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GEOTHERMAL SERVICE OF CANADA

SEISMIC REFRACTION STUDY IN THE MEAGER MOUNTAIN REGION, LILLOOET VALLEY, B.C., AUGUST - SEPTEMBER, 1977
12 pp., 4 figures

SEISMIC REFRACTION STUDY IN THE MEAGER MOUNTAIN GEOTHERMAL REGION, JOB CREEK AREA, UPPER LILLOOET RIVER VALLEY, B.C. NOVEMBER - DECEMBER, 1977
11 pp., 4 figures

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Earth Physics Branch Open File 78-3
Ottawa, Canada
1978

Price: $15.00

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ABSTRACT

Shallow depth profiles of the Lillooet Valley have been obtained at six locations, two below the confluence of Meager Creek, one at Meager Creek, and three in the upper valley above the confluence of Salal Creek. Sections generally show a few metres of dry sand and gravel, and up to 200 m of saturated, well consolidated sediment above bedrock. Velocities in bedrock show a wide variation, indicating different rock types.

RESUME

Dans la région de Lillooet Valley, on a obtenu des profiles de réfraction à faible profondeur en six endroits: deux, en aval du confluent de Meager Creek; un, à Meager Creek; trois, dans la partie supérieure de la vallée en amont du confluent de Salal Creek. En général les sections montrent la présence de quelques mètres de sable et de gravier secs, de sédiment saturé et bien consolidé qui a jusqu'à 200 mètres d'épaisseur. Le tout repose sur un socle dont les vitesses varient beaucoup, ce qui indique différents types de roc.

SEISMIC REFRACTION STUDY

in the

MEAGER MOUNTAIN GEOTHERMAL REGION

LILLOOET RIVER VALLEY, B.C.

August - September, 1977

for

DR. L.K. LAW
VICTORIA GEOPHYSICAL LABORATORY
DEPARTMENT OF ENERGY, MINES, & RESOURCES
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by

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October 31, 1977

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SEISMIC REFRACTION STUDY

in the

MEAGER MOUNTAIN GEOTHERMAL REGION
LILLOOET RIVER VALLEY, B.C.

INTRODUCTION

This report discusses the field procedure, computation of data and results of a seismic refraction survey carried out for Dr. L. K. Law of the Victoria Geophysical Laboratory of the Department of Energy, Mines and Resources. The project site was the upper part of the Lillooet River Valley, 43 to 63 kilometers northwest of the town of Pemberton, B.C.

The first half of the project was carried out from August 18th to 23rd, 1977 at which time it was temporarily suspended because of the forest closure due to the fire hazard. It was resumed on September 19th and finished on the 23rd, 1977. The scope of the survey consisted of three lines totalling 2,140 meters.

The purpose of the seismic work was to determine the validity of about 60 meters being the depth to bedrock previously calculated by audio-magnetotellurics and magnetic dipole surveys.

The geophysical information presented in this report is based upon our best interpretation of the field data which were collected according to generally accepted field procedures. These results are interpretive in nature and are considered to be a reasonably accurate presentation of the existing conditions within the limits of the method employed.

SUMMARY

The seismic depth profiles are shown on sheets 2 through to 5.

Profiles A and C-2 are each basically a three-layer case. Except for one small section on the west end, profile B-2 is a two-layer case.

The overburden velocities vary from 300 to 515 meters/second for unconsolidated surface material, and from 1,400 to 2,270 meters/second for consolidated water-saturated gravels.

The bedrock velocities were found to vary from 3,400 to 5,180 meters/second.

The depth to bedrock varies from 60 to 120 meters on Line A, 101 to 136 meters on line B-2 and 23 to 44 meters on Line C-2.

VELOCITY CLASSIFICATION

The following is a suggested velocity classification for the area as determined only from the immediate survey results.

Velocity (meters/second)	Suggested Classification
300 to 515	Loose, unconsolidated surface material
940 to 1,400	Partially saturated sands and gravels
2,000 to 2,270	Very consolidated, saturated sands and gravels, possibly glacial till as well.
3,400 to 3,570	Volcanic bedrock, probably of the Gambier Group
4,760 to 5,180	Granodiorite and quartz diorite bedrock.

PERSONNEL

The field crew consisted of three men as follows: the writer as geophycisist and supervisor, R.R. Fassler as geophysical technician, and Dan Pinder as helper during the first half, and David Glenn as helper during the second half.

LOCATION AND ACCESS

The project consisted of three lines located in the upper Lillooet River Valley on the north and northeast side of the river, 35 to 53 air kilometers northwest of Pemberton. Line A is located 43 kilometers by road northwest of Pemberton at Mile 11.5 (logging truck mileage) and on the northeast corner of the confluence of North Creek with the Lillooet River. Line B is located 52 kilometers northwest of Pemberton at Mile 17.5. Line C is located 63 kilometers northwest of Pemberton at Mile 24, about one kilometer past the Meager Creek confluence with the Lillooet River and at the bridge crossing of the Lillooet River. Part of this line runs on the southwest side of the river.

Access to each of the lines was excellent since they all occurred on secondary logging haulage roads and very close to the main haulage road.

GEOLOGY

The geological information is largely obtained from the geological map of the area compiled by Woodsworth.

All lines are shown to be underlain by Pleistocene to Recent unconsolidated sediments, alluvial and possibly glacial in origin.

What is probably the underlying bedrock is shown to be quartz diorite for Lines A and C, and granodiorite for Line B. These rocks are of unknown age. Line C occurs close to or on the contact with volcanics (probably andesite as observed by the writer in the field), of the Gambier Group, which is Lower Cretaceous in age.

INSTRUMENTATION AND FIELD PROCEDURE

This investigation was carried out using an SIE 12-channel refraction/reflection seismograph amplifier system with a photo-recording oscillograph and Mark Products 8-cycle per second marsh geophones.

The 'two-way, in-line shot' seismic refraction method was used for all traverses. The technique consisted of laying out 12 geophones in a straight line and recording arrival times from shots fired at either end of the spread. The arrival times for an additional shot point approximately half-way of the spread were also recorded. This provided the overburden depth and velocity variations along the spread. Finally for each spread, two additional off-end shots were fired. Since the off-end shots were fired fairly far from the nearest geophone, most or all of the first arrivals were from the bedrock interface. This was felt necessary so that one could correlate the refractions received from other shot points and assign them the correct layer number.

The geophone separations were 50 meters for Line A, 76.2 meters (250 feet) for Line B-2, 30.5 meters (100 feet) for Line C-1, and 15.25 meters for Line C-2. Line B was first attempted with a 50-meter spread (hence the relabelling as B-2) but was found inadequate for reaching bedrock. Line C was broken into two parts (C-1 and C-2) because of the Lillooet River.

The offend shots were fired at approximately half the spread length off of each end of each spread.

The shots were placed in holes 1 to 3 feet deep. Depending upon the conditions, the shot size ranged from 0.6 lbs to 20 lbs. The larger shots were necessary only when there was wind or river noise.

One velocity spread was set up on each line in order to obtain more velocity information. The geophone separation for these spreads varied from 4 meters on Lines A and B-2 to 1½ and 3 meters on Line C-2.

The quality of the records was excellent. Whenever the first arrivals were lost due to cross-feed or inadequate shot size, the data were retaken by varying the size of the shot.

COMPUTING METHOD

All seismic data were analyzed using an intercept-delay time technique. Implementation of this method requires reverse refraction profiles with bedrock refractions emanating from a common point for at least two detectors. This rock overlap is necessary in order to obtain a true refractor velocity and travel time in the overburden independent of bedrock dip and/or surface irregularities. The off-end shot times are used to extrapolate the rock refractions from either end back to their respective shot locations. With this information and related overburden velocities, it is possible to compute the depth to rock not only below each shot point but also below each detector. However, the computed depths below shot points should be considered slightly more accurate than those below detectors.

The procedure is as follows:

1. Pick the first arrivals from the field records and draw time-distance graphs for each spread;

2. With the help of a 'Russian', determine which points are bedrock and which are overburden, and how many layers occur in the overburden;

3. Draw a delay line for each end shot and from this determine the delay time for each geophone;

4. Proportion the delay time for each geophone into the various times spent in the various layers. Multiply each layer time by the corresponding layer velocity to obtain the layer thickness. Adding the layer thickness together will give the total overburden depth.

RESULTS AND INTERPRETATION

The location of the seismic lines are shown on Sheet 1 at a scale of 1:50,000. The seismic profiles are drawn on Sheets 2 to 4 at a scale of 1:1,000 (1 cm to 10 meters).

The data along all profiles have been interpretted as a three-layer case except for 460-meter section on Line B-2 which was interpretted as a two-layer case. The three layers are felt to be unconsolidated surface material; water-saturated and very compact sands, gravels and possibly glacial till; and bedrock. The two-layer section of Line B-2 is missing the unconsolidated surface material.

On any seismic profiling work, the main error in calculating depths to bedrock is usually caused by the inhomogenous nature of the overburden and bedrock. For example, if a certain overburden velocity is assumed for a profile section and there are significant lenses of lower velocity material not reflected in the data, then the bedrock will be shown deeper than is actually the case. The same can be said for higher velocity material not reflected in the data, except the reverse is true.

In general, the overburden material on this project seemed to be quite homogenous. The bedrock velocities varied somewhat on Lines A and C-2 but didn't cause too much of a problem in the interpretation.

The profiles are discussed in more detail as follows:

A. LINE A (Sheet 2)

This line is 800 meters long and was seismic-profiled with two 550-meter spreads. There was, therefore, an overlap of seven geophones. It ran in a S68W (248°) direction from the main road to within 114 meters of the Lillooet River.

The surface material has a velocity of 300 meters/second which shows it to be quite dry and unconsolidated. Its thickness varies from 2 to 4.5 meters.

The second layer is characterized by a velocity varying from 2000 to 2130 meters/sec. The overburden is likely alluvial in nature, and therefore, this layer is probably sands and gravels. However, in the writer's experience, 2130 meters/sec is a rather high velocity for sands and gravels that are water-saturated. Therefore, the sands and gravels are likely very consolidated and quite possibly have a silt content. An alternate explanation is that some or most of this second layer is glacial till. This becomes increasingly possible for Lines B-2 and C-1 where this layer has an even higher velocity.

The third layer is bedrock and has been interpretted to have two different velocities. Below geophones 1 to 5, the bedrock has a velocity of 5,180 meters/sec, and is, therefore, likely quartz diorite. From geophones 5 to 17, the bedrock velocity reduces to 3,570 meters/sec which is more indicative of volcanics, quite possibly of the Gambier Group. No volcanics are shown in the area, but according to Read, are found throughout the plutonics.

The depth to bedrock varies from 60 meters below geophones 1 and 13 to 120 meters below geophone 8 which appears to be the center of an old river channel.

An alternate interpretation for spread 1 is shown on Sheet 2. It assumes a bedrock velocity of 4,760 meters/sec and consequently greater depths to bedrock which range from 88 to 141 meters. The 4,760 meter/sec velocity is indicative of a plutonic rock. The writer considers this interpretation much less likely mainly because of its poor correlation with Spread 2.

B. <u>LINE B (Sheet 3)</u>

This line is 838 meters long and was seismic profiled with 1 spread. It runs in a N80W (280^{o}) direction roughly parallel to the Lillooet River.

The unconsolidated, unsaturated surface material with a velocity of 400 meters/sec was found definitely to occur below geophone 12 and was assumed to occur with decreasing thickness from geophone 11 to 8. The thickness of this material below geophone 12 is three meters.

The second layer has a velocity of 2,270 meters/sec and as noted above is likely very consolidated, saturated sands and gravels with a silt content, and/or possibly glacial till.

The third layer is bedrock with a velocity of 4,760 meters/sec which in this area is likely granodiorite. A low velocity zone appears to occur between geophones 10 and 11 and, therefore, is interpretted to be a fault. The depth to bedrock varies from 101 meters below geophone 12 to 136 meters below geophones 3 and 10.

C. <u>LINE C (Sheets 4 and 5)</u>

Line C-1 shown on Sheet 4, runs in a N39E (39°) direction starting 58 meters from the bridge and is 335 meters long.

The velocity of the surface material is quite high compared to the other profiles being about 940 meters/sec. This indicates the material to be partially saturated and/or more compact. Its thickness varies from 21 meters below geophone 12 to 7 (?) meters below geophone 1.

The second layer has a very similar velocity to that of profile B-2, being about 2,120 meters/sec. It therefore is likely consolidated and saturated sands and gravels.

The third layer is bedrock and appears to have a velocity of about 4,600 meters/sec. This is indicative of plutonic rocks which, in this area, could be either quartz diorite or granodiorite.

The depths to bedrock could not be calculated since the spread was not long enough. There was limited room for much longer spreads because of the Lillooet River and the hill to the north-east. However, it was estimated the average depth to bedrock to be about 140 meters with it decreasing significantly toward geophone 12.

In addition, from the shape of the time-distance curves, there appears to be a channel centered about geophone 5. The shape of the bedrock profile at the estimated depth is shown on Sheet 4.

Line C-2, shown on Sheet 5, runs in a S30W (210^{o}) direction along the haulage road up Meager Creek and about 100 meters from the bridge over the Lillooet River. It is on the southwest side of the river and is 168 meters long.

The surface material, which, from the writer's observations, is probably sand, has a velocity of 515 meters/sec and a thickness of 8 to 10 meters.

The second layer has a velocity of 1,400 meters/sec and therefore does not seem to be the same material as the second layer of the other profiles, but is closer to being the same material as the surface layer of Profile C-1. Being that water-saturated materials usually have a velocity above 1,500 meters/second, this layer is likely partially saturated sands and gravels.

The third layer is the bedrock and below most of the geophones has a velocity of 5,080 meters/second. As mentioned above, this velocity is typical of plutonic rocks which in this area is likely quartz diorite. However, there is a lower bedrock velocity of about 3,400 meters/second from geophones 8 to 11. Considering that this velocity is typical of volcanics and that according to the geology map of the area, the profile is found near or on the contact with Gambier Group volcanics, this lower velocity probably reflects a volcanic rock of the Gambier group. From the relationship of the time-distance curves to each other, it appears the contact between geophones 7 and 8 is dipping in an apparent direction of S30W and that between geophones 11 and 10, N30E.

The depths to bedrock vary from 23 meters below geophone 12 to 44 meters below geophone 8.

This line runs along the bottom of a steep hill to the northwest. It must therefore be remembered that the seismic-interpretted depths to bedrock are not necessarily directly below each geophone, but rather the depth to bedrock closest to each geophone. Therefore, in this case, the seismic-interpretted depths to bedrock are likely the depths to bedrock at an angle towards the hill. That is, it is expected the bedrock has a slope parallel to the slope of the hill.

Respectfully submitted,
GEOTRONICS SURVEYS LTD.

David G. Mark
Geophysicist

October 31, 1977

REFERENCES

Read, Dr. P.B. Personal Communication Regarding Bedrock, Geology in the Area, August, 1977.

Woodsworth, G.J. Geology Map of the Pemberton (92J) Map-Area. Open File 482, Geol. Surv. of Can., 1977.

LEGEND

Seismic line showing geophone number at each end

Road (sketched)

SCALE

KILOMETERS 1 1/2 0 1 2 3 4 KILOMETERS

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DEPARTMENT OF ENERGY, MINES, & RESOURCES
MEAGER MOUNTAIN GEOTHERMAL STUDY
UPPER LILLOOET RIVER VALLEY, B.C.

SEISMIC REFRACTION STUDY
PLAN

DATE BY	SCALE	DATE	JOB No.	SHEET No.
D.G.M.	1:50,000	Oct., 1977	77-32	1

LEGEND

G-3 Geophone location

Computed depth point on inferred layer boundary

6,000 m/s Average velocity in metres per second

NOTE The elevations above sea level as shown are estimated only

Direction of line — S 68°W (248°)

SCALE

METRES 20 0 20 40 60 80 METRES

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MEAGER MOUNTAIN GEOTHERMAL STUDY
UPPER LILLOOET RIVER VALLEY, B.C.

SEISMIC REFRACTION STUDY
PROFILE A

DATE BY	SCALE	DATE	JOB No	SHEET No
D.G.M	1:1,000	Oct., 1977	77-32	2

LEGEND

- G-3 — Geophone location
- Computed depth point on inferred layer boundary
- 6,000 m/s — Average velocity in metres per second

NOTE The elevations above sea level as shown are estimated only.

Direction of line — N 80 W (280°)

SCALE

METRES 20 0 20 40 60 80 METRES

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SEISMIC REFRACTION STUDY
PROFILE B-2

DATE BY	SCALE	DATE	JOB No.	SHEET No.
D.G.M.	1 : 1,000	Oct., 1977	77 - 32	3

LEGEND

G-3 — Geophone location

— — Computed depth point on inferred layer boundary

6,000 m/s Average velocity in metres per second

NOTE: The elevations above sea level as shown are estimated only.

Direction of line — as shown

SCALE

METRES 20 0 20 40 60 80 METRES

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UPPER LILLOOET RIVER VALLEY, B.C.

SEISMIC REFRACTION STUDY
PROFILES C-1 & C-2

DATE BY	SCALE	DATE	JOB No.	SHEET No.
D.G.M.	1:1,000	Oct., 1977	77 - 32	4

SEISMIC REFRACTION STUDY

in the

MEAGER MOUNTAIN GEOTHERMAL REGION
JOB CREEK AREA
UPPER LILLOOET RIVER VALLEY, B.C.

November-December, 1977

for

DR. L.K. LAW
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January 18, 1978

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SEISMIC REFRACTION STUDY

in the

MEAGER MOUNTAIN GEOTHERMAL REGION
JOB CREEK AREA
UPPER LILLOOET RIVER VALLEY, B.C.

INTRODUCTION

This report discusses the field procedure, computation of data and results of a seismic refraction survey carried out for Dr. L. K. Law of the Victoria Geophysical Laboratory of the Department of Energy, Mines & Resources. The project site was the upper part of the Lillooet River Valley in the area of Salal Creek, Job Creek and Mosaic Creek, 66 kilometers N55W of the town of Pemberton, British Columbia.

The project was carried out from November 22nd, 1977 to December 10th, 1977. Being wintertime, the crew stayed in Pemberton and travelled each day by helicopter to the project site.

The scope of the survey consisted of three lines, totalling 2,780 meters.

The purpose of the seismic work was to determine depth to bedrock and velocity of the bedrock for control for other geophysical surveys and possibly drill site location.

This survey is the follow-up of a previous seismic survey carried out by Geotronics from August to September, 1977.

Three lines, labelled A to C, were profiled. The results are in a report by the writer dated October 31, 1977.

The geophysical information presented in this report is based upon our best interpretation of the field data which were collected according to generally accepted field procedures. These results are interpretive in nature, and are considered to be a reasonably accurate presentation of the existing conditions within the limits of the method employed.

SUMMARY

The seismic depth profiles are shown on Sheets 5 through to 7.

Each of the profiles are basically a three-layer case.

The overburden velocities vary from 400 to 760 meters/second for unconsolidated surface material, and from 1200 to 2000 meters/second for consolidated water-saturated gravels.

The bedrock velocities were found to vary from 3,190 to 6,620 meters/second.

The depth to bedrock varies from 19 to 107 meters on Line D, 184 to 242 meters on Line E and 50 to 165 meters on Line F.

VELOCITY CLASSIFICATION

The following is a suggested velocity classification for the area as determined only from the immediate survey results.

Velocity (meters/second)	Suggested Classification
400 - 760	Loose, unconsolidated surface material
1,200 - 1,440	Partially saturated sands and gravels
1,550 - 2,000	Very consolidated, saturated sands and gravels, possibly glacial till as well.

Velocity (meters/second	Suggested Classification
3,190 - 4,080	Volcanic bedrock, probably of the Gambier Group or Garibaldi Group.
4,760 - 6,620	Intrusive bedrock, probably quartz diorite.

PERSONNEL

The field crew consisted of three men as follows: the writer, as geophysicist and supervisor; Trent Pezzot as geophysical technician, and Darrell Roberts as helper.

LOCATION AND ACCESS

The project consisted of three lines located in the upper Lillooet River Valley on the southwest and northeast sides of the river, 66 air kilometers N55^{o}W of Pemberton, British Columbia.

All lines are located in the valley bottom. Line D was located about half way between Salal Creek and Job Creek, Line E a few hundred meters east of Job Creek, and Line F a few hundred meters west of Mosaic Creek. The location of the lines are shown on Sheet No. 1.

Access to each of the lines can only be gained by helicopter.

GEOLOGY

The geological information is largely obtained from the geological map of the area compiled by Woodsworth.

All lines are shown to be underlain by Pleistocene to Recent unconsolidated sediments, alluvial and possibly glacial in origin.

The underlying bedrock, projected from the nearest exposures, appears to be volcanics of the Garibaldi Group below Line D and volcanics of the Gambier Group and quartz diorite intrusives below Lines E and F. The Gambier Group is Lower Cretaceous in age, the Garibaldi Group, Piocene to Recent, and the quartz diorite, unknown.

INSTRUMENTATION AND FIELD PROCEDURE

This investigation was carried out using an SIE 12-channel refraction/reflection seismograph amplifier system with a photo-recording oscillograph and Mark Products 8-cycle per second marsh geophones.

The 'two-way, in-line shot' seismic refraction method was used for all traverses. The technique consisted of laying out 12 geophones in a straight line and recording arrival times from shots fired at either end of the spread. The arrival times for an additional shot point approximately half-way off the spread were also recorded. This provided the overburden depth and velocity variations along the spread. Finally, for each spread, two additional off-end shots were fired. Since the off-end shots were fired fairly far from the nearest geophone, most or all of the first arrivals were from the bedrock interface. This was felt necessary so that one could correlate the refractions received from other shot points and assign them the correct layer number.

The geophone separations were 50 meters for Line D and 76.2 meters for Lines E and F. Line E was first attempted with a 50-meter spread but was found inadequate for reaching bedrock.

The offend shots were fired at approximately half the spread length off of each end of each spread.

The shots were placed in holes 0.5 to 1 meter deep. Depending upon the conditions, the shot size ranged from 1 kgm to 23 kgms. The larger shots were necessary only when there was wind or river noise.

In order to plant the shots and geophones, an average of 1.5 meters of snow had to be dug through. This was slow and time-consuming and because of this no velocity spreads were done. The purpose of velocity spreads is to determine the velocity of the surface overburden layer, which often cannot be determined from larger spreads. However, using the velocity information from the previous survey, the writer felt that any possible errors from not doing velocity spreads would be minimal and certainly within the error margin inherent within the seismic refraction method.

The quality of the records was excellent. Whenever the first arrivals were lost due to cross-feed or inadequate shot size, the data were retaken by varying the size of the shot.

COMPUTING METHOD

All seismic data were analyzed using an intercept-delay time technique. Implementation of this method requires reverse refraction profiles with bedrock refractions emanating from a common point for at least two detectors. This rock overlap is necessary in order to obtain a true refractor velocity and travel time in the overburden independent of bedrock dip and/or surface irregularities. The off-end shot times are used to extrapolate the rock refractions from either end back to their respective shot locations. With this information and related overburden velocities, it is possible to compute the depth to rock not only below each shot point but also below each detector. However, the computed depths below shot points should be considered slightly more accurate than those below detectors.

The procedure is as follows:

1. Pick the first arrivals from the field records and draw time-distance graphs for each spread;

2. With the help of a 'Russian', determine which points are bedrock and which are overburden, and how many layers occur in the overburden;

3. Draw a delay line for each end shot and from this determine the delay time for each geophone;

4. Proportion the delay time for each geophone into the various times spent in the various layers. Multiply each layer time by the corresponding layer velocity to obtain the layer thickness. Adding the layer thickness together will give the total overburden depth.

RESULTS AND INTERPRETATION

The location of the seismic lines are shown on Sheet 1 at a scale of 1:50,000. The seismic profiles are drawn on Sheets 5 to 7 at a scale of 1:1,000 (1 cm to 10 meters).

The data along all profiles have been interpretted as a three-layer case. The three layers are felt to be unconsolidated surface material; water-saturated and compact sands, gravels and possibly glacial till; and bedrock.

On any seismic profiling work, the main error in calculating depths to bedrock is usually caused by the inhomogenous nature of the overburden and bedrock. For example, if a certain overburden velocity is assumed for a profile section and there are significant lenses of lower velocity material not reflected in the data, then the bedrock will be shown deeper than is actually the case. The same can be said for higher velocity material not reflected in the data, except the reverse is true.

The overburden material on this project seemed to be quite homogeneous. The bedrock velocities varied somewhat on all profiles but except for Line D didn't cause too much of a problem in the interpretation. On Line D two interpretations are given.

The profiles are discussed in more detail as follows:

A. LINE D (Sheet 5)

This line is 1,100 meters long and was seismic-profiled with two 550-meter spreads. It ran in a N20E (20°) direction from a point about 60 meters N20E of the Lillooet River.

The surface material has been given a velocity of 400 meters/second which is the average velocity from the previous survey. Its thickness varies from 2.5 to 4 meters.

The second layer is characterized by a velocity varying from 1,200 to 1,550 meters/sec, a very typical velocity range for partly to fully saturated sands and gravels. This layer decreases in velocity away from the river which is probably caused by a decrease in water content.

The third layer is bedrock and has been interpretted to have four different velocities. Three of these velocities are 3,190, 3,410 and 4,080 meters/second which is a typical range for volcanics. Therefore, these velocities probably reflect volcanics of the Garibaldi Group.

The fourth velocity is 5,360 meters/second which is quite high and which therefore is probably reflecting an intrusive. In this case the intrusive would likely be quartz diorite.

The depth to bedrock, except below geophone 23, varies from 57 meters below geophone 21 to 107 meters below geophone 13. At geophone 23, which is on the hill, the bedrock depth, not unexpectedly, decreases to 19 meters.

An alternate interpretation for geophone 1 to 5 is shown on Sheet 5. It assumes a bedrock velocity of 5,360 meters/second and, therefore, no geological contact below geophone 6. As a result, there are greater depths to bedrock ranging from 76 to 105 meters. The writer considers this interpretation less likely.

B. LINE E (Sheet 6)

This line is 838 meters long and was seismic profiled with one spread. It runs in a true north (0^{o}) direction roughly perpendicular to and 600 meters from the Lillooet River.

The unconsolidated, unsaturated surface material was found to vary in velocity from 500 to 760 meters/second. The higher velocity, as observed in the shot hole at geophone 1, was found to be reflective of sand. The thickness of this layer varies from 14 to 26 meters.

The second layer has an average velocity of 2,000 meters/second which is somewhat higher than the correlating layer below Line D. The higher velocity could be caused by a higher water content, greater consolidation, and/or a different material such as glacial till or ash-filled gravels.

The third layer is bedrock with a velocity ranging from 3,730 meters/second within the center of the profile, to 4,760 meters/second on the north end, and 5,260 meters/second on the south end.

The 3,730 meter/second velocity being typical of volcanics is likely reflective of the Gambier Group. The two higher velocities are probably reflective of quartz diorite.

The spread actually was not long enough to determine the depth to bedrock, although the writer feels the inadequacy of the length was very small. Therefore, assuming the first arrival below geophone 12 from the end shot at geophone 1 refracted through bedrock, the depths below each geophone were calculated. These depths are considered to be a minimum depth. The shape of the profile, however, would be the same though the depths may be greater. The calculated minimum depths vary from 184 meters below geophone 5 to 242 meters below geophone 1.

C. <u>LINE F</u> (Sheet 7)

Line F runs in a N50E (50°) direction.

The velocity of the surface material is 400 meters/second and its thickness varies from 4 to 7 meters.

The average velocity of the second layer is 1,800 meters/second which also is quite typical of compacted and water-saturated sands and gravels.

The third layer is bedrock and has a velocity over most of the profile of 3,630 meters/second. As mentioned above, this is a velocity typical of volcanic-type rocks which on this line is probably of the Gambier Group.

From geophone 7 to 9 the bedrock has a much higher velocity of 6,620 meters/second. The high velocity indicates a hard, dense intrusive, possibly quartz diorite. The bedrock profile shows this rock type as a bedrock 'hump' which also is indicative of a hard, dense rock.

The depth to bedrock generally increases from geophone 1 to 12 and varies from 50 meters below geophone 1 to 165 meters below geophone 12. The sharp decrease in depth from geophone 3 to 1 is due to the fact of geophone 1 being 50 to 100 meters from the bottom of the hill.

Respectfully submitted,
GEOTRONICS SURVEYS LTD.,

David G. Mark
Geophysicist

January 18, 1978

REFERENCES

Read, Dr. P.B. Personal Communication Regarding Bedrock, Geology in the Area, August, 1977.

Woodsworth, G.J. Geology Map of the Pemberton (92J) Map-Area, Open File 482, Geol. Surv. of Can. 1977.

LEGEND

Seismic line showing geophone number at each end

Road (sketched)

SCALE

KILOMETERS 1 1/2 0 1 2 3 4 KILOMETERS

Revised: JAN. 1978

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MEAGER MOUNTAIN GEOTHERMAL STUDY
UPPER LILLOOET RIVER VALLEY, B.C.

SEISMIC REFRACTION STUDY PLAN

DATE BY	SCALE	DATE	JOB No	SHEET No
D.G.M.	1:50,000	Oct., 1977	77-32	1

LEGEND

G-3 — Geophone location

Computed depth point on inferred layer boundary.

2040 m/s — Average velocity in meters per second.

NOTE The elevations above sea level as shown are estimated only

SCALE

Meters 20 10 0 20 40 60 Meters

Direction of line — N. 20° E (20°)

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SEISMIC REFRACTION STUDY
PROFILE D

DRAWN BY:	SCALE:	DATE:	JOB No:	SHEET No.
D.G.M.	1 : 1000	JAN. 1978	77 - 46	5

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LEGEND

G-3	Geophone location
	Computed depth point on inferred layer boundary.
2040 m/s	Average velocity in meters per second.

NOTE: The elevations above sea level as shown are estimated only.

SCALE

Meters 20 0 20 40 60 Meters

Direction of line — N (0°)

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SEISMIC REFRACTION STUDY
PROFILE E

DRAWN BY:	SCALE:	DATE:	JOB No:	SHEET No.
D.G.M	1:1000	JAN. 1978	77-46	6

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LEGEND

G-3 — Geophone location

Computed depth point on inferred layer boundary.

2040 m/s — Average velocity in meters per second

NOTE: The elevations above sea level as shown are estimated only.

SCALE

Meters 20 10 0 20 40 60 Meters

Direction of line – N 50 E (50°)

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SEISMIC REFRACTION STUDY
PROFILE F

DRAWN BY	SCALE	DATE	JOB No.	SHEET No.
D.G.M	1 : 1000	JAN. 1978	77-46	7

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