultant, December 1978" enclosed in the Appendix of the report.

The field work consisting of detailed refractions seismic survey was carried out on the following dates during the 1978 field season. August 14, 18, 26, September 5, 12, 13, 16, 18, 20, 21, 23 and 26, 1978. Final computations and cross sections require approximately one half as much time as the recording of field data. Two men were used in the field most of the time.

The equipment used to carry out the detail refraction seismic survey on the placer leases is the Model ES-125 Signal Enchancement Seismograph. The equipment is manufactured by Geometrics, Inc. 395 Java Drive, Sunnyvale CA.

94086. Two geophones were used with reversed profiles in most of the survey. The spread length varied from 100 to 250' depending on field conditions and subsurface penetration required.

HISTORY

The Cariboo area of Central British Columbia is well known for its production of both placer and lode gold. Since the gold rush, which started in 1861, the general Cariboo Area has produced many millions of dollars worth of gold from both lode and placer mining. A large portion of the gold taken from placer operations was never reported. During the gold rush there were many thousands prospectors and gold miners, operating small placer diggings centered near Barkerville. Some very rich placer deposits were worked on Lightning, Keithley and Williams Creeks. Lode gold was produced from two underground mines near Wells, B. C.

Since the gold rush there has been very little exploration for or production of placer gold in the Cariboo area. A very significant discovery of placer gold on Mary Creek in the Cottonwood Area, some three miles west of Wingdam, was made in October 1972. The deposit is quite rich, near the surface and the gold is very coarse. The extent of this deposit is not yet known, however, the fact that the gold is coarse and near the surface may well produce some substantial placer gold deposits in an area which up to now has not produced a great deal of placer gold. A re-evaluation of the old Tertiary drainage pattern must now be made and exploration work carried out on this basis. The new drainage pattern extends also into the Wingdam area in the vicinity of the placer leases held by Tanacana Mines.

WHM

The rich auriferous gravel on bedrock some 160 feet below the present Lightning Creek near Wingdam, in the vicinity of the placer leases held by Tanacana Mines, was discovered in the early 1900. Gold was discovered further up Lightning Creek by Ned Cambell in July 1861. Numerous churn drill holes were put down in an effort to outline and evaluate the deep gravels. Several attempts have been made to mine these rich gravels with various underground mining techniques. Very little or no gold has been mined from this deep channel due to the "slum" and heavy ground encountered. The only sizeable gold production in the Wingdam area was from a bench on the south side of Lightning Creek some 85 to 125 feet below the surface. Gold values obtained in the churn drill holes ran as high as $95.00 per cubic yard at $30.00 an ounce gold. The origin of the gold is believed to be residual in that the glacial drift which filled the original valley some 600 feet deep was eroded or washed away and the gold remained on bedrock or false bedrock. There is no placer gold activity on these deeper deposits at the present time.

GEOLOGY

Bedrock, though concealed over a large portion of the leases by rock debris and vegetation, outcrops on the tops of ridges, on steeper slopes and at various places along the stream beds. The rock debris consists mainly of morainal matter and land slide material on the steep slopes of Lightning Creek. In many places on the sides of the valley of Lightning Creek the slides contain bedrock as well as glacial drift material. The bench on the south side of Lightning Creek on lease #5332, where operations were set up by Tanacana Mines, is believed to be a bedrock slide from higher up the steep

WHM

valley of Lightning Creek. The general areas of slide material is shown on the enclosed geological map with this report. These slide areas were outlined by geological mapping and the refraction seismic surveys in 1976.

Bedrock in the immediate area of the leases is composed of limestone, sericite schist, slate, argillite and quartz, etc., of the Cariboo Series. The Cariboo Series is Precambrian in age and is the same formation containing commercial lode gold deposits in the Wells-Barkerville area to the east. Throughout the general Cariboo area, the Cariboo Series of rocks are more favourable and contain the better lode gold mineralization. Gold mineralization in the form of replacement type ore bodies and quartz veins with pyrite and gold are present in the Cariboo Series in the underground workings of Wells, B. C. Bedrock to the south of the lease block is composed of shale, argillite, greenstone basalt, andesite and flow-breccia tuff of the Quesnel River Group. This series is younger in age and rests unconformably on the Cariboo Series. Gold mineralization is not too prevalent in this formation.

The rocks of the Cariboo Series lie in the southwest limb of a broad anticlinal structure whose axis lies approximately three miles north northeast of the lease block. The axis of the anticline 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 generally dip southwest, however, the beds are distorted in places by minor folding and faulting. Bedding planes are often distorted or obscured by shearing. The best bedrock outcrop in the area of the lease block, located northwest of Wingdam Lake, is composed of sericite schist and quartzite. The strike and dip conforms in general to the regional structure mentioned above. There is considerable shearing in the outcrop with alteration and quartz with pyrite and possible gold mineralization. Outcrops on the northwest side of Lightning Creek consist of slate and argillite of the Cariboo Series. The rocks contain a high degree of shearing and bedding planes obscured. There appears to be some major faulting in this area, however, the fault could not be mapped. Many parts of the outcrop contain quartz veins with pyrite and possible gold mineralization. In most of the outcrop area the pyrite has been oxidized.

RESULTS OF DETAILED REFRACTION SEISMIC SURVEY

The location of the eleven seismic lines is shown on the enclosed topographic map prepared by McElhanney Surveying & Engineering Ltd., of Vancouver from 1977 aerial photographs with a scale of 1"=200 feet or 61 metres. The lines were located on the ground with flagging and tied to topographic features with a compass and tape traverse, consequently the location of the lines on the maps are approximate and will have to be surveyed in at a later date.

The results of the seismic survey is presented in the form of cross sections for each line and enclosed in the Appendix of this report.

The results of the shallow refraction seismic survey of the placer leases are considered to be good and very significant with an excellent potential for further testing with drilling or test pitting for placer gold. The more significant results of the survey are tabulated below.

1. The possible existence of a deep channel some 3500 feet southeast of Lightning Creek and some 550 feet higher than the present creek bed. The trend and actual depth of the channel could not be determined due

WHM

to surface conditions. It is interesting and possibly significant to note that this channel appears to cross Wingdam Creek at a pronounced change in direction of the present creek bed. Bedrock was identified with the seismic survey on both sides of the channel as shown on cross section. Bedrock is very steep on both sides of the channel and the seismic survey indicates possible faulting of bedrock.

2. The detailed seismic survey on the bench just above Lightning Creek, where placer gold washing equipment is set up and limited operations were carried out in the past by the Company, indicates fairly definitely that this is not a true bench in the subsurface as previously determined from churn drilling and reconnaissance type refraction seismic survey. All of the seismic lines across this bench show lower velocities below bedrock located some 10 to 20 feet below the surface. Seismic profiles along or parallel to the bench indicate considerable relief on bedrock below the bench. The sharp relief on bedrock and lower velocities recorded below bedrock on the bench are interpreted as a possible bedrock slide on the side of the steep Lightning Creek channel to the north near the present creek bed.

3. The detailed seismic survey indicates a possible deep channel below the northern end of the bench near the confluence of Lightning and Wingdam Creeks. Bedrock is very steep on the northside of the indicated channel and possibly faulted. The channel appears to be over 75 feet deep but the exact depth could not be determined with the seismic work due to surface conditions. It is quite possibe that at this location the indicated channel may be part of the Lightning

Creek cahnnel as defined by churn drilling further north. If this is true then there is a widening or sharp bend in the Lightning Creek channel as outlined by churn drilling.

4. The seismic survey indicates another possible deep cahnnel on Line W.11.78 located approximately 1200 feet southeast of Lightning Creek. The true depth of the channel and the trend could not be determined with the seismic survey due to surface conditions. It is highly possible that this channel could be the same channel found near the confluence of Wingdam and Lightning Creeks to the northwest. If this is true then the trend of this deep channel would be parallel to the postulated trend of the channel further to the southeast described earlier under section one.

The results obtained on each of the eleven seismic lines and plotted on the enclosed cross sections as well as the regional cross section of the leases is discussed in detail under the following separate headings:

Seismic Lines W.1.78, W.2.78 and W.3.78

These three lines are plotted on a single cross section since they are contigueous with minor changes in direction. The lines are located along a bulldozed trail running from Lightning Creek to Wingdam Lake. The lines are located on a relatively flat area above the steep Lightning Creek valley. All three lines have a westerly trend. Bedrock outcrops at the surface approximately 100 feet southeast of Line W.1.78. On line W.1.78 bedrock dips to the northwest at a fairly uniform rate. At station 2+00 typical hard pan or boulder clay velocities were recorded above bedrock.

Since bedrock velocities varied from 9500 feet to 10,000' per second it is quite possible that the typical hard pan on boulder clay velocities could be weathered or broken bedrock at or near the postulated faulting at the start of Line W.2.78 where bedrock drops off sharply to the northwest. The higher than normal surface velocities at station 3+00 could be due to local concentration of rocks near the surface or possible higher content of water in surface material. The second layer with velocities ranging from 3700 to 4600 feet per second is in the range of normal gravel saturated with water. This range of velocities could also be gravel with clay and minimum water content. Since the road is above creek level the material is more apt to be gravel and clay with low moisture content. To the northwest on Line W.3.78 this layer is replaced completely with normal fill material as mapped. Both layers appear to be very homogeneous with very little or no stratification. No bedrock velocities were recorded northwest of station 4+50 on line W.2.78. By assuming a bedrock of velocity of 10,000 feet per second at the end of the spread a computation of -42 feet to bedrock can be made. Since no bedrock velocities were recorded then bedrock is deeper than 42 feet below the surface from station 4+50 on line W.2.78 to station 10+50 on line W.3.78. A low velocity layer was recorded near station 9+50 on line W.3.78. With a velocity of 2600 feet per second at this depth the material is quite soft and is similar to blue clay velocities identified in other areas of the Cariboo. Near station 11+00 on line W.3.78 good bedrock velocities were recorded at 24 feet below the surface. The bedrock velocity of 9500 feet per second was fairly uniform and several feet of penetration were recorded on seismic survey. There was some evidence of faulting with steep bedrock interphase

WHM

near station 10+50 on line W.3.78. Near the northwest end of line W.3.78 normal fill or soil velocities were recorded down to bedrock. No hard pan or boulder clay velocities were recorded on lines W.2.78 and W.3.78.

Seismic Line W.4.78

This line is located on the bench just above the confluence of Lightning and Wingdam Creeks. On the southwest end of the line near Lightning Creek bedrock is some 38 feet below the surface. The bedrock interphase appears to be very irregular with very steep bedrock segments. This irregular bedrock surface could be due to large rocks or pieces of bedrock indicating possible bedrock slide material. On some profiles lower velocities were recorded below the high velocity bedrock segments. It is very possible that the high velocity material from 20 to 40 feet below the surface is bedrock slide material from the steep canyon of the old Lightning Creek channel. The high velocity (20,000 feet per second) is in all probability an apparent or up dip velocity. Further to the northeast, what appears to be true bedrock, was recorded on the seismic work some 75 feet below the surface. In this area a steep dipping bedrock interphase was recorded. Bedrock is overlain by typical hard pan or boulder clay velocity. Bedrock outcrops at the surface approximately 100 feet northeast of the end of the line. In the area of outcrop the bedrock is highly broken and may not be in place. There appears to be a deep channel below the southwest portion of this line. This could be part of the deep Lightning Creek channel defined by churn drilling or possibly a tributary to Lightning Creek when the original drainage was northerly into the Beaver Pass area.

WHM

Seismic Line W.5.78

This line is located on the bench above Lightning Creek and is southeast of Wingdam Creek. The line crosses the bench from Lightning Creek to the bedrock outcrop just above the bench. Bedrock velocities were recorded some 20 feet below the surface. The bedrock interphase was very irregular or uneven as on other profiles on the bench. Here again this could be due to large rocks on bedrock or fragments of bedrock material. Above bedrock the material has a higher than normal gravel velocity. The higher velocity could be due to a greater percentage of large rocks within the gravel. Fragments of lower velocities recorded on the seismic rock below the bedrock slide material were not continuous enough to interpret. Good bedrock velocities were recorded on the southeast portion of the line and probably represent true bedrock depths. Bedrock outcrops at the surface near the southeast end of the line.

Seismic Line W.6.78

This line is located on the lower bench just above Lightning Creek. The line is parallel to Lightning Creek and crosses lines W.5.78, W.7.78 and W.8.78 approximately at right angles. Near the northeast end of the line in close proximity to Wingdam Creek true or normal bedrock velocities were recorded at a depth of 26 feet below the surface. The bedrock interphase was normal and good penetration was obtained on the seismic survey. This is in contrast to the irregular bedrock interphase recorded on line W.5.78 in this immediate area. Since this line is further from bedrock outcrops the data may be more reliable and true bedrock may very well be at this depth rather than bedrock slide material mapped as interpreted on

WHM

line W.5.78. Bedrock at approximately 26 feet below the surface is overlain by material with higher than normal gravel velocities same as on line W.5.78. Here again this could be due to a higher percentage of large rocks in the gravel. The higher than normal velocity for this layer could be hard pan or weathered bedrock lying on true bedrock. To the southwest near station 1+00 bedrock velocities were recorded at 8 feet below the surface,however, typical gravel velocities (4500 f.p.s.) were recorded below the bedrock at 8 feet. At station 2+00 there appears to be a low on bedrock some 32 feet below the surface. Gravel velocities in this area were recorded above and below the possible boulder clay (6800 f.p.s.) layer. To the southwest, the seismic data was very irregular and not conclusive. The possible true bedrock at 37 feet near station 4+00 is inconclusive in that only a few points of high velocity material were recorded. It is very possible that the material below the near surface layer of soil is bedrock slide material as shown on cross section.

Seismic Line W.7.78

This line is located near the southern limit of the bench above Lightning Creek. The bench is fairly narrow in this area due to a meander of the creek. The line crosses the bench and approximately at right angles to line W.6.78. The seismic data recorded was poor and not too reliable. A very irregular bedrock interphase was recorded on the northwest end of the line near Lightning Creek. At station 1+00 a low velocity (1000 f.p.s.) was recorded below the surface layer of soil. This could well be a highly weathered bedrock or clay. To the southeast a steep bedrock inerphase was recorded. The higher than normal bedrock velocity (19,000 f.p.s.) is no

WHm

doubt an apparent or up dip velocity since bedrock outcrops near the end of the line.

Seismic Line W.8.78

This line is located on the bench immediately south of Lightning Creek. The line crosses the bench from the creek to the break in slope where bedrock outcrops. The bearing of the line is approximately S40°E. Near the northwest end of the line and in the vicinity of Lightning Creek bedrock velocities of 11,000 feet per second were recorded at 8.5 feet below the surface of the bench. Since the bench is approximately 8 feet above the creek the high velocity material is just below the creek bed. Lower velocity segments were recorded on the seismic work below the higher bedrock velocity layer. The lower velocity layers were intermittent and varied betwen 4500 f.p.s. and 6200 f.p.s. The above conditions have been interpreted as a bedrock slide material with clay and or gravel and clay below the slide material. Depths to the lower velocity layers could not be computed from the seismic data. Southeast between stations 1+00 and 2+00 the high velocity bedrock slide material drops off very sharply and is replaced with gravel and large rock, and possible clay with a velocity of 6200 f.p.s. This velocity is similar to that found in other areas of the bench and could be highly faulted and weathered bedrock. Further to the southeast between station 2+00 and 2+50 this layer has a velocity of 4500 f.p.s. or typical gravel with good continuous bedrock velocities below near 15 feet below the surface. Bedrock comes to the surface near the end of the line.

WHM

Seismic Line W.9.78

Line W.9.78 is located on the bench immediately northeast of the confluence of Lightning and Wingdam Creeks. The line is parallel to Lightning Creek and is more or less an extension of line W.6.78 to the northeast. The line crosses line W.4.78 at approximately right angles at station 3+00. On the southeast end of the line near Wingdam Creek good bedrock velocities were records at some thirty feet below the surface. Bedrock is overlain with possible boulder clay with a velocity of 6000 f.p.s. Here again this could be a highly broken and weathered bedrock. Segments of high velocity material near the base of this layer and near bedrock have been interpreted as large rocks or fragments of bedrock in a lower velocity (6000 f.p.s.) medium. In this general area the boulder clay is overlain with gravel and large rocks to a depth of approximately 20 feet below the surface. The surface velocities down to a depth of 10 feet are normal velocities for soil composed of clay and rocks. To the northeast near station 1+50 and station 3+00 on line W.4.78 bedrock drops off very sharply to a depth of over 75 feet. The overlying layers of soil and gravel remain constant in the thickness and the boulder clay thickens very sharply with a low velocity layer (2500 f.p.s.) above bedrock. The low velocity layer is extremely low for this depth and probably is from new soft material. The exact thickness and depth could not be computed on seismic data. The deep bedrock shown between stations 2+00 and 3+00 corresponds very well with the deep bedrock recorded on line W.4.78 in this immediate area. At station 3+50 a good bedrock interphase was recorded at 57 feet below the surface. The overlying material in this area has a higher velocity than the boulder clay to the southwest. This could very well be due to the presence

WHM

of more rocks or possibly faulted and weathered bedrock. Bedrock outcrops just above the road along the northeast portion of the line.

Seismic Line W.10.78

Line W.10.78 is located south of Wingdam Creek some 400 feet from the bench just above Lightning Creek. The line is approximately 100 feet higher than the bench on Lightning Creek. The bearing of the line is N80W. Bedrock dips slightly to the southeast with a depth of approximately 40 feet. Bedrock appears to be in place with no lower velocities recorded below it. The bedrock is overlain with possible boulder clay or hard pan material (6800 f.p.s.). The velocity is slightly higher than average for boulder clay (6000-6500 f.p.s.), however, with large rocks the velocity would be higher. The material appears to be uniform with slight higher velocity variations. To the northwest the layer does have a velocity of 6300 f.p.s. The surface velocities along the entire line are higher than normal. The ground in the area of the line appears to be clay with some rocks and probably does not have normal soil at the surface. Below 5 feet a layer of material with velocities of 4500 f.p.s. was recorded on top of the boulder clay. This layer could be the same material as at the surface with moisture or more compaction or even more rocks. Near the northwest end of the line boulder clay velocities were recorded at 9 feet immediately below surface layer with higher than normal velocities. Bedrock velocities were recorded at station 2+50 near the northwest end of the line. Lower velocities (6300 f.p.s.) were recorded below the high velocity layer. This material is interpreted as bedrock slide material with possible true bedrock at a depth of 36 feet. Bedrock does outcrop at the surface some 200 feet northwest of the end of the line.

WHM

Seismic Line W.11.78

Line W.11.78 is located along the bulldozed trail from Lightning Creek to Wingdam Lake. The line is some 1000 feet southeast of Lightning Creek and approximately 130 feet higher than the bench just above the creek. The line is approximately 200 feet northeast of line W.10.78 with a bearing of S30E, almost at right angle to line W.10.78.

Bedrock velocities were recorded at a depth of 20 feet near the northwest end of the line. A steep bedrock interphase was recorded on the seismic work in this area. Bedrock outcrops at the surface approximately 250 feet northwest of the end of the line. Surface velocities (3000 f.p.s.) are very high in this area. It is probably due to clay and large rocks at the surface as noted on the bulldozed trail. At a depth of 14 feet fairly high velocities of 8000 f.p.s. were recorded. To the southeast this layer is replaced by material with 6100 f.p.s. velocity. The 6100 f.p.s. velocity probably is boulder clay or hard pan. The higher velocity (8000 f.p.s.) material could be a boulder clay with large rocks or even broken bedrock. Lower velocities (3100 f.p.s.) were recorded below the boulder clay material or higher velocity (8000 f.p.s.) layer. At station 2+00 what appears to be true bedrock velocities were recorded at a depth of 31 feet. A steep bedrock interphase was recorded immediately southeast of station 2+00. Bedrock velocities of 9000 f.p.s. were recorded at a depth of 9 feet at station 2+50 near the end of the line. Seismic data was poor and inconclusive near this end of the line. Surface velocities were also extremely high in this area.

WHM

REGIONAL CROSS SECTION A.B.C.D.

The location of the regional cross section is shown on the enclosed topographic map. The cross section from Lightning Creek to Wingdam Lake approximately 6300 feet long, was prepared from the results of the detail seismic survey together with existing data from churn drill holes on Lightning Creek. Surface relief was taken from the topographic map. The cross section also shows the placer lease boundaries. The cross section in general is at right angles to Lightning Creek and parallel to Wingdam Creek. The relationship of the three possible deep channels, as determined by the detail seismic survey, is demonstrated on the cross section. The difference in the elevation of these possible channels is very significant in that the old drainage of Lightning Creek and its tributaries was to the north into Beaver Pass area thence to Willow River in sharp contrast to the present drainage to the south. This old drainage pattern probably corresponds to a similar northerly drainage of the Fraser River Tertiary Drainage-history, by Douglas Lay, Bulletin No. 11, British Columbia Department of Mines, 1941. The different elevations of the possible deep channels would correspond with the level or elevation of erosion at that stage. The higher channel northwest of Wingdam Lake could very well represent the older pre-Tertiary drainage of the area when the drainage was northerly into the Willow River. There are several high benches and/or channels which have been found in the Cariboo area.

It is very interesting and possibly significant to note on the cross section. that these possible deep channels are located at or near fairly pronounced topographic changes at surface and the seismic work indicated possible

WHM

faulting in the subsurface. Numerous present clay creeks or streams follow fault zones where the rock is broken and softer. Additional exploration work should be done on these possible deep channels in an effort to map the trend.

CONCLUSIONS

The conclusions resulting from the detail refraction seismic survey of the placer leases during the 1978 season are tabulated below, however, they are not necessarily in order of importance.

1. The indicated deep channel located northwest of Wingdam Lake on PML 6106 and associated with possible bedrock faulting, could very well be part of an old northerly trending drainage pattern established in the area when Lightning Creek flowed to the north into the Willow River. The exact depth of the indicated channel could not be determined due to surface conditions and close proximity to bedrock. Bulldozing will have to be done in the area before further seismic work can be done to establish both the depth and trend of the indicated channel. The terrain in the area of the indicated channel is favourable and it is possible that the channel can be exposed with mechanical equipment (backhoe) to the southwest where Wingdam Creek possibly cuts the indicated channel (depending on trend) at a lower elevation.

2. The detail seismic survey on the lower bench just above Lightning Creek, where previous placer gold testing was carried out by Tanacana Mines Ltd., proves fairly conclusively that this is not a true bench in the subsurface as previous thought. On most all of the seismic lines across this bench do indicate lower velocity, or softer material,

below bedrock velocities near the surface. This seismic data along with other data from old test pits on the bench is interpreted as a possible bedrock slide in the area of the bench with a cover of gravel rocks and fragments of bedrock up to 20 feet thick. Several slides similar to this have been identified in the churn drill holes put down on Lightning Creek over the years to outline the deep channel some 160 feet below the present creek. Benches have been mined, on the south side of Lightning Creek in the past some 100 feet below the surface and it is possible there may well be a deeper bench in this area, however, the shallow bench probably does not exist.

2. The detail seismic work indicates a possible deep channel near the north-east end of the lower bench immediately northeast of the confluences of Lightning and Wingdam Creeks. The possible deep channel in this area was indicated on two seismic lines. On both lines typical boulder clay velocities were recorded above bedrock. The exact depth of the channel could not be determined with the seismic work due to surface conditions. Bedrock depths in the channel would be greater than 75 feet below the surface. It is quite possible that due to the location of the lines, that this indicated channel could be part of the deep Lightning Creek channel as outlined by churn drill holes to the northwest. If this is true, however, then there is a sharp local bend or meander of the old channel not mapped by the drilling. It is possible that this indicated channel on the seismic survey, is a tributary of the old deep channel of Lightning Creek. It is very interesting and possibly significant to note that very poor gold values were obtained in the churn drill holes located southwest of the confluence of Lightning and Wingdam Creeks.

WHM

Since there is a possibility that Lightning Creek did flow to the north-east into the Willow River in its past history and very little gold has been found in the old channel southwest of this area, further exploration work and testing should be done on the indicated channel which could be a tributary to the deep Lightning Creek channel.

4. A possible deep channel was indicated on the seismic work some 1300 feet up Wingdam Creek from its confluence with Lightning Creek. The exact depth to bedrock could not be determined with the seismic work due to surface conditions. Boulder clay velocities were recorded below the surface. Lower velocities, possible gravel were recorded below the boulder clay. Steep bedrock interphase with possible faulting recorded on the northeast end of the line. There is a possibility that this may be part of the same deep channel indicated near Lightning Creek to the northwest. If this is true then the old channel (possible tributary to Lightning Creek channel) would have a general northerly trend. Further exploration work in this area should try to establish this trend.

RECOMMENDATIONS

Further exploration work in the form of refraction seismic surveys, possible test pitting and drilling, is recommended to determine both the trend and depth to possible auriferous gravels in the areas of the indicated deep channels. An access road will have to be built to the possible deep channel area on Placer Mining Lease 6106 northwest of Wingdam Lake. Bulldozer trails will also have to be made to areas of future seismic surveys due to the thick underbrush in the vicinity of Wingdam Creek. It is very possible that if an access road can be made into Wingdam Creek, near where the

WHM

possible deep channel cuts the creek, the channel can be tested with a backhoe provided there is sufficient surface relief at the point of intersection. It appears possible on the topographic map but it depends on the trend of the channel which will have to be determined first. A drill will have to be used to evaluate the possible deep channel near the confluence of Wingdam and Lightning Creeks.

Respectfully submitted,

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. H. MYERS
Expiry Date: June 16, 1979

Wm. Howard Myers, P.Eng.(B.C.), P.Geol.(Alberta)
Geological-Geophysical Consultant
427 - 510 West Hastings Street
Vancouver, B. C. V6B 1L8

December 1978

APPENDIX

WHM

BIBLIOGRAPHY

British Columbia Department of Mines
Bulletin # 3 Douglas Lay, 1940
Bulletin # 11 Douglas Lay, 1941

Canada Department of Mines
Memoir #181, G. Hansen, 1935
Bulletin #149, Johnson & Unglow, 1926

Geological Survey of Canada
Maps of the Provincial Auriferous Creeks in the Cariboo Mining Division
British Columbia - Amos Bowman, 1895

Department of Mines and Resources - Canada Mines and Geology Branch
Map # 336 A
Map # 563 A
Map # 564 A
Map # 335 A
Map # 562 A

WHM

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 refraciton 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 form a familiar low of optics known as Snell's law where $\frac{\text{Sin } i}{\text{Sin } r} = \frac{V1}{V2}$.
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

WHm

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° then the above equation (Snell's law) becomes $\text{Sin } i_C = \frac{V_1}{V_2}$.

Interpretation:

The process of refraciton 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 form 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 form 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 Thickness = $\frac{XV1}{2} \sqrt{\frac{V2-V1}{V2+V1}}$, where XV1 is the horizontal distance from the zero point or detector to the change from velocity one to velocity two. The function $\sqrt{\frac{V2-V1}{V2+V1}}$ for the different velocities can be plotted on a graph so that a direct read out can be determined for

WHM

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 $D_2 = 0.8D_1 + \frac{XV-2}{2}\sqrt{\frac{V3-V2}{V3+V2}}$ (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 shop 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.

WHM

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.

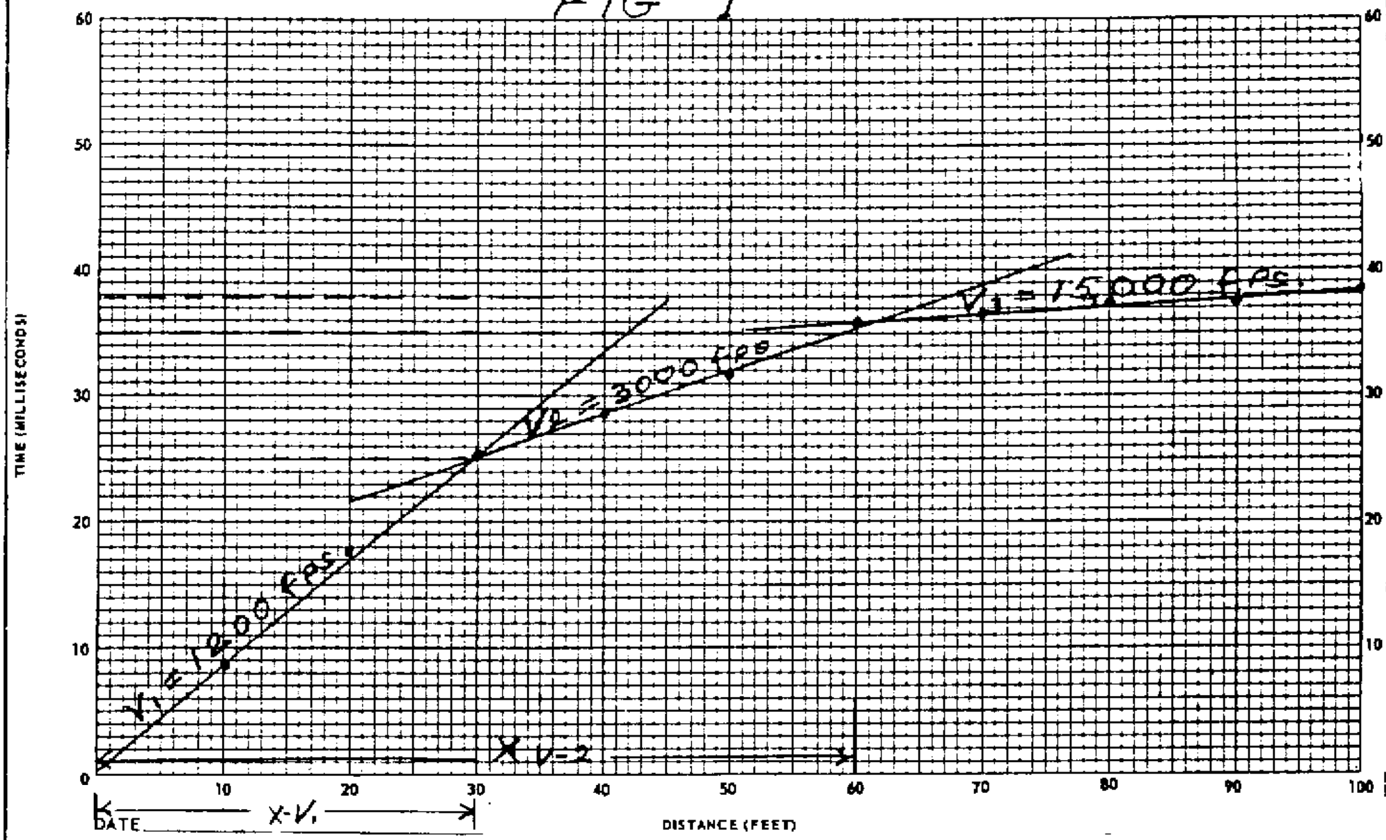
(d) Type of bedrock and possible weathering or faulting.

(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.

WHM

FIG #1



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

$v_1 = \frac{30}{.025} = 1200$ FPS - $V_2 = \frac{30}{.010} = 3000$ FPS - $V_2 = \frac{40}{.0027} = 15{,}000$ FPS

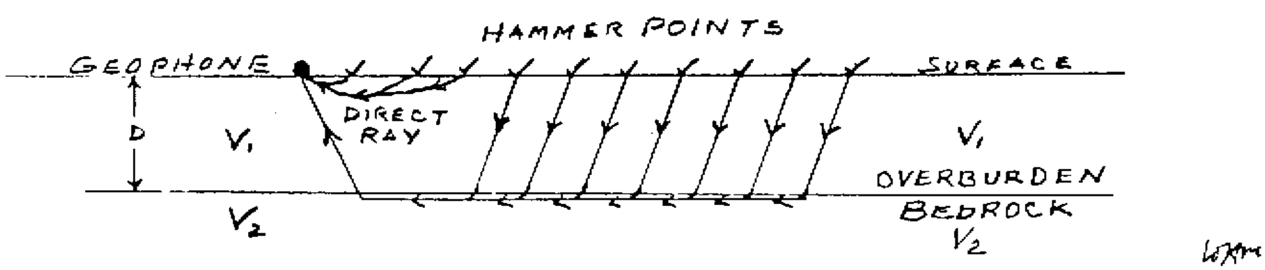
Depth Calculation - $D_1 = \frac{XV\text{-}1}{2}\sqrt{\frac{V2-V1}{V2+V1}}$ - $D_2 = \frac{XV\text{-}2}{2}\sqrt{\frac{V3-V2}{V3+V2}} + 0.8\ D_1$

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

Results:

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

FIGURE # 2



TYPES OF PLACER GOLD DEPOSITS
CARIBOO AREA, BRITISH COLUMBIA

by

Wm. Howard Myers, P.Eng., (B.C.), P.Geol., (Alberta)
Consultant, Vancouver, B. C.

December 1978.

Placer gold deposits in the Cariboo Area of British Columbia, can be divided into three general categories or types based primarily on mode of occurrence. The three types of deposits are: (1) Pre-glacial, Tertitary channel or "gut gravels", (2) Interglacial,(3)Post-glacial or recent.

Pre-glacial, Tertiary or "gut gravels"

During the Tertiary Era the streams were carrying a high mineral content due to severe erosion caused by uplift of the general area. The heavy mineral content was also high at this time. The heavy minerals were deposited in areas where favourable placer traps were produced by a change in velocity of the stream. The change in velocity in general was produced by a change in the gradient of the stream bed or a change in direction of the stream. By nature the size of this type of deposit is not large and usually takes the form of a bar or bench in or near the stream bed. The inside of a bend would produce a lower or slower velocity consequently would be more favourable for heavy mineral concentration. When the concentration was exposed to the air oxidation took place and the material was cemented. In many Tertiary or gut gravels deposits in the Cariboo the cementation is so strong that the rocks or gravel will break before the cementing material breaks. These deposits are usually reddish brown in colour due to the oxidation of the pyrite and other minerals. Rich con-

WHM

centrations of placer gold are usually found near or in close proximity to lode gold mineralization since gold does not move very far down stream due to its high specific gravity.

The drainage pattern in Tertiary Era was substantially different than the present pattern. It has been well estbalished that the Fraser River flowed to the north into the Peace River drainage during Tertiary times (Douglas Lay, Bulletin No. 11, British Columbia, Department of Mines, 1941). There is good evidence that Lightning Creek flowed to the north through Beaver Pass into the Willow River before the glacial epoch or even later. This is in sharp contrast to the present drainage into the Cottonwood River to the south. The gradient of the streams during the Tertiary Era was also greater than the present stream gradient. The reconstruction of the old Tertiary drainage pattern in the Cariboo Area, as compiled by the writer has produced some very interesting and potential placer gold deposits away from present stream beds.

Inter-glacial Deposits

Inter-glacial placer gold deposits were formed primarily between glacial expochs or from the melting of the glaciers. In general there are two types of interglacial deposits. The residual interglacial deposit is formed by the sand gravel and clay being washed away by the water from the melting ice and the heavy minerals including gold remaining to be concentrated downward on bedrock or false bedrock. Where there was sufficient water to form streams or rivers large enough to carry the heavy minerals then they were concentrated in normal placer traps. Interglacial deposits in general are not as rich as gut or channel gravels, however, they are usually larger in

WHm

lateral extent. In most instances interglacial deposits are related to the pre-glacial drainage pattern rather than present drainage.

Post-Glacial Deposits

Post-glacial or recent placer gold deposits are those formed in or in close proximity to present streams. The source for the gold is primarily glacial drift material therefore it is not necessary to have near by lode gold mineralization. Post-glacial deposits are usually in the form of bars or benches formed in areas of favourable placer traps in or near the stream. Gold values per cubic yard are usually smaller than the other two types of placer gold deposits. In most instances the gold flakes are small (flour gold or micron gold) and present a problem in concentrating. Post-glacial deposits have an advantage over other types of deposits in that they have less overburden to remove, and the sand or gravel of the deposit is cleaner and free of clay. Many of the deposits in the Fraser River are the post glacial type of deposit with enrichment from local lode gold mineralization.

WHM

<u>CERTIFICATE</u>

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 fourteen 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 1939 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 fourteen years. The detailed refraction survey field work was carried out on the following days during the 1978 season: August 14, 18, 26, September 5, 12, 13, 16, 18, 20, 21, 23, 26, 1978. A total of 12 full days were spent in the field. A total of six days was spent in the office computing and plotting the field data. The topographic map, enclosed with this report and used to plot the location of the detailed seismic survey, was prepared by McElhanney Surveying and Engineering, Vancouver, B. C. from aerial photography flown in 1977. The cross sections along each of the eleven seismic lines and enclosed in the report was prepared by myself and drafted by Versatile Industries Ltd., Vancouver, B. C..

WHM

I have no interest in the property or securities of the Company 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.

Wm. Howard Myers, P.Eng. (B.C.)., P.Geol.(Alberta).
Consultant.

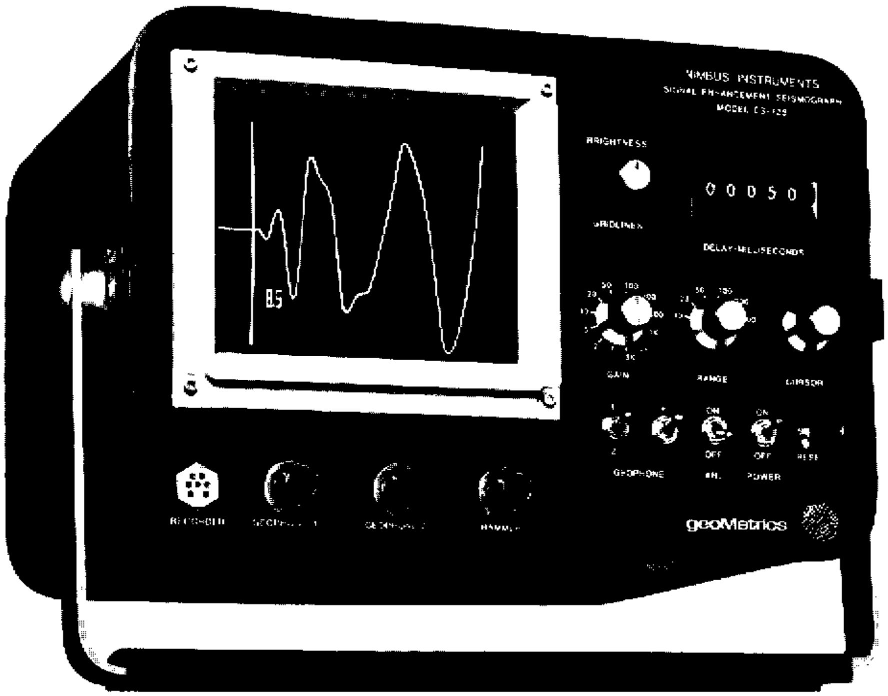
December 1978.

PROFESSIONAL
PROVINCE OF
W. H. MYERS
BRITISH COLUMBIA
ENGINEER
Expiry Date: June 16, 1979

Nimbus Instruments
A Division of geoMetrics INC.

SIGNAL ENHANCEMENT EXPLORATION SEISMOGRAPH

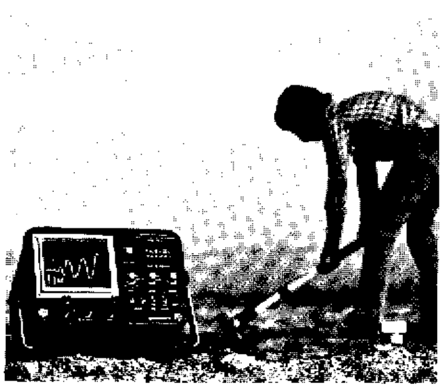
Model ES-125



- One-man operation.
- Signal enhancement for greater sensitivity, improved waveform definition and more accurate time measurements. Lets you operate under high natural and man-made background noise conditions.
- *Exclusive* automatic noise limiting and start-inhibit alarm prevents waveform loss because of transient, high-level noise being stacked into memory.
- Continuous waveform display.
- Daylight-visible CRT display—the largest available on a single-channel instrument. Special viewing hood not required. Grid lines aid readout.
- *Exclusive* vertical line cursor on CRT display. Does not distort waveform and is easier to read than conventional marker pips.
- Stepped gain control for fast reset to the same absolute value each operation.
- 100 μsec resolution.
- Memory size: 8 bits x 256 words (256 x 256 points).
- Solid state hammer switch.
- Hammer delay adjustable from 0 to 9999.9 milliseconds. Automatically added to arrival time.
- Record duration switch from 10 to 400 msec.
- 8-hour performance from internal rechargeable battery. Charger included.
- Strip chart recorder output.
- Shear wave measurement capability.
- Utilizes latest LSI technology—compact, low cost, simple to operate. Rugged, all-aluminum case.

- Preliminary site geology for highways, pipelines, and other structures.
- Detailed foundation investigations including site response.
- Estimating excavation costs (rippability).
- Evaluating gravel deposits.
- Groundwater studies.
- Mineral and geothermal exploration.
- Landslide and slope stability studies.
- Fault location.
- All other applications requiring knowledge of near subsurface characteristics.

SIGNAL ENHANCEMENT EXPLORATION SEISMOGRAPH
Model ES-125



The Nimbus Model ES-125 offers more convenience and performance features than any other instrument in its price range. Using time-proven, signal enhancement techniques, automatic noise limiting and the latest in electronic technology, the ES-125 is the ideal instrument for all shallow seismic exploration needs.

The Model ES-125 is an excellent instrument for professional geologists and a low-cost, easy-to-use tool for soil engineering firms, contractors and other organizations with varied subsurface exploration needs. The ES-125 is ideal for use as a teaching instrument. Its low cost may warrant having several units in operation at a time. Explosives are not required, and because the operation is simple, students can concentrate on the application rather than the instrument.

SIGNAL ENHANCEMENT

Most shallow seismic exploration utilizes sledge hammers or other mechanical sources to produce shock waves. These sources are easier and safer to use than explosives, but exploration depth can be limited when the seismic waves are masked by man-made or natural background vibrations.

Nimbus seismographs have a unique signal enhancement feature that provides greater sensitivity to weak wavefronts. As hammer impacts are repeated, the signals are added in the equipment's digital memory. As shown to right, random background signals cancel out, while the desired signal grows progressively larger. This simplifies selection of arrival times, and lets the operator survey greater distances with smaller energy sources.

NEW AUTOMATIC NOISE LIMITING

The ES-125 is the only seismograph offering automatic noise limiting, a feature which interrupts operation and lets the operator know when transient, high-level noise exceeds a preset limit. This feature alleviates the common frustration of inadvertently spoiling a good waveform, as well as wasting hammer blows and survey time, when high level noise is present. Your survey goes faster and you are sure of consistent, accurate results.

OTHER NEW FEATURES

The new ES-125 incorporates several new features not available elsewhere. Battery life has been extended to 8-hours, enough for up to three days in the field. The daylight-visible CRT is the largest available on a single-channel instrument. It produces a clear, sharp display, eliminating the need for viewing hoods or waveform controls. Its exclusive vertical CRT cursor is easier to read than marker pips and does not distort the waveform. Arrival times are displayed on the screen.

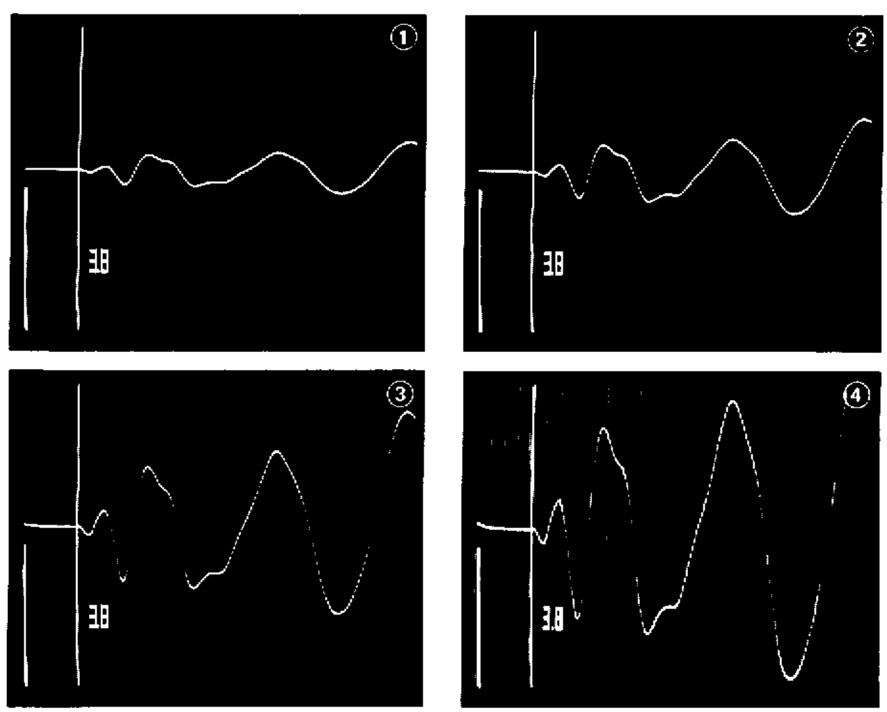
The ES-125 utilizes a stepped gain control instead of the normal volume-control type, providing for quick resetting to the same absolute value each operation. A 9999.9 millisecond delay circuit allows the operator to delete early insignificant signals and maintain the best combination of range and control settings. The delay time is automatically added to the arrival time eliminating the possibility of addition errors. For permanent record, the ES-125 adapts to standard oscilloscope cameras and strip chart recorders. Grid lines are provided so that timing information is preserved on the photograph or chart record.

Two-geophone operation is provided together with a polarity switch for shear wave surveys. A solid-state hammer switch, three times as fast as the traditional mechanical switch and having much lower timing error scatter, can be used with any hammer. The instrument is compact, lightweight, and can be easily backpacked and operated by one person. The unit comes complete with geophone, 90 meter cable, hammer switch, battery charger, striker plate and manuals.

SEISMIC EXPLORATION

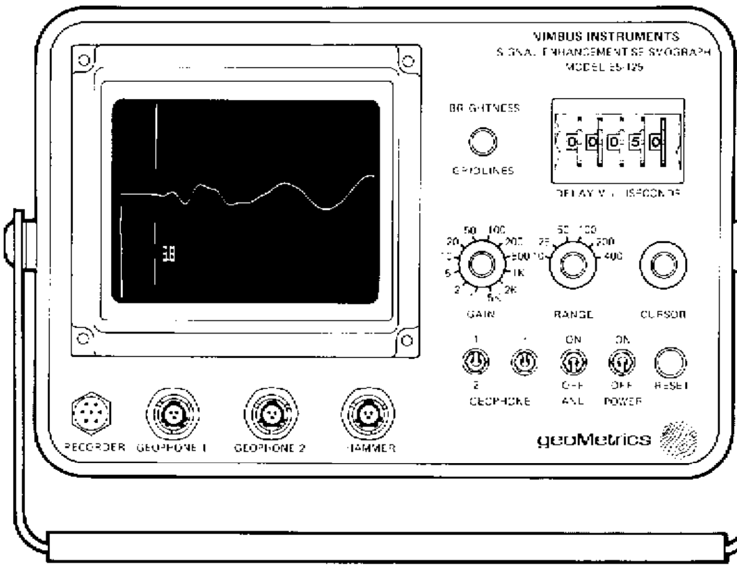
As shown to right, shock waves are generated by striking a metal plate with a hammer. The resulting waves propagate through the earth at a velocity dependent upon the compressive and shear strengths of the soil and rock. In general, shock waves travel much faster through hard, solid materials such as bedrock than through loosely packed topsoil. It is this difference that makes the seismograph useful in determining subsurface characteristics.

As illustrated, a seismograph and a vibration sensor (geophone) are set up at the point of interest. Successive hammer blows are struck at measured distances to produce shock waves for



Actual unretouched photos

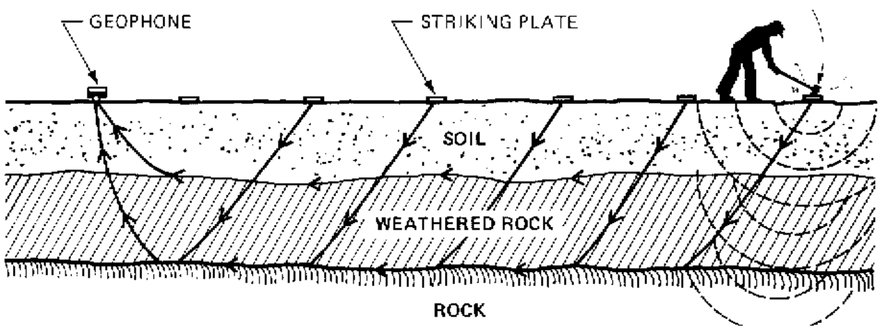
With signal enhancement, the desired signal is built up with repeated hammerblows, while unwanted background signals cancel out. Exclusive Nimbus vertical cursor simplifies line-up on point of first arrival, with time displayed simultaneously on CRT. Unique grid line feature, adjustable by front panel control, aids readout.



SIMPLE FOUR-STEP OPERATION

Despite its sophistication, the ES-125 is simple to operate and requires only a minimum of training for field personnel. After initial set-up, the following four-step procedure is all that is required at each survey point:

1. Select time RANGE and GAIN.
2. Strike ground as many times as is necessary to bring up a useable signal.
3. Turn CURSOR knob until the marker lies over first arrival. The seismic signal is continuously displayed for leisurely examination of the wave-form. Arrival time is shown on CRT.
4. Record time on graph pad and erase waveform.



detection by the geophone. As the spacing between the impact and the sensor is increased, the waves which refract through the deeper layers will arrive first, because part of their travel is through higher velocity materials. The arrival times, when plotted against distance, reveal the nature of the underground layering.

The waveform of the shock wave detected by the geophone is displayed on the seismograph CRT, or on an optional strip-chart recorder. When using the GeoMetrics/Nimbus ES-125, the operator merely moves a cursor to the first arrival of the wavefront as shown previously. The time is instantaneously displayed in milliseconds.

DATA REDUCTION

A graph is plotted of arrival times vs. distances between the striking plate and the geophone. As shown to right, "best fit" lines are drawn through the points. In practice, the survey is usually run in both directions resulting in two sets of overlapping lines. There will be a straight line segment for each subsurface layer, with the slope of each line segment equaling the apparent velocity in that layer.

The depths of each layer can be calculated as follows:

$$D_1 = \frac{X_{c_1}}{2}\sqrt{\frac{V_2 - V_1}{V_2 + V_1}} \quad \text{and}$$

$$D_2 = 0.8\,D_1 + \frac{X_{c_2}}{2}\sqrt{\frac{V_3 - V_2}{V_3 + V_2}}$$

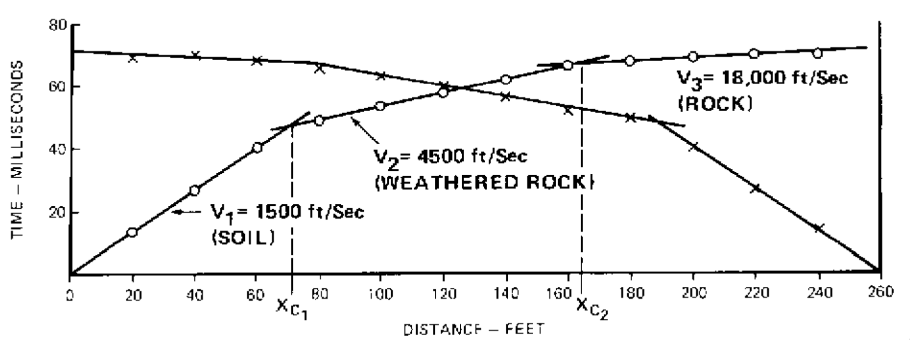
X_C = critical distances, where straight line segments intercept. V = velocity. D_1 = depth of first layer, D_2 = depth of second layer.

Irregularities, such as faults, dipping layers, large boulders, stream channels, dikes, lateral changes, etc., will produce corresponding irregularities in the time-distance graph. A number of solutions are available to solve for these various geometries by graphical means, pocket calculators or computer programs.

INTERPRETATION AND APPLICATION

The time-distance plot is used to draw a cross-sectional map of the subsurface below the survey line; delineating layers and structures with differing seismic velocities. When the velocities are coupled with knowledge of the local geology, the types and depths of material can be predicted.

This structural-material cross-section is useful in a wide variety of geological applications. The procedure of gathering and reducing the data is largely mechanical and easily learned. While geological interpretation comes into play, many applications do not require a wide range of expertise. Whatever your particular field, better subsurface knowledge obtained from seismic surveys can add immeasurably to your job. Complete applications information is available from GeoMetrics/Nimbus to assist field surveys.



Specifications

SIGNAL ENHANCEMENT

Incoming signals are sampled, digitized, and stored in a random access memory. Repeated signals are added while random noise is cancelled, or limited.

AUTOMATIC NOISE LIMITING

Background noise is monitored and start function is inhibited at adjustable levels. Noise limiting ON/OFF controlled by front panel switch.

MEMORY SIZE

8 bits x 256 words (256 x 256 points)

DISPLAY

Solid-state (except CRT) display, daylight-visible without special viewing hoods. Screen size 8 x 10 cm (3" x 4"). Continuously displays contents of memory (until erased), vertical line cursor, cursor time corrected for delay, battery level, and relative background vibrations.

TIME DISPLAY

On-screen display of cursor time to six digits. Resolution 100-microseconds on all ranges.

GRID LINES

When Brightness/Grid Line Knob is out, vertical lines are superimposed on the record to provide timing information on photographic copies of display. Time interval between grid lines varies with range switch setting to provide maximum resolution regardless of range.

NOISE LEVEL MONITOR

Leading edge of record bounces up and down in response to ground vibrations. Allows rapid selection of gain adjustment.

RECORD LENGTH

Switch selectable record duration: 10, 25, 50, 100, 200, or 400 milliseconds.

OPERATING CONTROLS

Range, Gain, 5-turn Cursor position, Delay Time, Geophone Selector, Geophone Polarity, Automatic Noise Limiter (ANL), Power, Reset, Brightness/Grid Lines.

GAIN

12-position, stepped gain control adjustable from 1 to 5000 in 1-2-5 stepping sequence.

RECORDER OUTPUT

Recorder output provides waveform and timing signals. Slow mode accesses memory in about 8 seconds so pen recorders can be used.

TIMEBASE

Crystal controlled clock synchronizes timing measurements with a basic accuracy of 0.01%.

TRIGGER

Start of record initiated by solid-state hammer switch, contact closure or saturated NPN transistor.

DELAY

Switch selected delay postpones start of record from 0 to 9999.9 milliseconds. Amount of delay is automatically added to time display so that cursor time indicates correct value without separate calculations.

POWER

Internal 7.5 AH battery provides approximately 8 hours operation. Can also be powered externally from any 12 VDC source.

BATTERY LEVEL

Indicated by vertical line on left edge of screen. Full scale approximately 14 volts, bottom edge approximately 10 volts.

BATTERY CHARGER

AC Battery Charger (110/220 V; 60/50 Hz) provides initial fast charge and automatic switchover to standby operation with light indicating that battery is charged.

PHYSICAL

Size: 28 x 18 x 28 cm (11 x 7 x 11 inches)
Weight: 7.7 kg (17 lbs)

SYSTEM INCLUDES

Seismograph, Geophone, 90 Meter (300 ft.) Hammer-geophone Extension Cable, Solid-State Hammer Switch, 110-220 volt Battery Charger, Striking Plate and Manual.

OPTIONAL ACCESSORIES

ESR-100	Strip Chart Recorder
C-5	Camera
HVB-1	High Voltage Capacitance Discharge Blaster
BP-1	Auxiliary Battery Pack (requires PC-1 and may require BC-3 depending on your application)
PC-1	Auxiliary Power Cable, ES-125 to Cigarette Lighter Plug
GH-3	Geophone, Horizontal

SPARE ITEMS*

GV-3	Geophone, vertical
EC-3	90-meter extension cable
HS-3	Solid-State Hammer Switch
SP-1	Aluminum Striker Plate
B-3	Replacement battery (two required) Globe GC-680
RP-1	Recording paper for ESR-100
BC-3	Battery charger, 110-200 VAC input, automatic fast charge

*A complete set of circuit boards and specialized hardware is available for extended operation in remote areas.

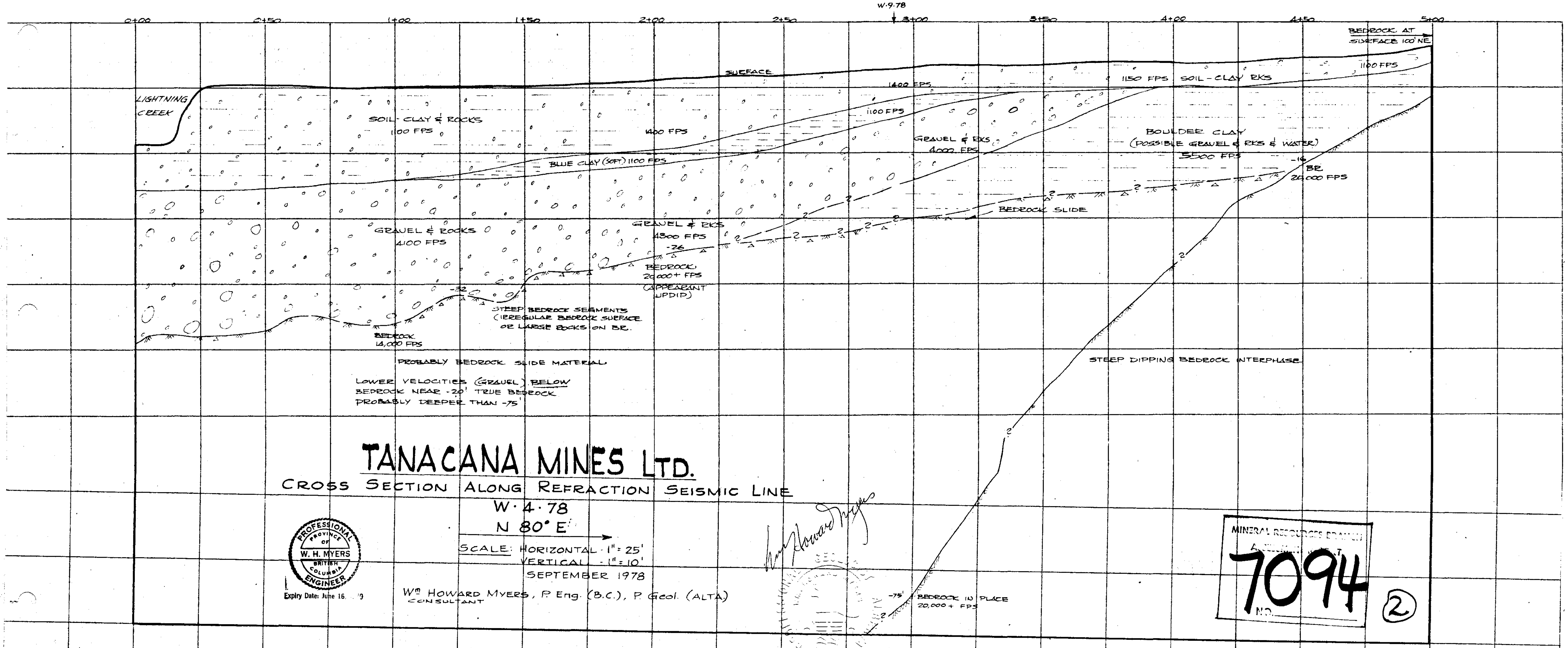
geoMetrics, INC.
A SUBSIDIARY OF EG&G
395 JAVA DRIVE
SUNNYVALE, CA. 94086 U.S.A.
TEL: (408) 734-4616
CABLE: GEOMETRICS
TELEX NO. 357-435

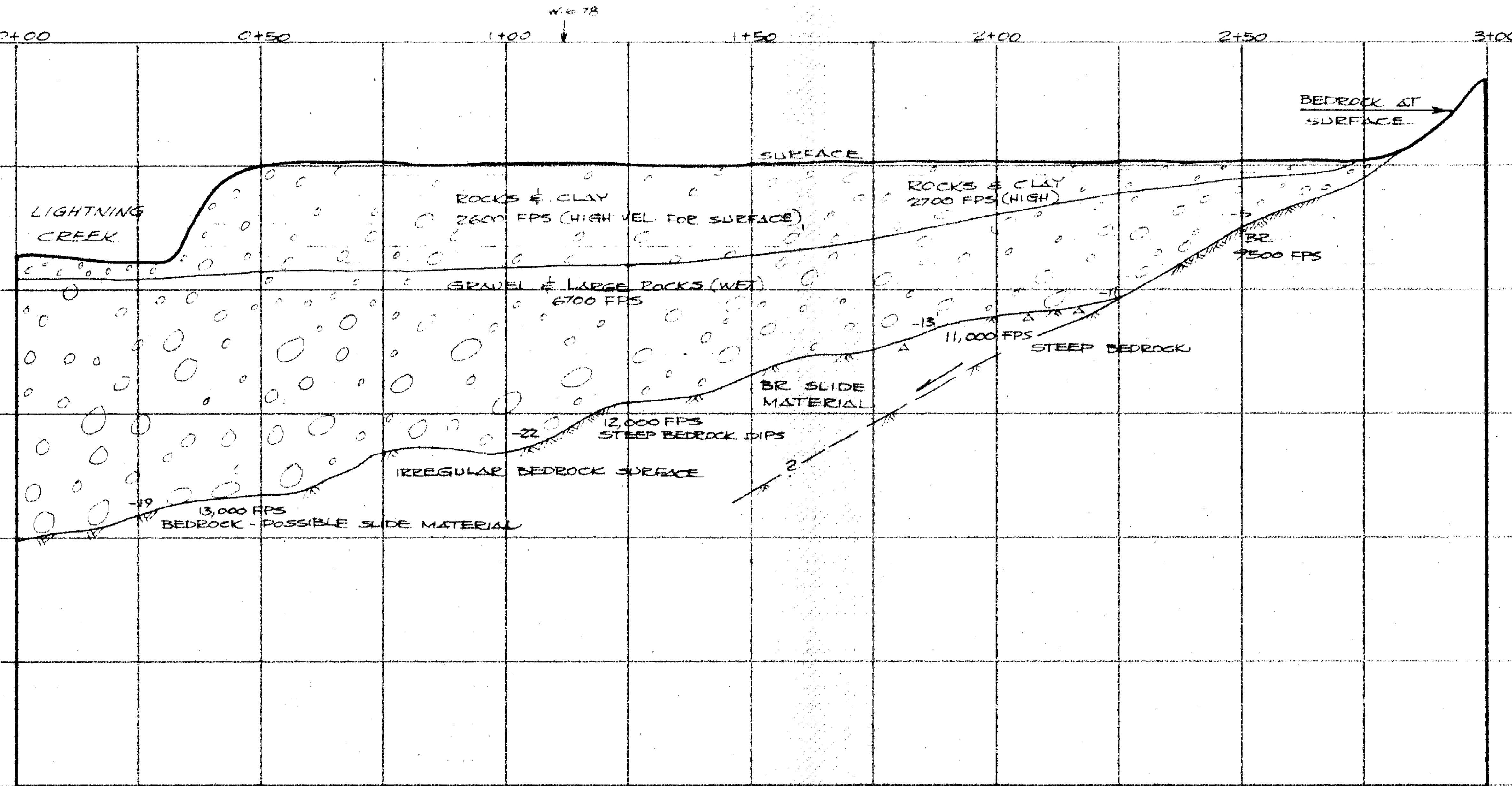
geoMetrics SERVICES (CANADA) LTD.
436 LIMESTONE CRESCENT
DOWNSVIEW (TORONTO)
ONTARIO, CANADA
TEL: (416) 661-1966
TELEX NO. 06-22694

geoMetrics INTERNATIONAL CORP.
80 ALFRED ST.
MILSONS POINT
SYDNEY NSW 2061
AUSTRALIA
TEL. 929-9942
TELEX NO. 790-22624

WORLD-WIDE AGENTS: EUROPE SCANDINAVIA UNITED KINGDOM JAPAN SO. AFRICA SO. AMERICA

BEDROCK AT SURFACE 100' SE.
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
11+50
12+00
12+50
13+00
W·1·78 N 60 W
W·2·78 N 70 W
W·3·78 N 75 W
1300 FPS
2100 FPS
3000 FPS
HIGH SURFACE VELOCITY
POSSIBLY MORE ROCKS
SURFACE
BEDROCK
10,000 FPS
4300 FPS
SOIL - CLAY & ROCKS
1900 FPS
1800 FPS
4600 FPS
SOIL - CLAY & ROCKS
BEDROCK
9500 FPS
4200 FPS
6100 FPS
HARD PAN
OR
BOULDER CLAY
BEDROCK
10,000 FPS
6100 FPS
3700 FPS
1500 FPS
BEDROCK
10,000 FPS
GRAVEL WITH SOME CLAY - (DRY)
SURFACE
1300 FPS
1100 FPS
1100 FPS
STEEP SURFACE
3800 FPS
CLAY & ROCKS
NO GRAVEL VELOCITIES
NO HARD PAN VELOCITIES RECORDED
IN THIS AREA
3800 FPS
1600 FPS
CLAY & ROCKS
NO BEDROCK VELOCITIES RECORDED
BEDROCK DEEPER THAN 42'
BELOW SURFACE
BEDROCK
9500 FPS
POSSIBLE BLUE CLAY
2600 FPS
NO BEDROCK
WITHIN 42'
NO BEDROCK VELOCITIES RECORDED ON SEISMIC SURVEY
IN THIS AREA
POSSIBLE DEEP CHANNEL
TANACANA MINES LTD.
CROSS SECTION ALONG REFRACTION SEISMIC LINES
W·1·78, W·2·78, W·3·78
SCALE HORIZONTAL 1" = 50'
VERTICAL 1" = 10'
SEPTEMBER 1978
WM HOWARD MYERS, P. Eng. (B.C.), P. GEOL. (ALTA)
CONSULTANT
PROFESSIONAL
PROVINCE
OF
W. H. MYERS
BRITISH
COLUMBIA
ENGINEER
Expiry Date: June 16, 1979
MINERAL RESOURCES BRANCH
ASSESSMENT REPORT
7094
NO.
①


W-9-78
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
BEDROCK AT SURFACE 100' NE
SURFACE
1100 FPS
1150 FPS SOIL - CLAY RKS
1400 FPS
LIGHTNING CREEK
SOIL - CLAY & ROCKS 1100 FPS
1400 FPS
1100 FPS
GRAVEL & RKS 4000 FPS
BOULDER CLAY (POSSIBLE GRAVEL & RKS & WATER) 5500 FPS
BLUE CLAY (SOFT) 1100 FPS
-16
BR 20,000 FPS
BEDROCK SLIDE
GRAVEL & ROCKS 4100 FPS
GRAVEL & RKS 4300 FPS
-26
BEDROCK 20,000+ FPS (APPEARANT UPDIP)
-32
STEEP BEDROCK SEGMENTS (IRREGULAR BEDROCK SURFACE OR LARGE ROCKS ON BR.
BEDROCK 14,000 FPS
PROBABLY BEDROCK SLIDE MATERIAL
LOWER VELOCITIES (GRAVEL) BELOW BEDROCK NEAR -20' TRUE BEDROCK PROBABLY DEEPER THAN -75'
STEEP DIPPING BEDROCK INTERPHASE
-75'
BEDROCK IN PLACE 20,000+ FPS
TANACANA MINES LTD.
CROSS SECTION ALONG REFRACTION SEISMIC LINE
W-4-78
N 80° E
SCALE: HORIZONTAL - 1" = 25'
VERTICAL - 1" = 10'
SEPTEMBER 1978
PROFESSIONAL PROVINCE OF BRITISH COLUMBIA W. H. MYERS ENGINEER
Expiry Date: June 16, 1979
Wm HOWARD MYERS, P. Eng. (B.C.), P. Geol. (ALTA)
CONSULTANT
MINERAL RESOURCES BRANCH
ASSESSMENT REPORT
7094
NO.
2



TANACANA MINES LTD.

CROSS SECTION ALONG REFRACTION SEISMIC LINE

W·5·78

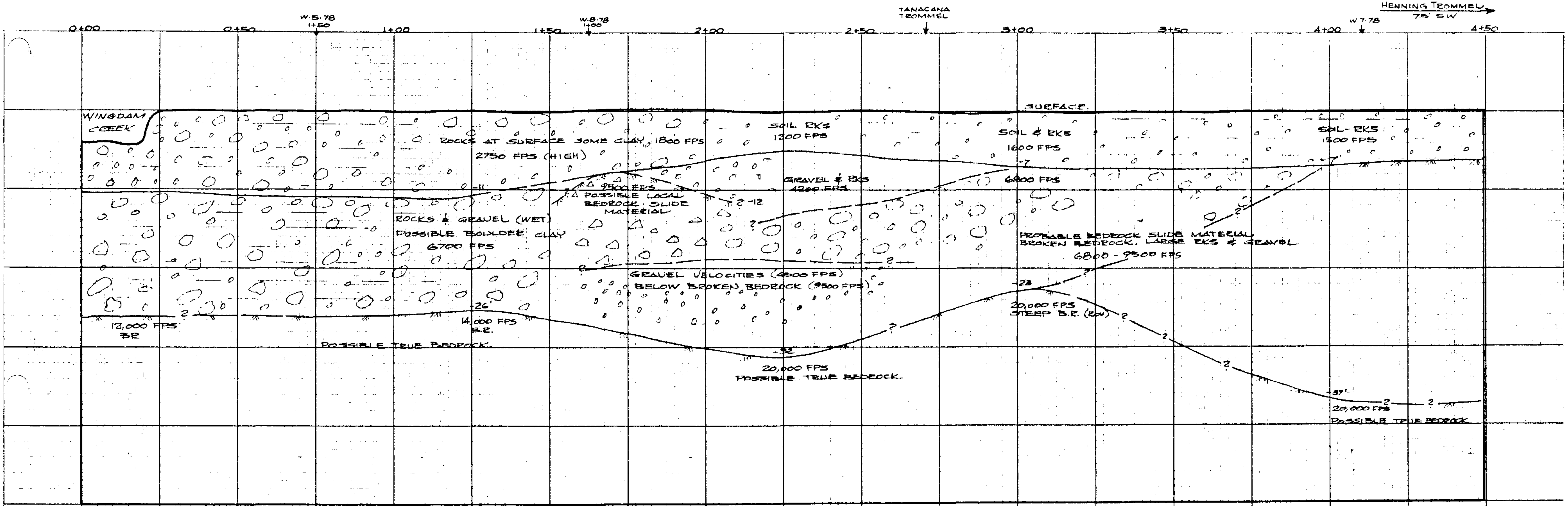
S 50° E →

SCALE: HORIZONTAL - 1" = 25'
VERTICAL - 1" = 10'
SEPTEMBER, 1978

Wm HOWARD MYERS, P. Eng (B.C.), P. Geol. (ALTA.)
CONSULTANT

[signature]

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — W. H. MYERS
Expiry Date: June 16 1979



TANACANA MINES LTD.

CROSS SECTION ALONG REFRACTION SEISMIC LINE
W · 6 · 78
S 50° W

SCALE: HORIZONTAL - 1" = 50'
VERTICAL - 1" = 10'
SEPTEMBER, 1978

Wm Howard Myers, P. Eng. (B.C.), P. Geol. (ALTA.)
CONSULTANT

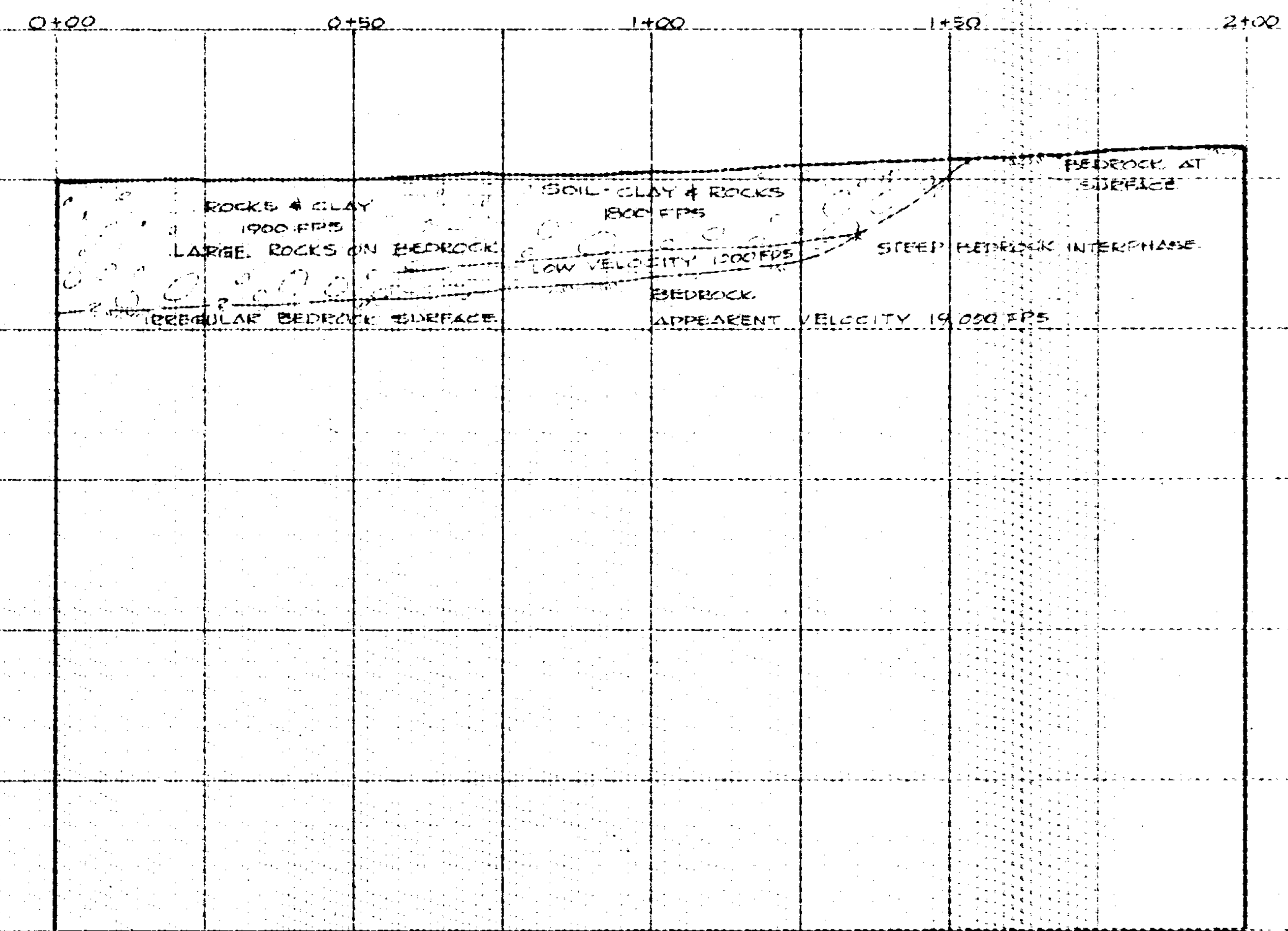
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. H. MYERS

Expiry Date: June 16, 1979

MINERAL RESOURCES BRANCH
ASSESSMENT REPORT
7094
NO.

(4)

W · 6 · 78



TANACANA MINES LTD.

CROSS SECTION ALONG SEISMIC LINE W·7·78

S 35° E.

SCALE: HORIZONTAL - 1" = 25'
VERTICAL - 1" = 10'

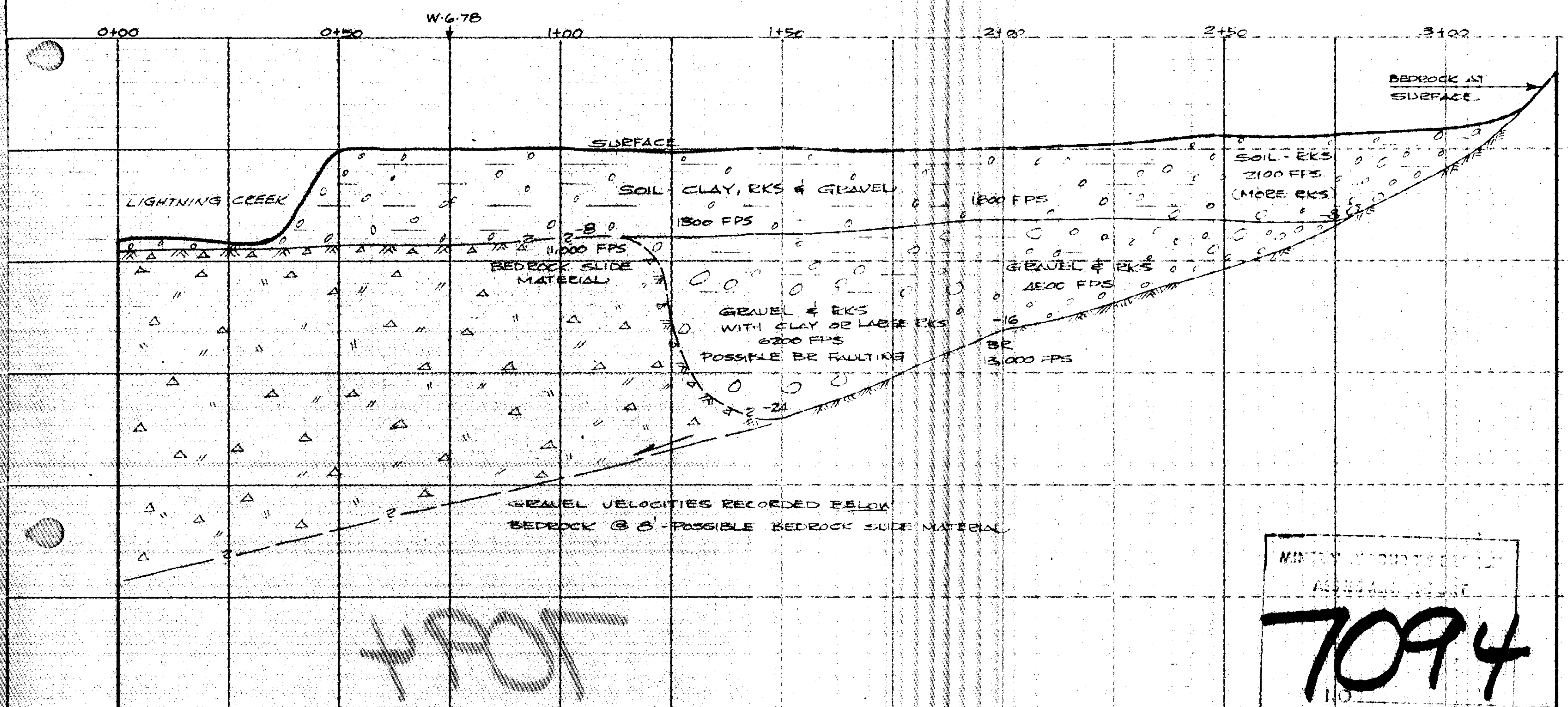
SEPTEMBER 1978

WM HOWARD MYERS, P.Eng.(B.C.), P.Geol.(ALTA.)

Expiry Date: June 16, 1979

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA W. H. MYERS

(5)



TANACANA MINES LTD.

CROSS SECTION ALONG REFRACTION SEISMIC LINE

W· 8· 78

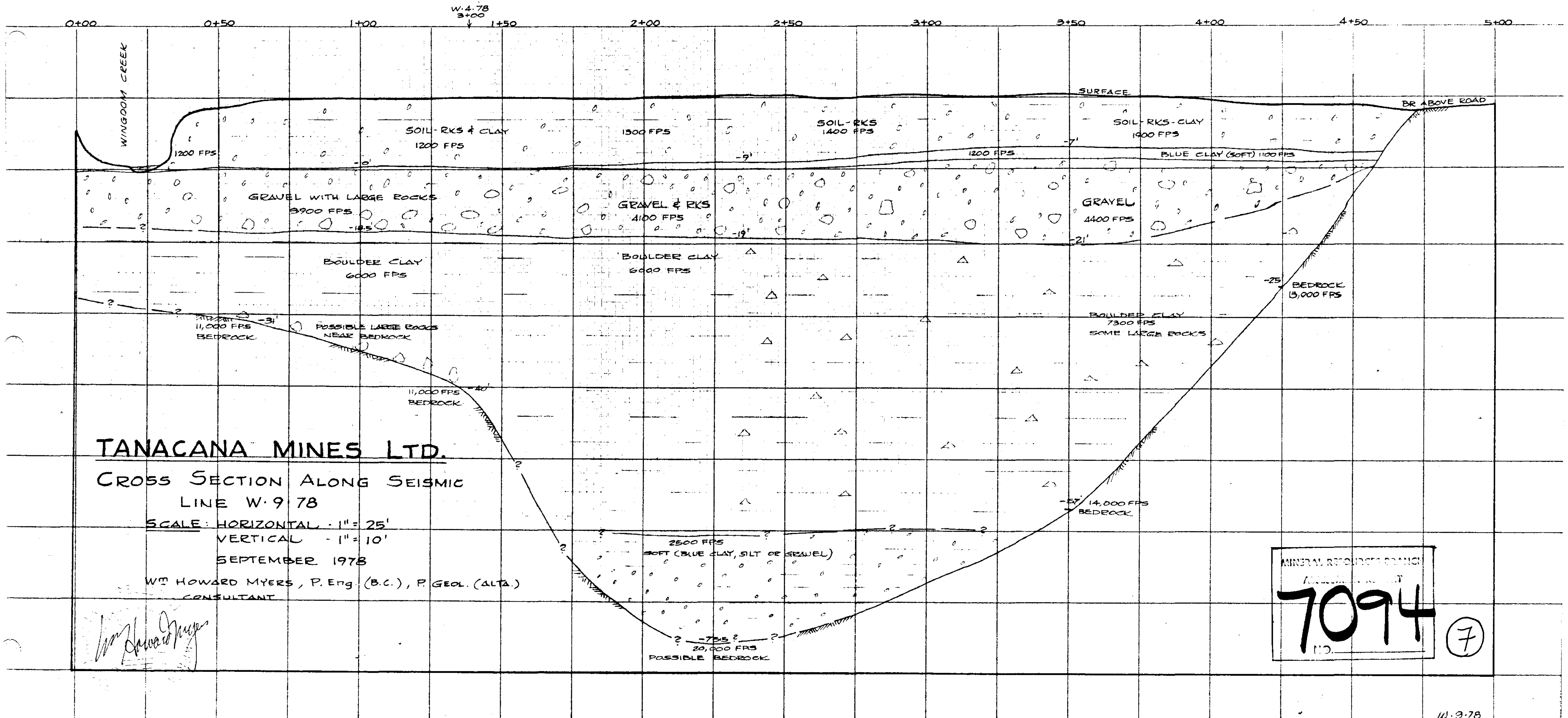
S 40° E

SCALE: HORIZONTAL - 1" = 25'
VERTICAL - 1" = 10'
SEPTEMBER, 1978

Wm HOWARD MYERS, P.Eng. (B.C.), P.Geol. (ALTA)
CONSULTANT

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — W. H. MYERS

Expiry Date: June 16, 1979



TANACANA MINES LTD.

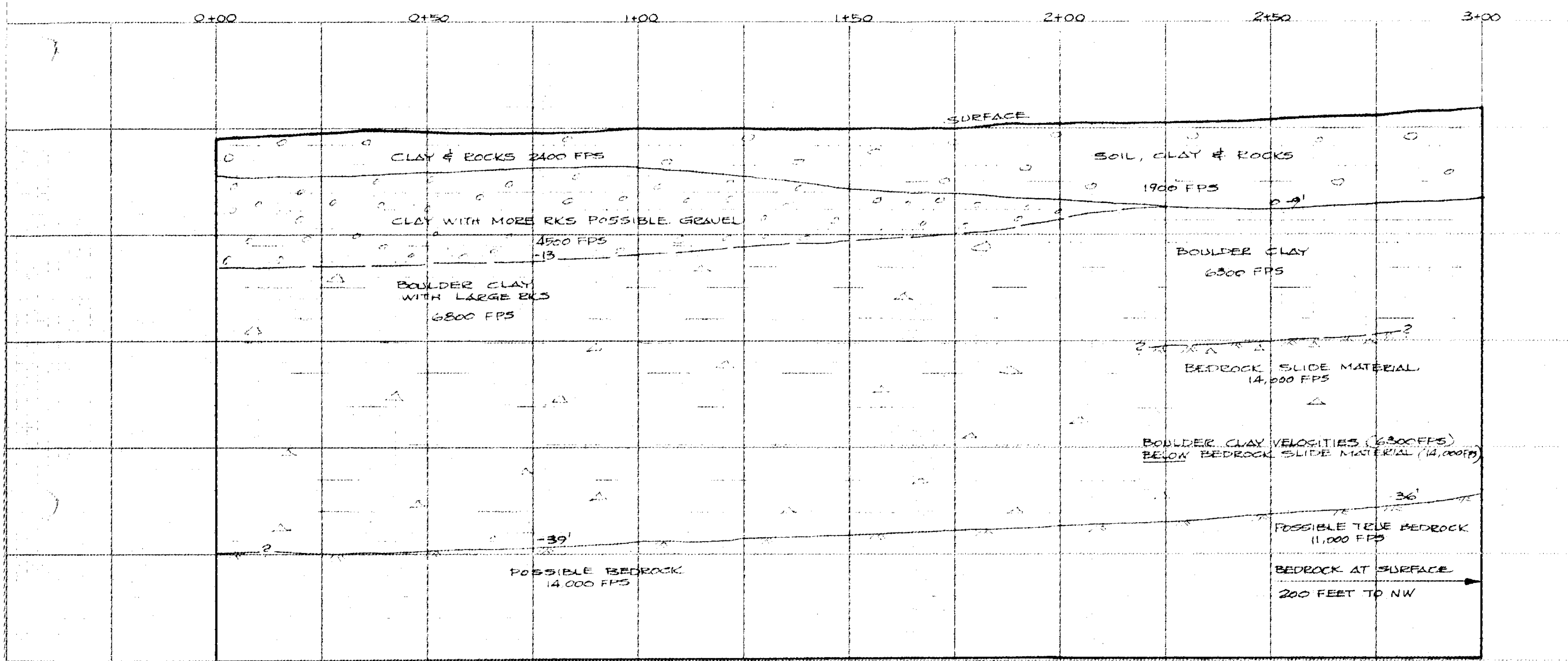
CROSS SECTION ALONG SEISMIC LINE W·9·78

SCALE: HORIZONTAL - 1" = 25'
VERTICAL - 1" = 10'

SEPTEMBER 1978

Wm HOWARD MYERS, P. Eng. (B.C.), P. GEOL. (ALTA.)
CONSULTANT

Wm Howard Myers



TANACANA MINES LTD.

CROSS SECTION ALONG REFRACTION SEISMIC LINE

W·10·78

N 80° W →

SCALE: HORIZONTAL - 1" = 25'

VERTICAL - 1" = 10'

SEPTEMBER, 1978

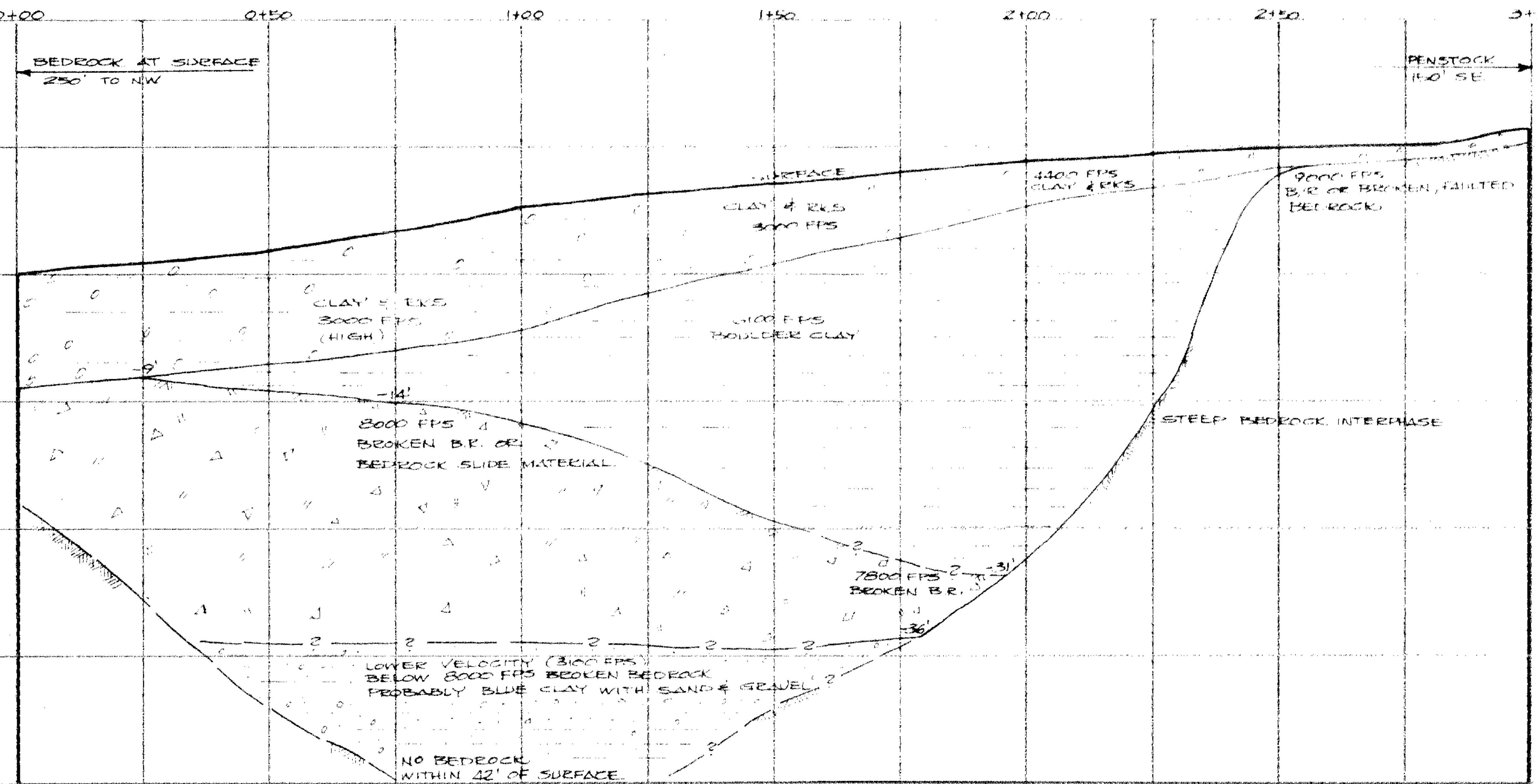
Wm Howard Myers, P. Eng. (B.C.), P. Geol. (ALTA.)
CONSULTANT

PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA, W. H. MYERS

Expiry Date: June 16, 1979

7094

(8)



TANACANA MINES LTD.

CROSS SECTION ALONG REFRACTION SEISMIC LINE W·11·78

S 30° E

SCALE HORIZONTAL - 1" = 25'
VERTICAL - 1" = 10'

SEPTEMBER 1978

Wm HOWARD MYERS, P. Eng. (B.C.), P. Geol. (ALTA.)
CONSULTANT

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. H. MYERS
Expiry Date: June 16, 1979

7094
NO.

(9)

TANACANA MINES LTD.

REGIONAL CROSS SECTION
ABCD
LIGHTNING CREEK-WINGDAM LAKE

PLACER LEASES
6708, 5332, 6106, 852, 7067
CARIBOO MINING DIVISION, B.C.

SCALE: 1" = 100' HORIZONTAL & VERTICAL

SURFACE RELIEF FROM TOPOGRAPHIC MAP BY McELHANNEY SURVEYING, 1978

SUBSURFACE DATA FROM 1978 DETAIL REFRACTION SEISMIC SURVEY

LOCATION OF CROSS SECTION SHOWN ON TOPOGRAPHIC MAP

TO ACCOMPANY REPORT ON RESULTS OF DETAIL REFRACTION SEISMIC SURVEY ON PLACER LEASES - 1978 SEASON

Wm HOWARD MYERS, P. Eng. (B.C.), P. Geol. (ALTA.)
CONSULTANT, VANCOUVER, B.C. - DECEMBER, 1978

LEGEND

W·4·78 - REFRACTION SEISMIC LINE WITH STATION No., 1978 SEASON

A B C D - CROSS SECTION - LIGHTNING CREEK TO WINGDAM LAKE

BR X - BEDROCK OUTCROP

TANACANA MINES LTD.
VANCOUVER, B.C.

11

LOCATION MAP
DETAIL REFRACTION SEISMIC SURVEY OF PLACER MINING LEASES No.'s 5332, 6106, 7067, 7092, 7117, 7074, 852

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

SCALE
200 100 0 200 400 600 FT.
61 0 61 122 183 M.

TOPOGRAPHIC MAP BY McELHANNEY SURVEYING AND ENGINEERING LTD., VANCOUVER, BRITISH COLUMBIA.
COMPILED FROM AERIAL PHOTOGRAPHY AT AN APPROXIMATE SCALE OF 1 INCH = 1670 FEET, FLOWN IN 1977.
TO ACCOMPANY REPORT ON RESULTS OF DETAILED REFRACTION SEISMIC SURVEY OF ABOVE PLACER MINING LEASES.
Wm HOWARD MYERS, P. Eng. (B.C.), P. Geol. (ALBERTA) - CONSULTANT, VANCOUVER, BRITISH COLUMBIA, DECEMBER, 1978.

Expiry Date June 16, 1979