016946

GEOPHYSICAL SURVEY
GRUM-VANGORDA GRID

Prepared for

CYPRUS ANVIL MINING CORPORATION

VANCOUVER, B.C.

Prepared by

GEO-PHYSI-CON CO.LTD.

CALGARY, ALBERTA

Job #79-13

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1.0 INTRODUCTION

This report describes the geophysical services performed by Geo-Physi-Con Co. Ltd. for Cyprus Anvil Mining Corporation in November, 1979 at the Cyprus Anvil mine, Faro, Yukon Territories. The work was authorized in letter dated November 1, 1979 by Mr. L. Peter Taggart, Manager, Feasibility and Development Group. Field work was begun on November 9, 1979 and completed on November 15, 1979. During this period the following length of seismic refraction profiling and electromagnetic conductivity measurements were made:

- 1200 metres of seismic refraction survey
- 6000 metres of electromagnetic surveys

Results of test holes were made available by Mr. R. Lopaschuk at the mine in Faro. The results of the test holes were used in arriving at the interpretation of the geophysical measurements given in this report.

2.0 METHODS OF INVESTIGATION

Two methods of geophysical exploration were used on the survey, ground conductivity measurements with electromagnetic induction and seismic refraction. The purposes of electromagnetic induction measurements were mainly to map permafrost and soil type, and the purpose of seismic refraction surveying was to determine depth to bedrock.

2.1 Electromagnetic Induction Measurements

In electromagnetic induction measurements the conductivity of the ground is measured. Soil types can generally be differentiated on the basis of their electrical conductivity values. Figure 1 shows the range of values of conductivity found for soil types. In non-saline ground clay content and clay type generally are the dominant factors determining ground conductivity. Frozen ground always has a lower conductivity than the same ground when unfrozen. Figure 2 shows that the conductivity of all soils are lower in the frozen state but that, for example, an unfrozen gravelly soil may have a lower conductivity than a frozen clay soil. Geophysical mapping of permafrost boundaries must, therefore, always be closely integrated with other geologic information.

Electrical conductivity can be measured by several different techniques. The electromagnetic induction methods offer the advantage that no contact with the ground is required. In electromagnetic induction measurements eddy currents are induced in the ground by a magnetic dipole transmitter (see Figure 3). The eddy currents in turn cause a secondary magnetic field which is measured by a receiver. The amount of eddy current flow is proportional to the conductivity of the ground.

Depth of exploration in magnetic induction measurements is altered by changing the spacings between the transmitter and receiver.

2.2 Seismic Refraction Measurements

In seismic refraction the velocity of propagation of elastic waves through the ground is measured. The velocity of propagation of seismic waves often has a characteristic range of values for certain soil and rock types. Generally the seismic velocity of subsurface strata increase with their competency or strength, so that soils (overburden) have lower velocities than rock. Massive rocks generally have lower velocities than fractured rocks, and sedimentary rocks tend to have lower velocities than metamorphic and intrusive rocks.

In seismic refraction prospecting the time of travel of elastic waves is measured as a function of distance. Figure 4 shows a typical data set. The lower part of the figure shows the arrival times at 12 geophones as a function of distance recorded from both ends of a spread. To determine which geophones record arrivals refracted from the bedrock surface, the time difference T_A-T_B is plotted as a function of distance (middle part of Figure 4). Arrival times of geophones recording refractions from the same bedrock surface form a straight line with little scatter. Points with travel paths entirely in the overburden are off the line.

For the geophones recording arrivals refracted from the bedrock the delay time is computed (top part of Figure 4) and subsequently the depth to bedrock is found. Depth to bedrock can be computed only under the geophones recording arrivals refracted from the bedrock. The method of data analysis described in Figure 4 was used in this report.

Depth of exploration is altered by increasing the distance between shot points and geophones.

2.3 Accuracy of Measurements

The accuracy of measurements in seismic refraction prospecting mainly depends on:

a) the contrasts in seismic velocities between the different subsurface strata

b) the number of different layers encountered in the overburden, and

c) lateral variations in overburden and bedrock.

The availability of test holes generally improve accuracy, since the overburden velocity can be adjusted to fit depth to bedrock at test hole location. The interpolation of depth to bedrock between test holes relies on the assumption that no major changes in overburden velocity occur over the area of interpolation.

The accuracy of depth to bedrock computed in the report is estimated to be ±10 percent.

3.0 LOGISTICS

For the seismic refraction and electromagnetic induction measurements a crew of 4 men was used. The crew consisted of 2 geophysical technicians from the Calgary office of Geo-Physi-Con Co. Ltd. and two laborers hired in Whitehorse, Y.T.

Explosives and caps were obtained in Whitehorse, Y.T. and were trucked to the mine at Faro, Y.T. The crew lodged in commercial facilities in Faro, Y.T. Transportation from Faro to the survey site was by 2 4-wheel drive trucks. There was no vehicle access along the survey lines.

After completion of the survey on the Vangorda grid 3.5 days of surveying was conducted for Golder Associates at the Cyprus Anvil mine for proposed site design of tailing dams. The crew was demobilized to Calgary after completion of that work.

A log of daily activity is given in Table 1.

TABLE 1

LOG OF DAILY ACTIVITY OF GEOPHYSICAL CREW

Date	Day #	Activity
Nov. 8	1	Crew travels from Calgary to Whitehorse, hires local laborers, picks up explosives, drives to Faro
Nov. 9	2	Locates survey lines, shoot half line 1
Nov. 10	3	Complete shooting line 1, and half of line 2
Nov. 11	4	Complete shooting line 2, and half of line 3
Nov. 12	5	Complete shooting line 3, and line 4
Nov. 13	6	Complete shooting line 5
Nov. 14	7	Conduct EM survey on lines 1, 2, 3 and 4
Nov. 15	8	Complete EM survey on line 5 by 11:30 a.m.
Nov. 16-19	9, 10, 11	Perform survey work for Golder, and travel back to Whitehorse
Nov. 20		Crew returns to Calgary

4.0 DATA ACQUISITION

4.1 Exploration Objective

In exploration by drilling on the Grum-Vangorda grid just south of Doal Lake large changes in depth to bedrock were found. The objective of the geophysical surveys was to map depth to bedrock over an area approximately 250 metres by 250 metres where rapid changes in depth to bedrock were encountered.

Discontinuous permafrost was previously encountered in the mine area. Frozen ground can significantly affect the interpretation of seismic refraction data. The purpose of electromagnetic measurements was to delineate sections of frozen ground so that proper corrections in seismic interpretation could be made.

4.2 Electromagnetic Measurements

Figure 5 shows the location of electromagnetic measurements. Measurements were made with the Geonics EM34-3 on the existing Grum-Vangorda grid. Along the survey lines distances were measured by a hip chain. A hip chain rolls a biodegradable cotton string over a counting wheel. The interval of measurements on the survey lines was 100 metres. Manufacturer's specification on the Geonics EM34-3 are given in Appendix A.

4.3 Seismic Refraction Measurements

Figure 6 shows the location of the five seismic spreads layed out on the Grum-Vangorda grid. Spreads of 12-geophones with a geophone spacing of 20 metres was used. The 12-channel Geometrics ES-1210F seismograph was used to record the data. Manufacturer's specification on this instrument are given in Appendix A.

5.0 RESULTS

5.1 Electromagnetic Surveys

Two sets of measurements were obtained with the EM34-3. They are:

a) Measurements at 40 metres separation of transmitter and receiver with the loops in a vertical co-planar orientation (effective exploration depth approximately 40 metres).

b) Measurements at 40 metres separation of transmitter and receiver with the loops in a horizontal co-planar orientation (effective exploration depth approximately 60 metres).

The results are given in Figure 7 and 8 as conductivity profiles. Although the main objective of the work was to map permafrost, other qualitative information can be derived from the data. In particular the EM34-3 data appears to map change in bedrock type at the south end of the lines well. A descriptive interpretation has been entered on Figure 7. Clay layers are expected at depth when the readings with the loops in a horizontal co-planar orientation are higher than with the loops in a vertical co-planar orientation. On Figure 7 the apparent changes in bedrock type as mapped by the electromagnetic data have been outlined. The zone of bedrock change is also displayed on the location map of Figure 5.

5.2 Seismic Refraction Survey

The depth to bedrock derived from interpreting the seismic refraction measurements are listed under each geophone station on the map of Figure 6. A few depth to bedrock contours are also placed on the map in the area covered by the survey. Bedrock appears to fall off steeply between lines 2 and 3. Also shown on the map are the depths to bedrock found in the test holes supplied by Mr. R. Lopaschuk. Table 2 compares the depths to bedrock found in test holes with depth to bedrock computed under nearby geophone stations.

A comparison between depths to bedrock found in test holes and depths derived from geophysical interpretations shows the following.

a) The trend in the depths agree well. The test holes also show sharply increasing depths between lines 2 and 3. The depths to bedrock contours fit both the geophysical and the test hole data.

b) The largest discrepancy occurs at test hole A-138, where bedrock in the test hole was found at a depth of 40 metres. Geophysical data show bedrock at about 50 metres. However, depth to bedrock derived from geophysical interpretations agree within 10 percent at nearby test holes, A-100, A-143.

Part of the discrepancy in interpreted depth will be due to the fact that bedrock dips steeply. Interpreted depths are an average value which reflect the data from each end of a spread. A test hole

TABLE 2

COMPARISON OF DEPTHS TO BEDROCK FOUND IN TEST HOLES AND COMPUTED FROM SEISMIC REFRACTION SURVEYS

Test Hole #	Depth to Bedrock in Test Holes	Depth to Bedrock Derived from Seismic Refraction		Percent Error
A-96	49.0	41.0 55.0 45.0	47	4
A-100	52.0	50 49 48	49	6
A-138	40	50.0 52.0 59.0	53	35
A-143	30.0	29.0 22.0 39.0 33.7	31	3
A-106	39.0	41.0 48.0	44.5	16
A-116	62.0	51.0 53.0	52	15
A-139	52.0	46.7 51.0	49	6
A-137	87.0	83.0 82.7 80.	82	6

gives a very local value of depth to bedrock, while seismic refraction yields values representative of an area of about 400 m^2 on the bedrock surface in the vicinity of a geophone.

THE ASSOCIATION OF
PROFESSIONAL ENGINEERS,
GEOLOGISTS and GEOPHYSICISTS
OF ALBERTA
PERMIT NUMBER
P 2802
Geo Physi Con Co.
Ltd.

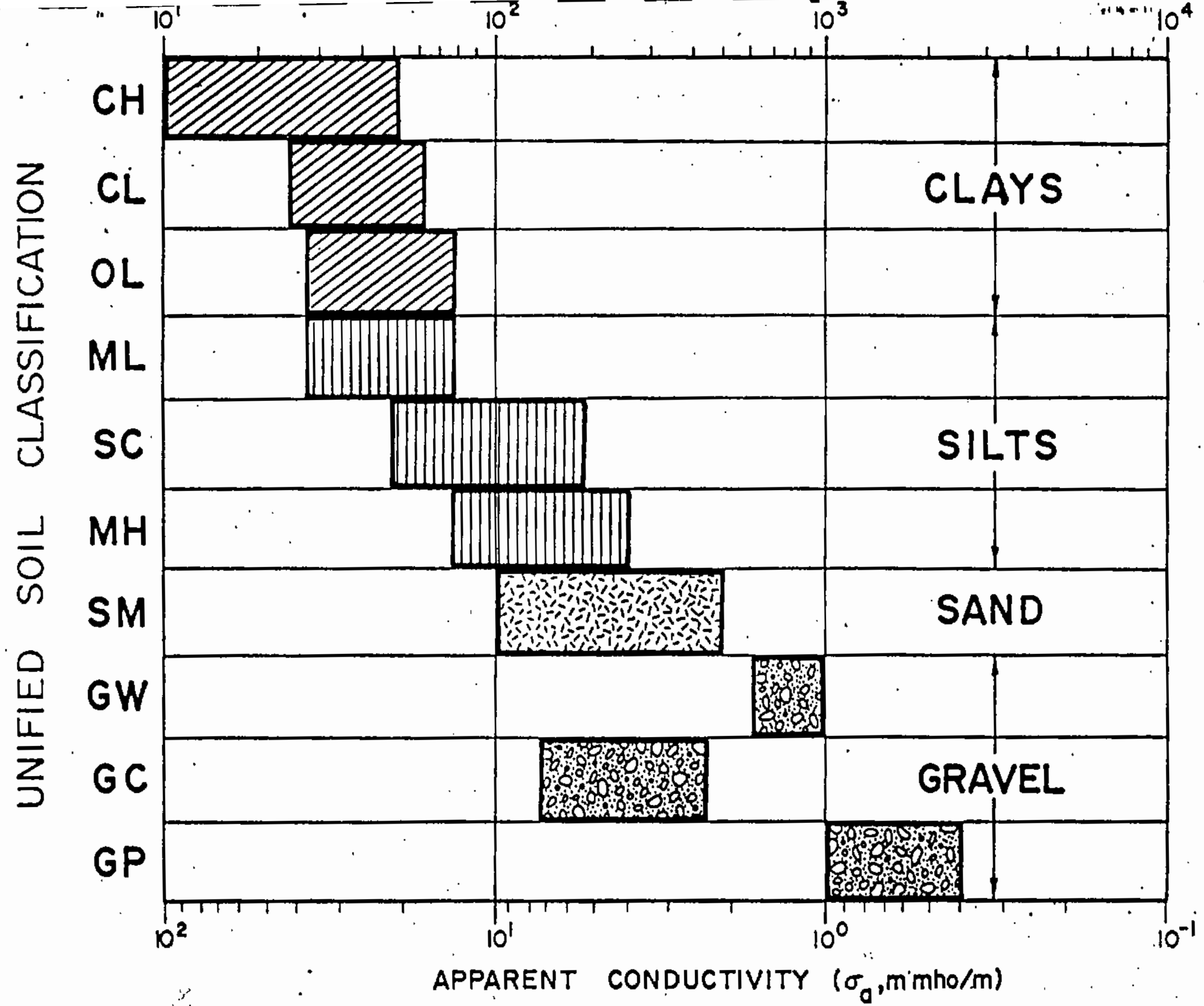
Respectfully submitted,

GEO-PHYSI-CON CO. LTD.,

Per:

Pieter Hoekstra, Ph.D.,P.Eng.
President

Calgary, Alberta.
December, 1979.
79-13



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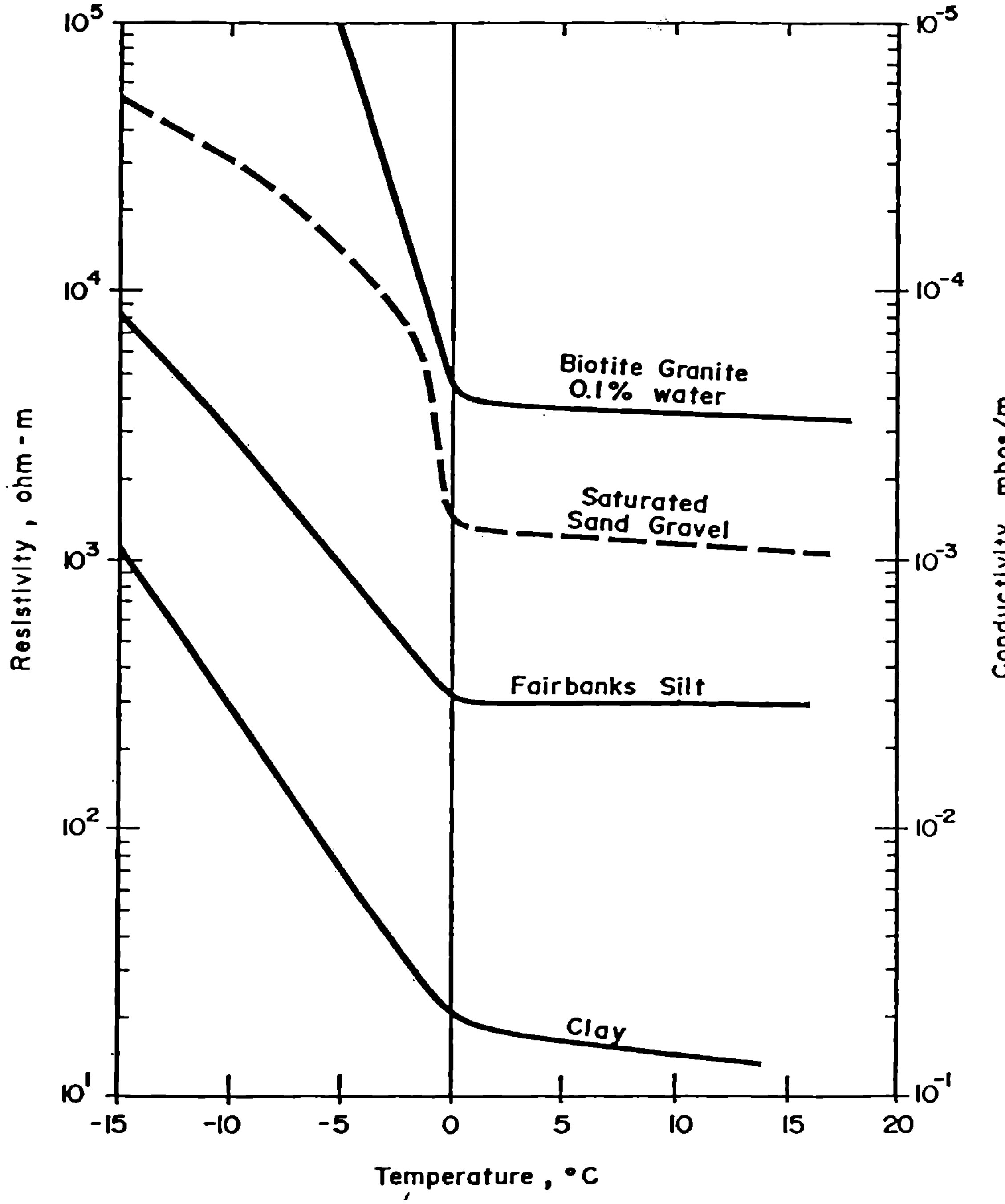
RESISTIVITY vs SOIL TYPE

JOB NO. 79-13

Figure 1



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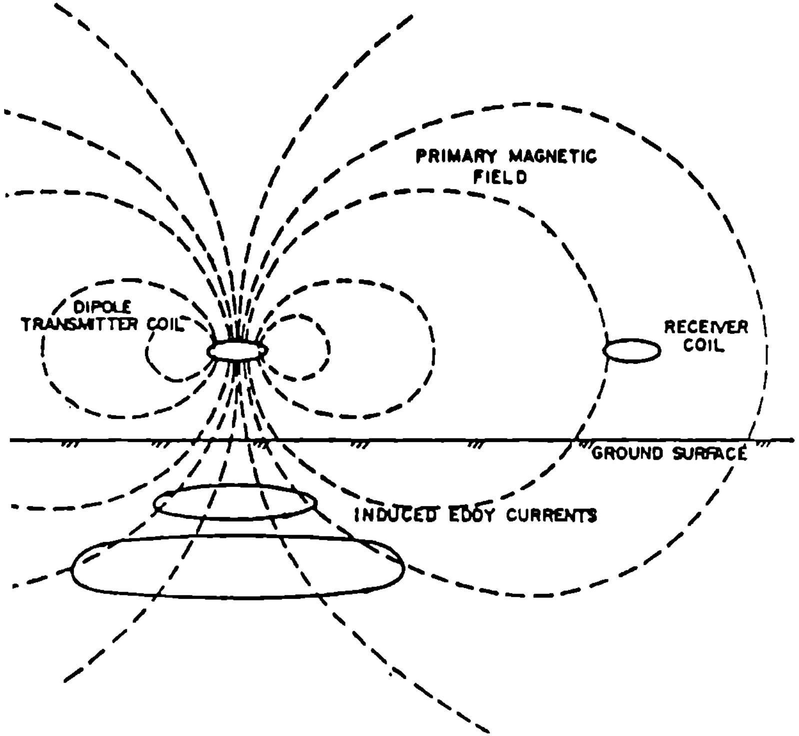
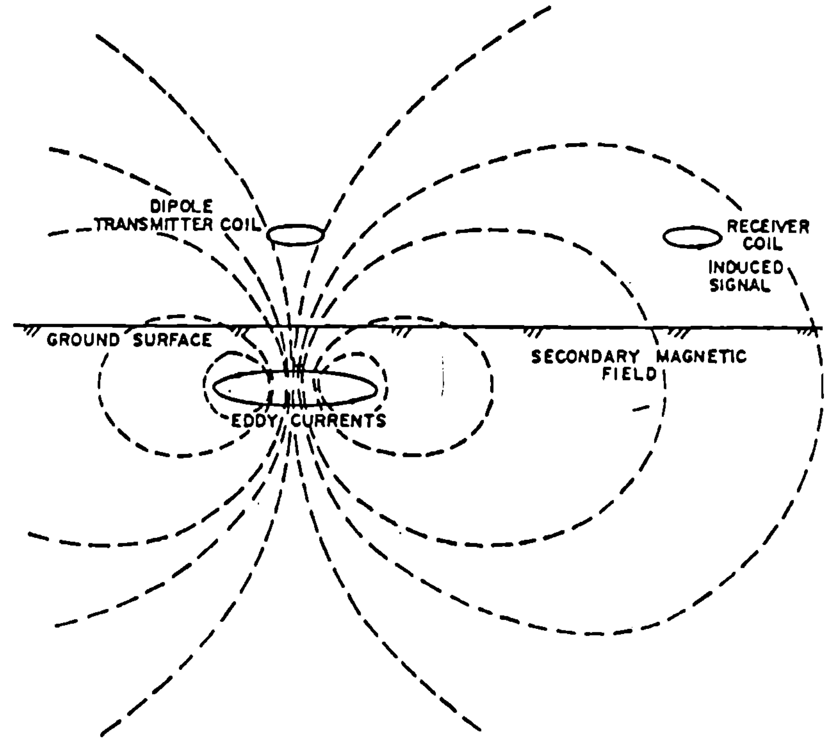
RESISTIVITY vs TEMPERATURE



PRIMARY FIELD



SECONDARY FIELD

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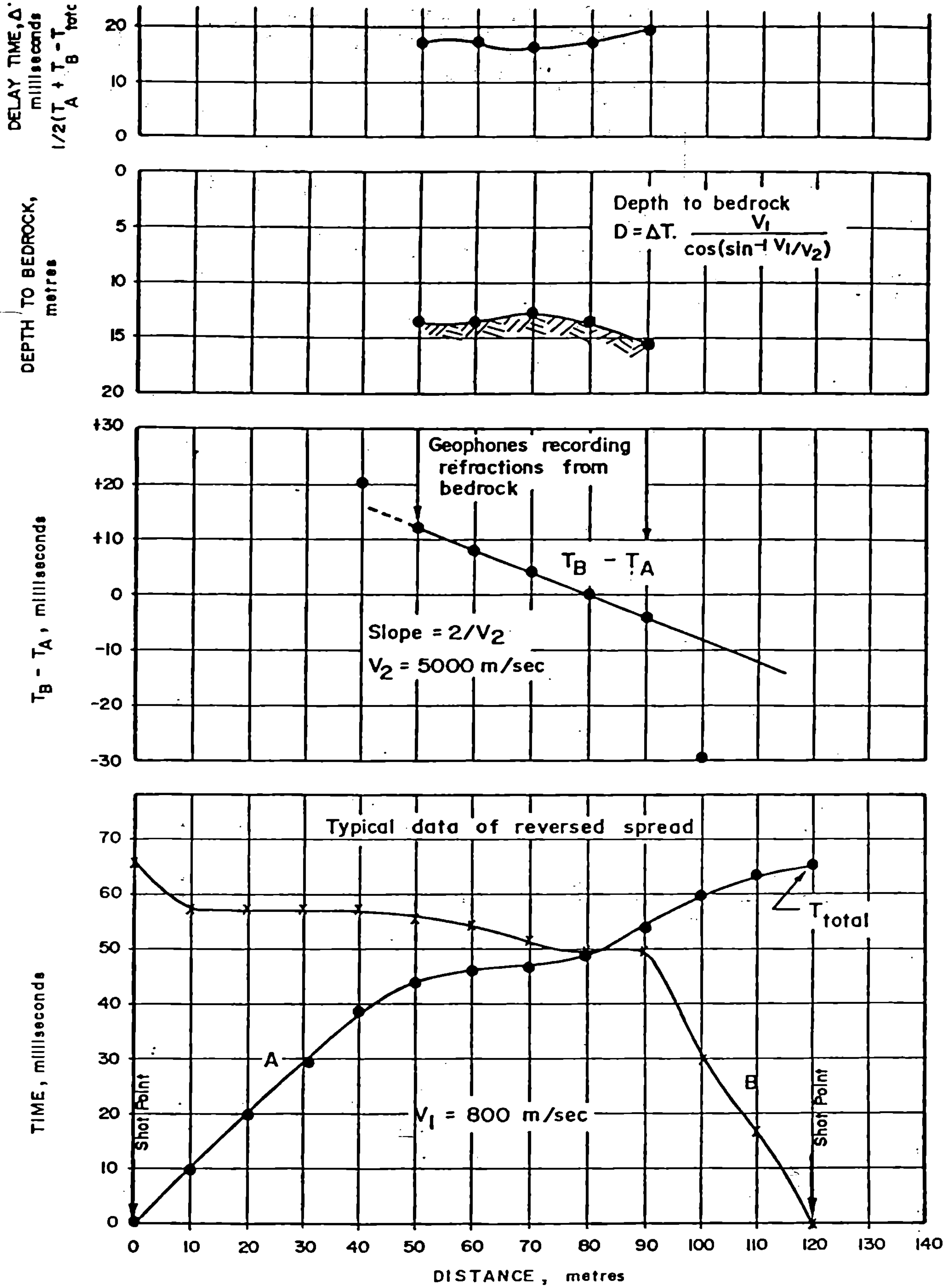
PRINCIPALS OF MAGNETIC INDUCTION IN SOIL CONDUCTIVITY MEASUREMENTS

79-13

Figure



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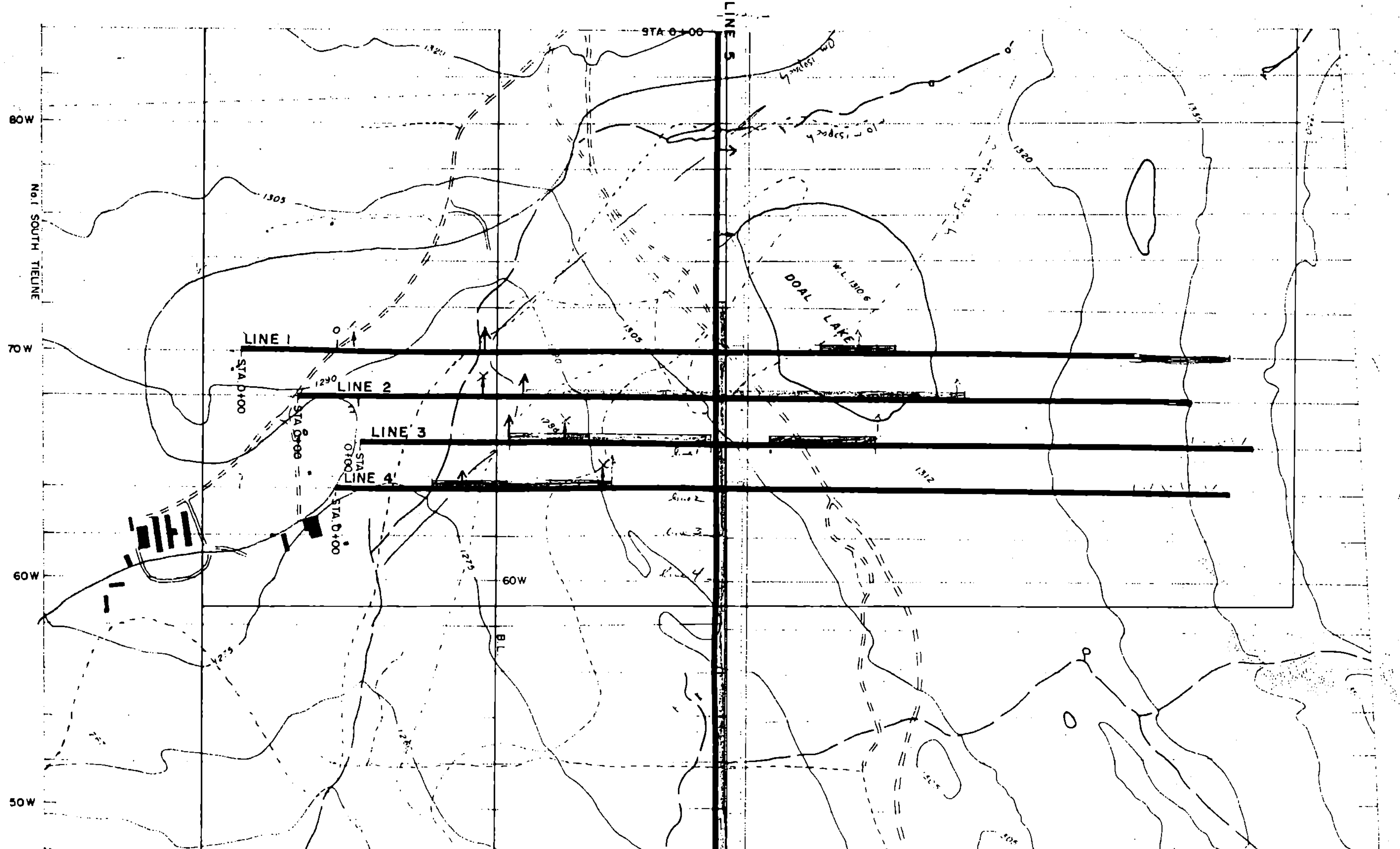
TYPICAL
REVERSE SEISMIC REFRACTION DA
AND ANALYSIS

Figure



0 50 100 200 metres
SCALE

| Change in bedrock type

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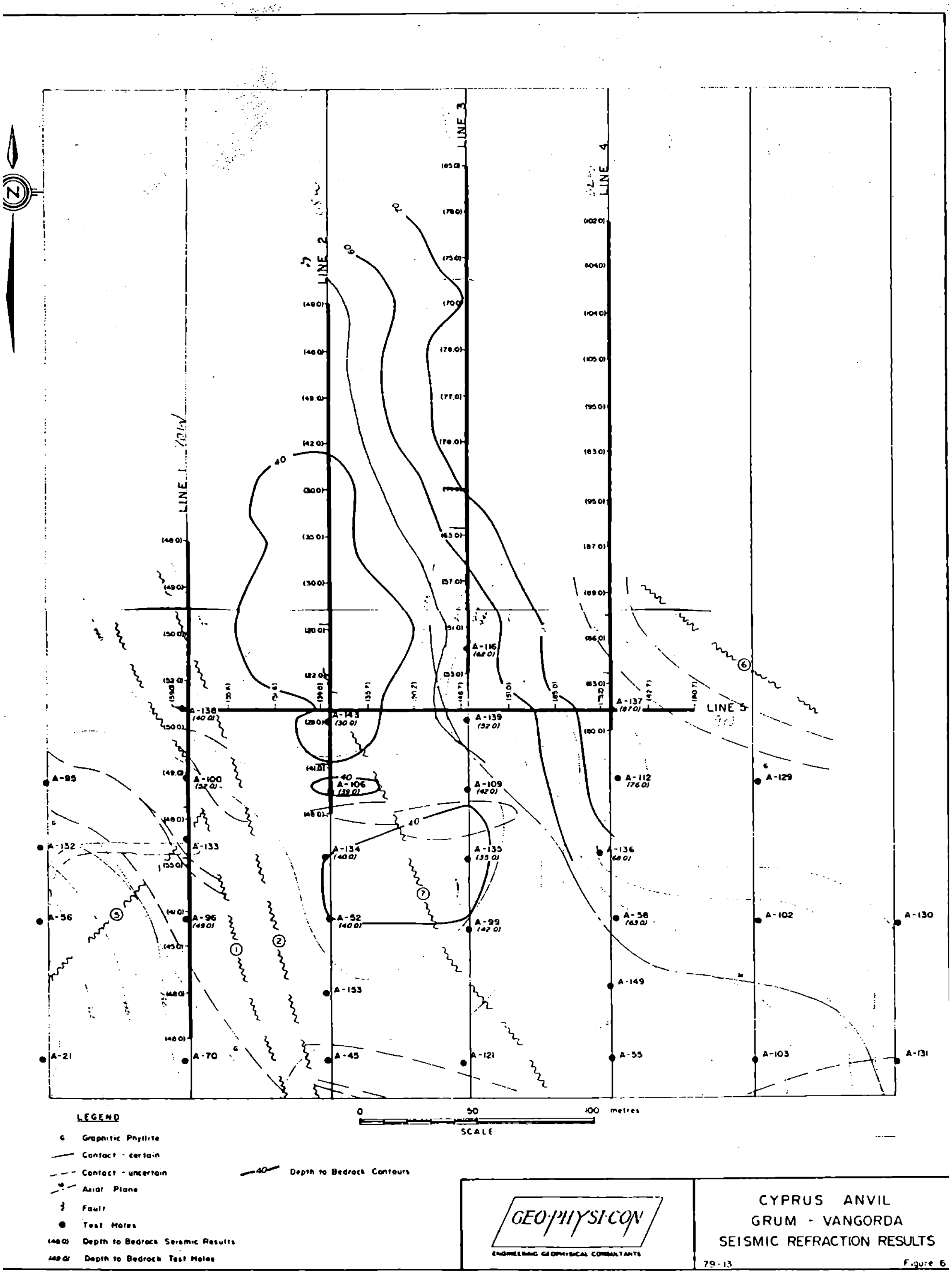
CYPRUS ANVIL
GRUM - VANGORDA
EM SURVEY LINE LOCAT
79-13


LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
A-138
A-143
A-137
A-139
A-100
A-106
A-109
A-112
A-129
A-85
A-132
A-133
A-134
A-135
A-136
A-56
A-96
A-52
A-99
A-58
A-102
A-130
A-149
A-153
A-21
A-70
A-45
A-121
A-55
A-103
A-131
0 50 100 metres
SCALE
LEGEND
G Graphitic Phyllite
Contact - certain
Contact - uncertain
Axial Plane
Fault
Test Holes
Depth to Bedrock Seismic Results
Depth to Bedrock Test Holes
Depth to Bedrock Contours
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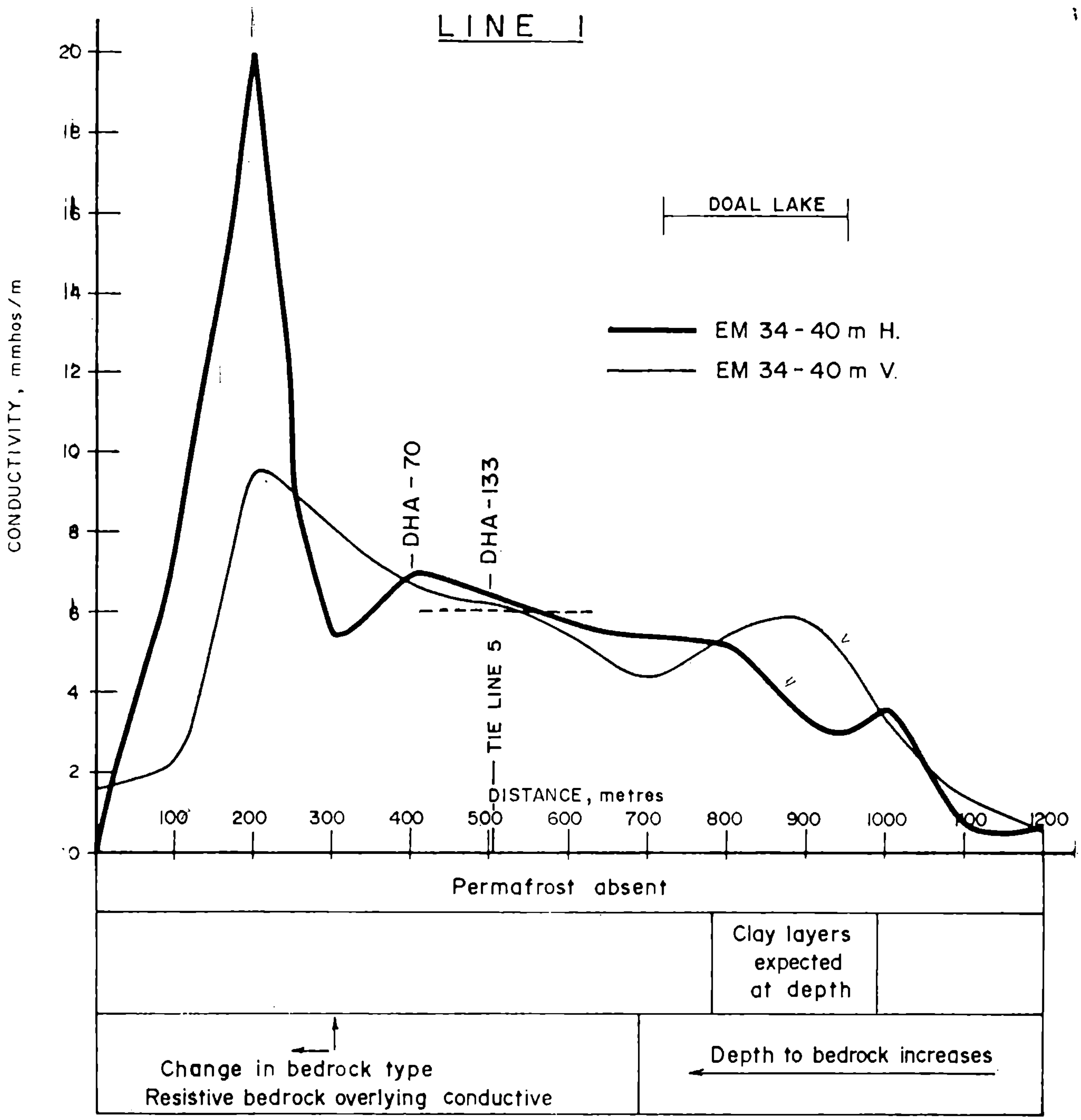
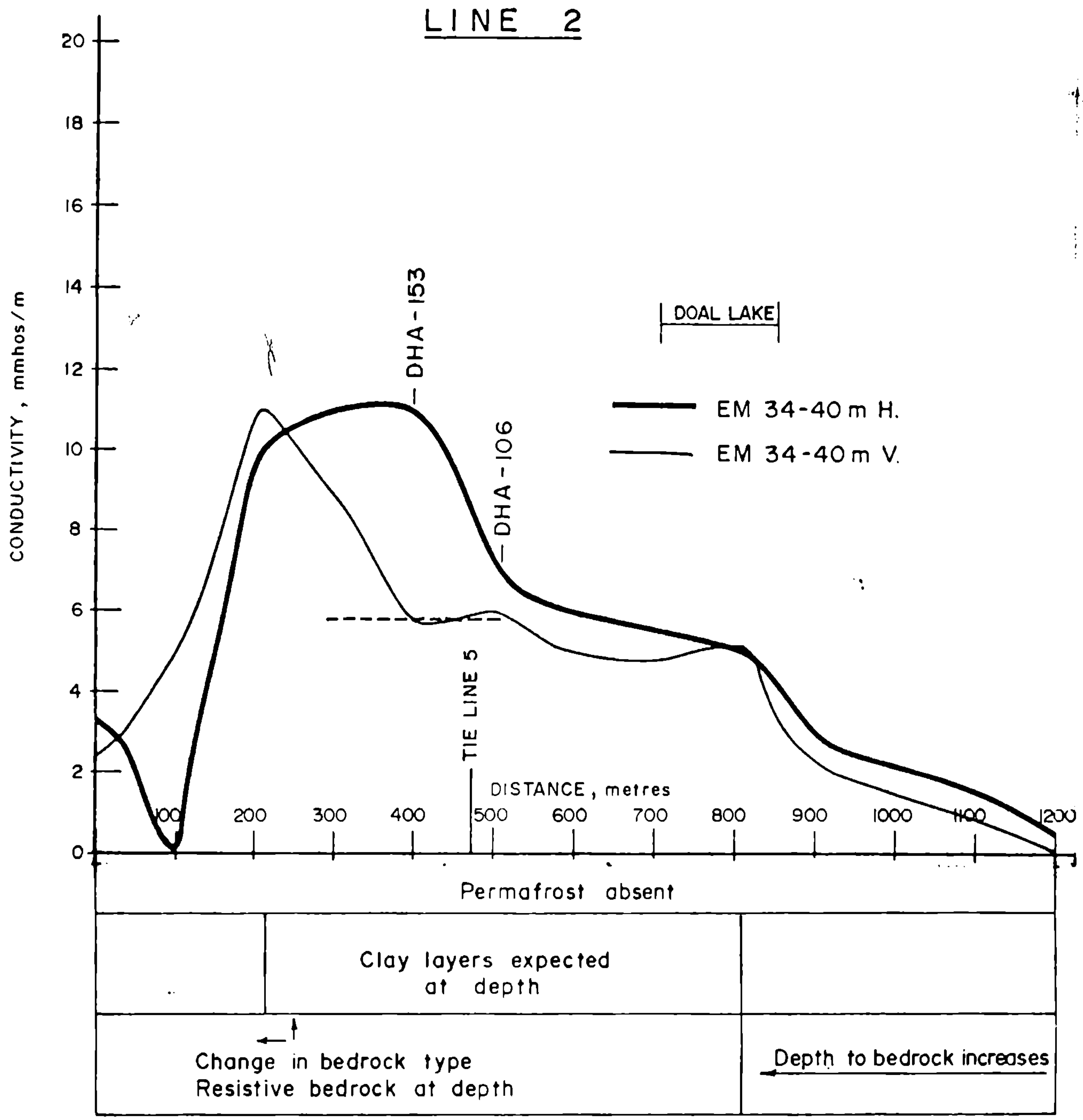
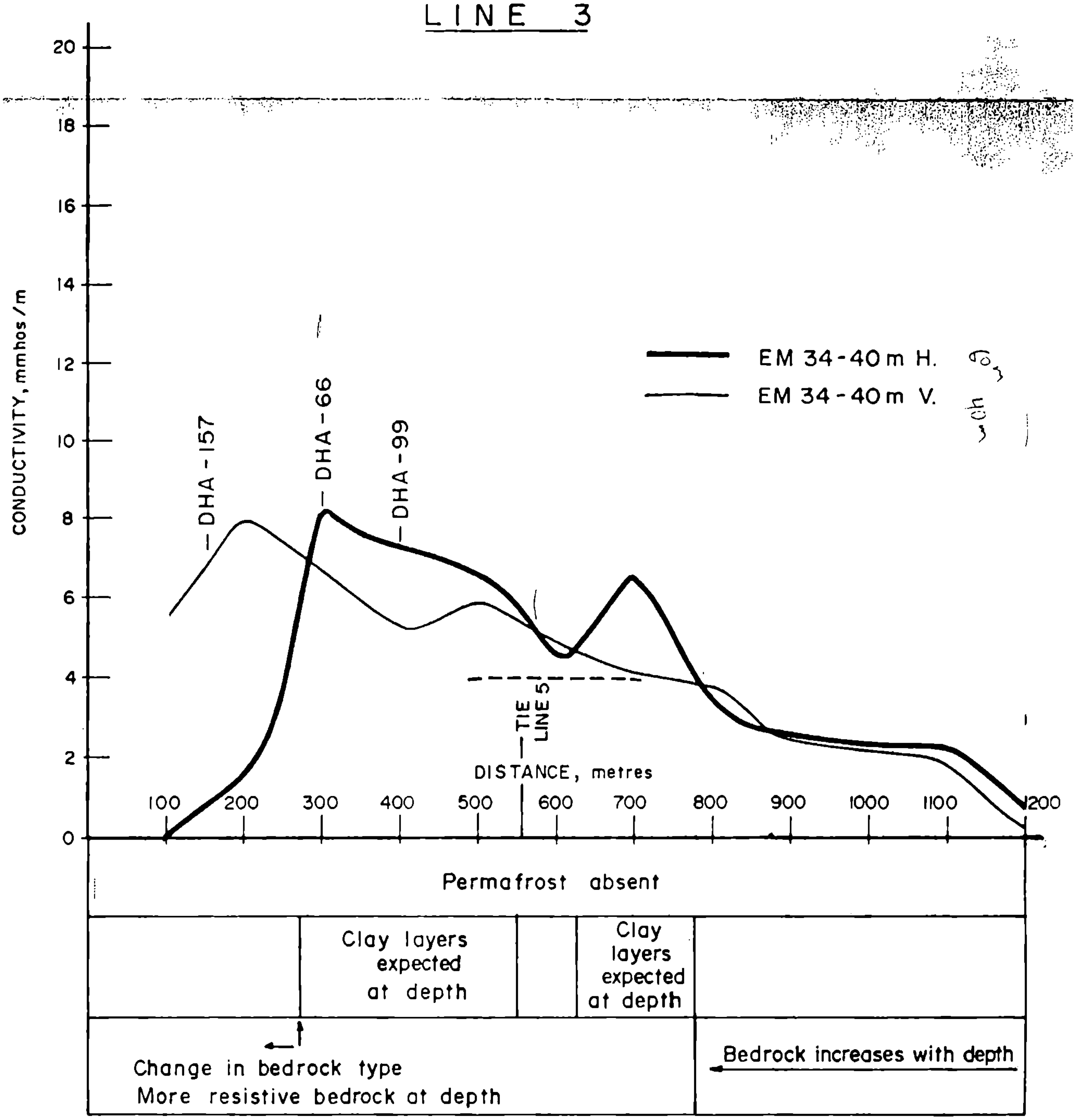
ENGINEERING GEOPHYSICAL CONSULTANTS
CYPRUS ANVIL
GRUM - VANGORDA
SEISMIC REFRACTION RESULTS
79-13
Figure 6


LINE I
DOAL LAKE
EM 34 - 40 m H.
EM 34 - 40 m V.
CONDUCTIVITY, mmhos/m
20
18
16
14
12
10
8
6
4
2
0
DHA - 70
DHA - 133
TIE LINE 5
DISTANCE, metres
100
200
300
400
500
600
700
800
900
1000
1100
1200
Permafrost absent
Clay layers expected at depth
Change in bedrock type
Resistive bedrock overlying conductive
Depth to bedrock increases

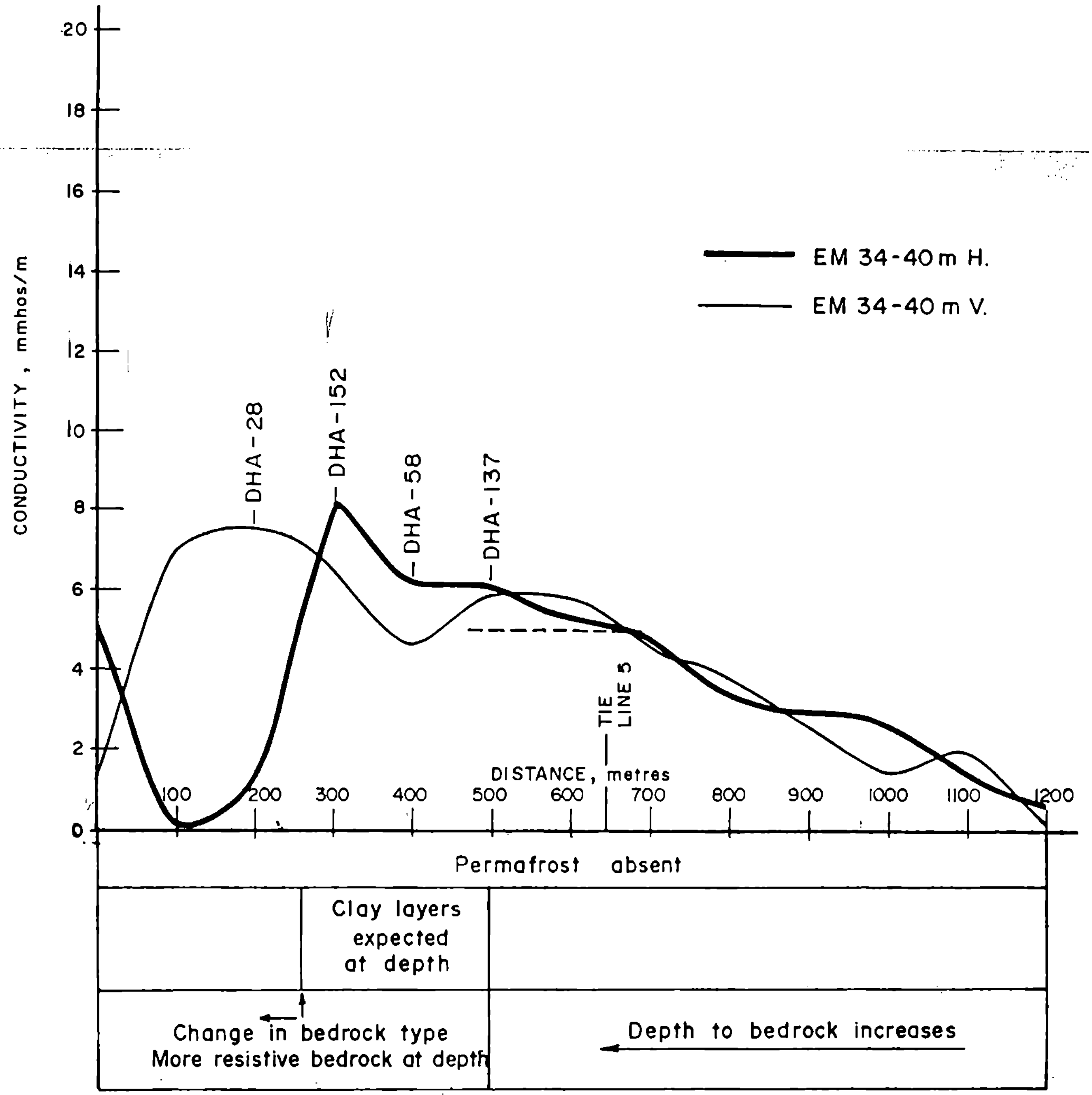

LINE 2
CONDUCTIVITY, mmhos/m
20
18
16
14
12
10
8
6
4
2
0
DHA-153
DHA-106
DOAL LAKE
EM 34-40 m H.
EM 34-40 m V.
TIE LINE 5
DISTANCE, metres
100
200
300
400
500
600
700
800
900
1000
1100
1200
Permafrost absent
Clay layers expected
at depth
Change in bedrock type
Resistive bedrock at depth
Depth to bedrock increases

LINE 3



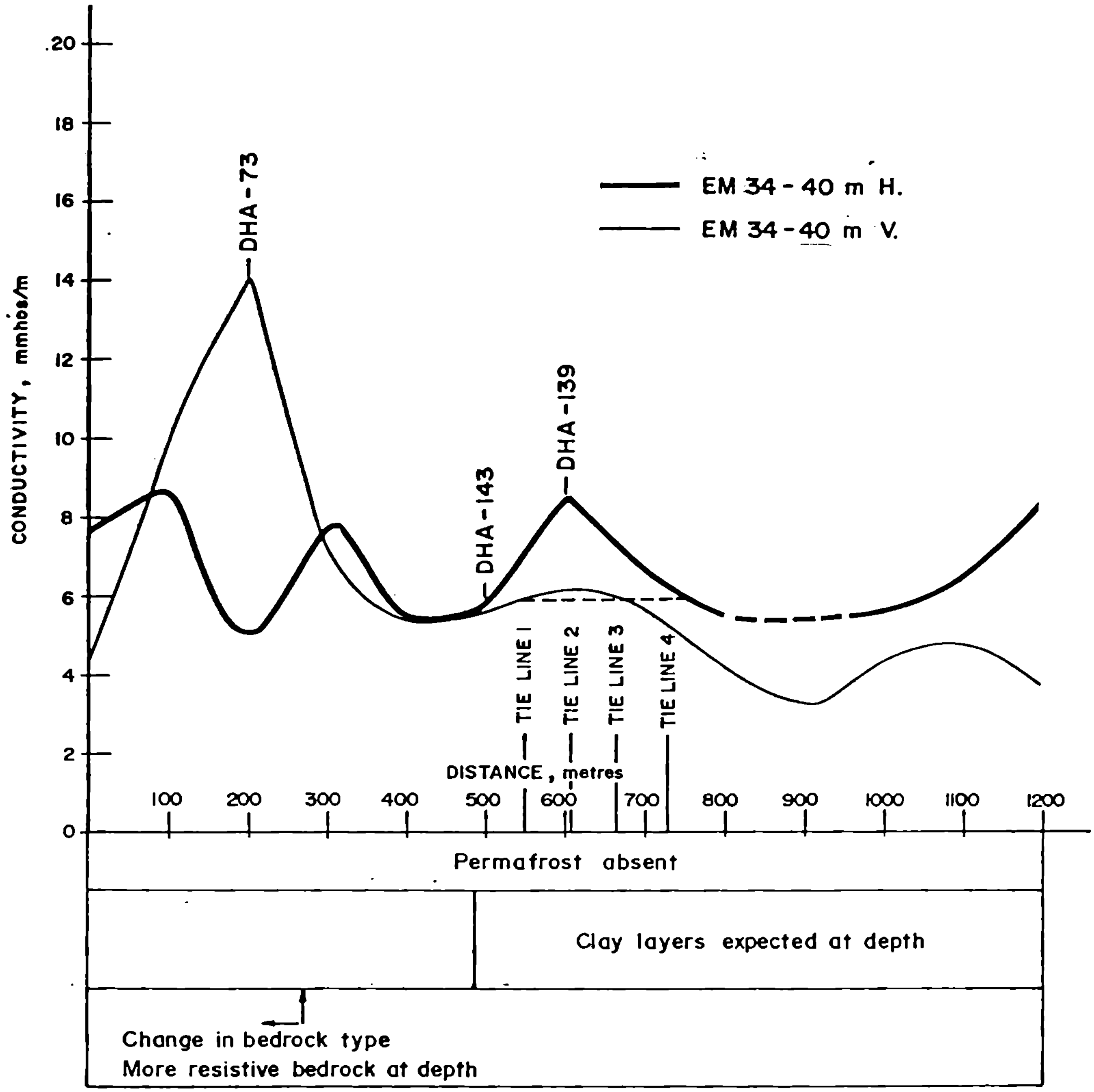
CONDUCTIVITY, mmhos/m
20
18
16
14
12
10
8
6
4
2
0
EM 34-40m H.
EM 34-40m V.
DHA-157
DHA-66
DHA-99
TIE LINE 5
DISTANCE, metres
100
200
300
400
500
600
700
800
900
1000
1100
1200
Permafrost absent
Clay layers expected at depth
Clay layers expected at depth
Change in bedrock type
More resistive bedrock at depth
Bedrock increases with depth

LINE 4



CONDUCTIVITY, mmhos/m
20
18
16
14
12
10
8
6
4
2
0
EM 34-40 m H.
EM 34-40 m V.
DHA-28
DHA-152
DHA-58
DHA-137
TIE LINE 5
DISTANCE, metres
100
200
300
400
500
600
700
800
900
1000
1100
1200
Permafrost absent
Clay layers expected at depth
Change in bedrock type
More resistive bedrock at depth
Depth to bedrock increases

LINE 5



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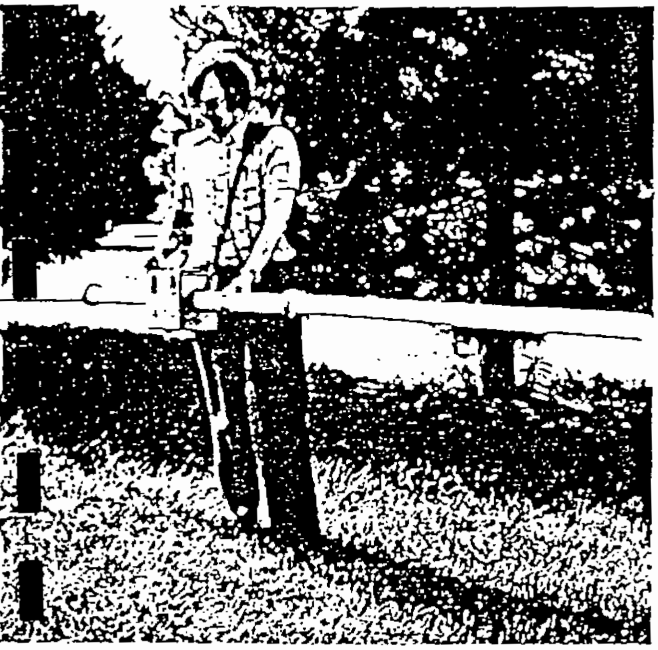
ELECTROMAGNETIC SURVEY DATA

EM 34-3, 40 METRE COIL SPACING

CONDUCTIVITY METERS

[redacted]E MAN - CONTINUOUS READING



M[redacted]1

[redacted]Geonics EM31 provides a measurement of terrain conductivity without contac[redacted] the [redacted]ound using a patented inductive electromagnetic technique. The in[redacted]en[redacted] direct reading in millimhos per meter and surveys are carried out simply [redacted]versing the ground.

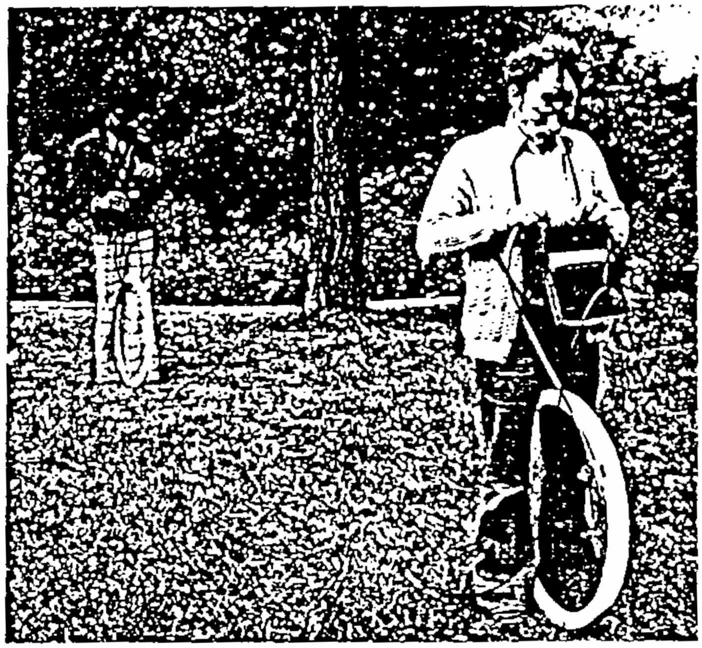
[redacted]ffec[redacted]ve depth of exploration is approximately six meters making it ideal for [redacted]eer[redacted] geophysics. By eliminating ground contact, measurements are easily [redacted]d o[redacted]in regions of high resistivity such as gravel, permafrost and bedrock. [redacted]a uniform half space the EM31 reads identically with conventional resistivity [redacted]he measurement is analogous to a conventional galvanic resistivity survey [redacted] fi[redacted] array spacing. Interpretation curves supplied with each instrument [redacted]per[redacted] an estimate of a layered earth.

[redacted]dvantages of the EM31 are the speed with which surveys can be carried out, [redacted]ility to precisely measure small changes in conductivity, and the continuous [redacted]ut w[redacted]ch provides a previously unobtainable lateral resolution.

[redacted]ecifications

[redacted]URE[redacted]QUANTITY	Apparent conductivity of the ground in millimhos per meter.
[redacted]RY [redacted]ELD SOURCE	Self-contained dipole transmitter
[redacted]R	Self contained dipole receiver
[redacted]OIL SPACING	3.66 meters
[redacted]TING FREQUENCY	9.8 kHz
[redacted] SU[redacted]LY	8 disposable alkaline 'C' cells (approx. 20 hrs life continuous use)
[redacted]CTIVITY RANGES	3, 10, 30, 100, 300, 1000 mmhos/meter
[redacted]REM[redacted]NT PRECISION	±2% of full scale
[redacted]REM[redacted]T ACCURACY	±5% at 20 millimhos per meter
[redacted]EVEL	< 0.1 millimhos per meter
[redacted]OR CONTROLS	• Mode Switch • Conductivity Range Switch • Phasing Potentiometer • [illegible] • [illegible]
[redacted]	Boom: 4.0 meters extended, 1.4 meters stored Console: 24 x 20 x 18 cm Shipping Crate: 155 x 42 x 28 cm Instrument Weight: 9 kgm Shipping Weight: 23 kgm

TWO MAN - VARIABLE DEPTH



EM34-3

Operating on the same principles as the EM31, the EM34-3 is designed to achieve a substantially increased depth of exploration and a readily available vertical conductivity profile.

The underlying principle of operation of this patented non-contacting method of measuring terrain conductivity is that the depth of penetration is independent of terrain conductivity and is determined solely by the instrument geometry i.e. the intercoil spacing and coil orientation. The EM34-3 can be used at three fixed spacings of 10, 20, or 40 meters and in the vertical coplanar (as shown) or horizontal coplanar mode. In the vertical coplanar mode, the instrument senses to approx. 0.75 of the intercoil spacing. In the horizontal coplanar mode, the instrument can sense to 1.5 times the intercoil spacing. For the horizontal coplanar mode, however, coil misalignment errors are more serious than in the vertical mode so greater care must be exercised to achieve the maximum 60 meter depth.

Simple operation, survey speed and straight forward data interpretation makes the EM34-3 a versatile and cost effective tool for the engineering geophysicist.

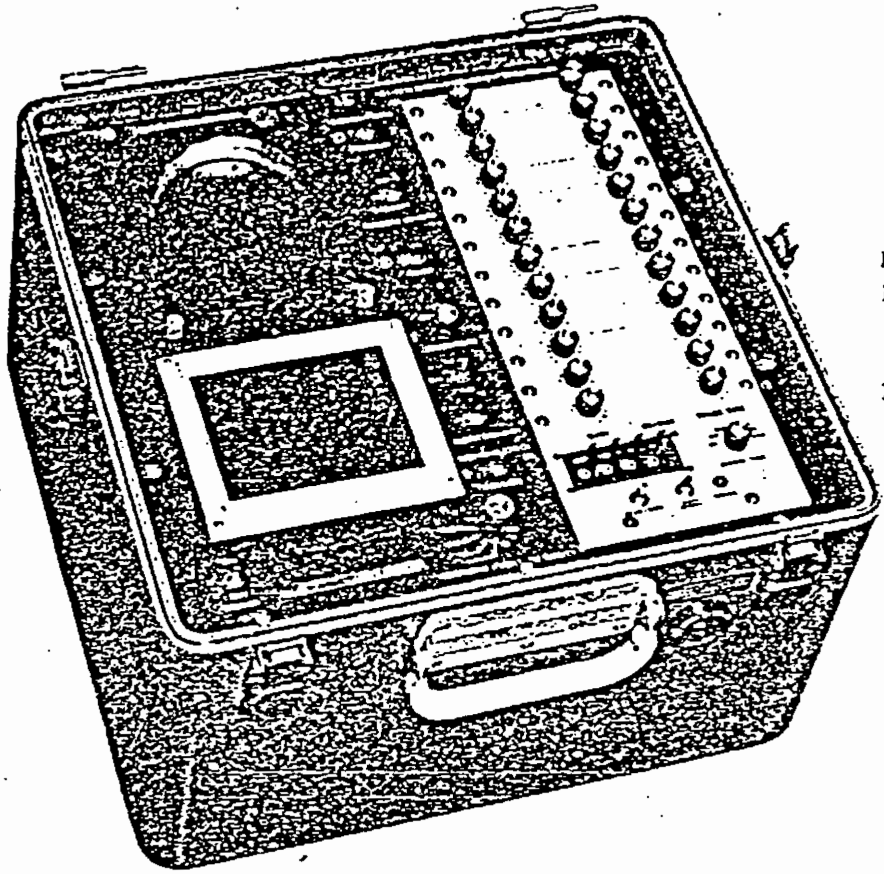
Specifications

MEASURED QUANTITY	Apparent conductivity of the ground in millimhos per meter
PRIMARY FIELD SOURCE	Self-contained dipole transmitter
SENSOR	Self contained dipole receiver
REFERENCE CABLE	Lightweight, 2 wire shielded cable
INTERCOIL SPACING & OPERATING FREQUENCY	• 10 meters at 6.4 kHz • 20 meters at 1.6 kHz • 40 meters at 0.4 kHz
POWER SUPPLY	Transmitter: 8 disposable 'D' cells Receiver: 8 disposable 'C' cells
CONDUCTIVITY RANGES	3, 10, 30, 100, 300 mmhos/meter
MEASUREMENT PRECISION	±2% of full scale deflection
MEASUREMENT ACCURACY	±5% at 20 millimhos per meter
NOISE LEVEL	< 0.2 millimhos per meter
DIMENSIONS	Receiver Console: [illegible] Transmitter Console: 15 x 8 x 26 cm Coils: 63 cm diameter
WEIGHTS	Receiver Console: 3.1 kg Receiver Coil: 3.2 kg Transmitter Console: 3.0 kg Transmitter Coil: 6.0 kg Shipping Weight: 41 kg

EG&G

Exploranium
geoMetrics

436 Limestone Crescent
Downsview (Toronto)
Ontario, Canada
M3J 2S4
Tel: (416)661-1966
Telex: 06-22694



MULTICHANNEL SIGNAL
ENHANCEMENT SEISMOGRAPH
MODEL ES-1210

Preliminary Data Sheet

Signal enhancement for greater sensitivity, improved waveform definition, and more accurate time measurements. Operates under high noise conditions and surveys to greater depths without explosives.

Multichannel oscillograph provides permanent records on high-contrast, sunlight proof, reproducible paper with wiggle trace or variable area format.

* *Daylight-visible CRT monitor* displays the signal stored in memory.

* Compact, lightweight and portable. Ruggedly packaged in weatherproof case.

* Optional digital magnetic tape recorder for computer compatible data storage.

The Nimbus ES-1210 Multichannel Signal Enhancement Seismograph is unique in its combination of CRT display, signal enhancement and oscillograph recording in a single small field instrument. Simple to use yet powerful in performance, this new instrument is ideally suited for all shallow geologic investigations for mining, construction and geologic exploration.

Signal enhancement is a term used to describe the stacking process used in the ES-1210. The seismic signals for each hammer blow or shot are digitized and stored in a computer-like memory in the instrument. Unlike conventional analog seismographs, the record is not made at the instant of the hammer impact or explosion. Instead, it is held indefinitely and printed at the operator's convenience. If the impact or explosion is repeated, the seismograph will add the new signal and the old one, storing the sum back in the memory. As this process is repeated, the signal will grow larger and larger, thus enhancing its appearance on the display or oscillograph record. Seismic noise in the earth, which provides the most significant limitation in depth penetration, is random and does not add in the signal enhancement process at the same rate that the true signal does. As a result, surveys can be performed to about three times the depth that could be realized without enhancement using an equivalent energy source.

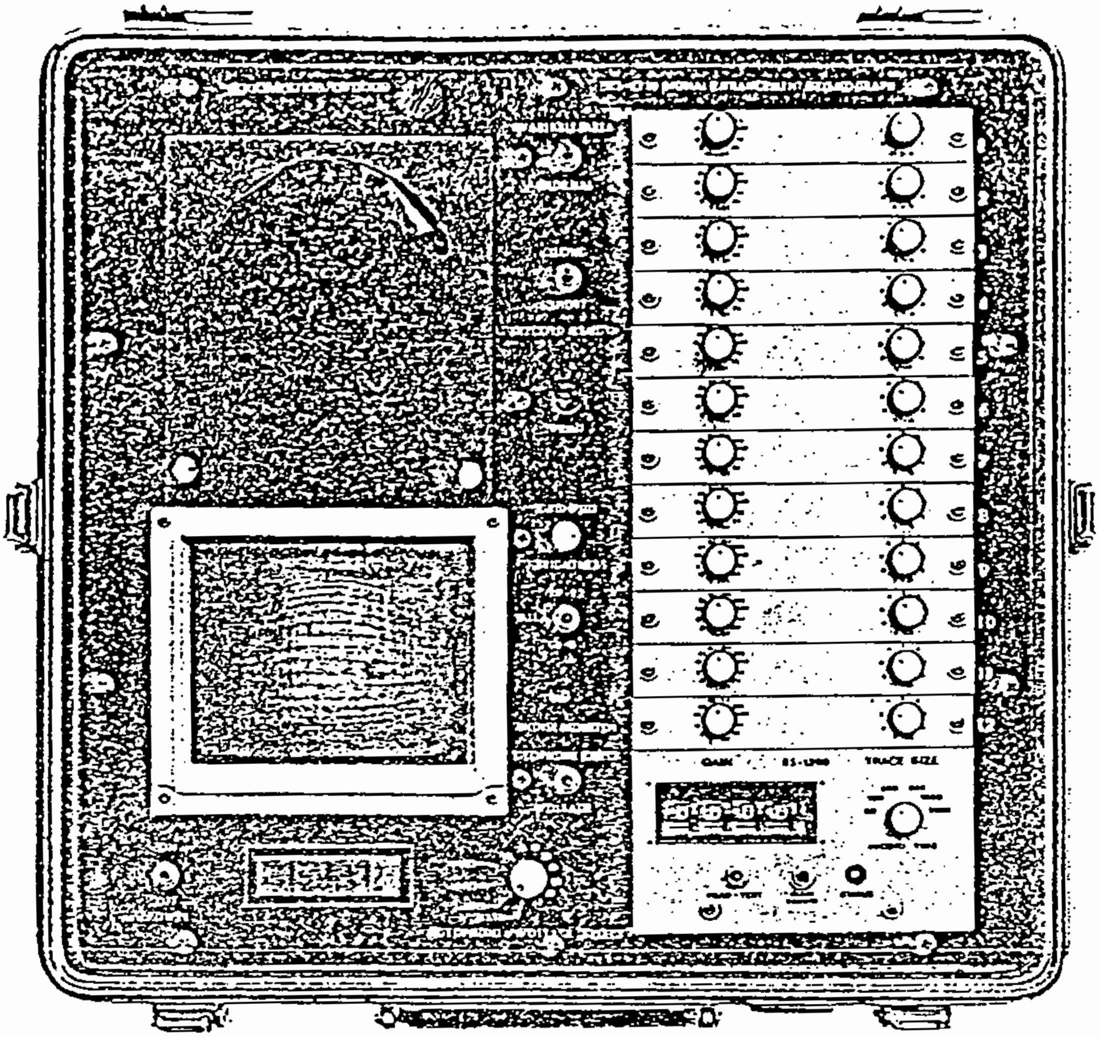
Signal enhancement is also a significant improvement in making shear wave velocity measurements. These types of surveys are important because of the dynamic parameters of foundations can be calculated from shear wave velocities, liquid saturation can be discriminated from other conditions with equivalent P-wave velocities, and shear strength can be estimated. The most reliable shear wave studies are made with mechanical sources, which means that signal enhancement is often a requirement.

Signal enhancement provides other, less obvious advantages, even when using explosive sources. Since the playback gain of the signal stored in memory is adjustable, there is less guess work involved in getting good records. Multiple copies can be made without reshooting the blast. Since the frequency response is not limited by galvanometers and paper speed, a higher time resolution is available, an important factor when working in high-velocity materials.

The signal stored in the memory is displayed on the built-in CRT monitor, and the display will have the same appearance as the paper record. A paper record can be made as often as necessary, at will, without disturbing the data stored in memory. The trace size control can be changed to optimize the record for an application. The gain may be set high for sharp breaks on the P-wave arrivals, and a hard copy made. Then the gain can be turned down for better shear waves or reflections and another copy made.

Both the CRT and oscillograph record in conventional wiggle trace and variable area. A wiggle trace record, like that of a conventional seismograph, would be selected for refraction and shear wave studies. Variable area recording (often seen on examples of petroleum reflection records) is best for reflection because that presentation emphasizes coherent events and resembles geologic structure.

The CRT display is especially important in three other situations. When working in areas with significant background noise, the display gives an instant observation of the signal quality so that it is immediately known whether to repeat impacts, freeze specific channels, or erase and start over. The other use is in shallow reflections. The instant examination of all the channels simultaneously is important in recognizing these events in the record. The third use of the CRT display is in gain selection. With the NOISE MONITOR switch depressed real time signals are shown on the CRT and the gain setting for each channel can be chosen appropriately.



CONTROLS AND FEATURES

Amplifier (input) GAIN is controlled by a 12-position switch, selectable from relative gain of 1 to 5000 in steps of 1-2-5-10 etc. Each amplifier has a 10 bit by 1024 sample memory which stores the digitized signal. Playback gain is controlled over a 20 to 1 range by the TRACE SIZE control. Pulling up the trace size control freezes the memory on that particular channel so that it will not further enhance or erase, thus saving the data while allowing operation on the other channels. Playback or display are not affected by memory freeze.

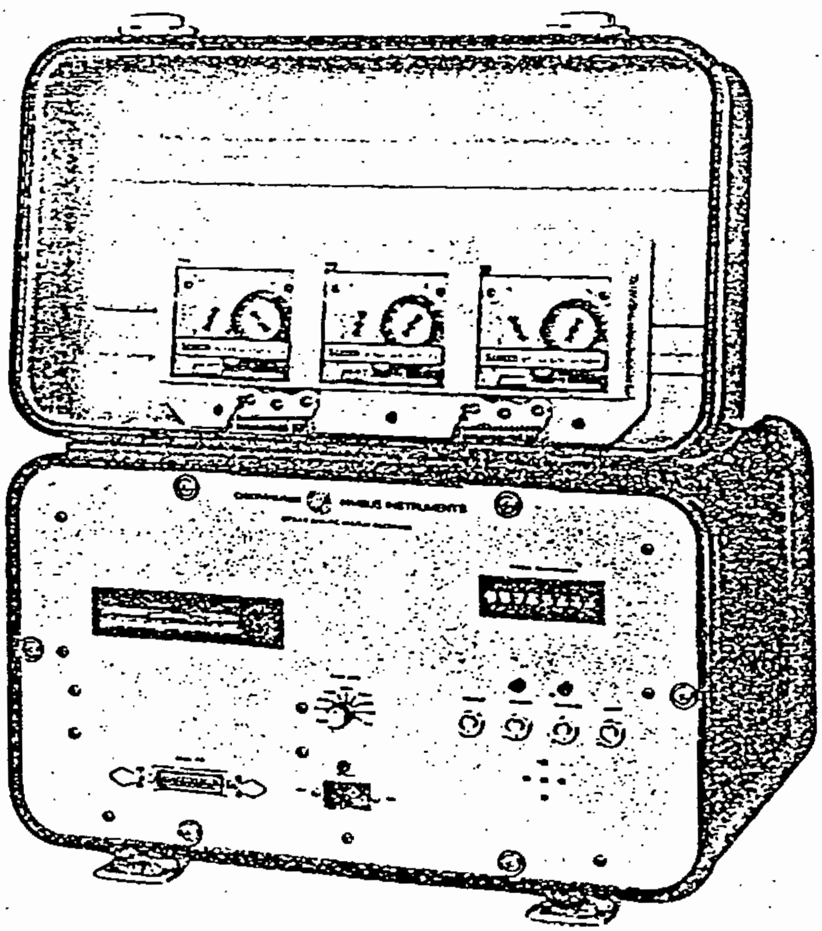
Enhancement control electronics include the RECORD LENGTH control, which selects total time of the record among 50, 100, 200, 500, 1000 or 2000 milliseconds. The record DELAY postpones the start of the record up to 9.999 seconds in one milliseconds increments, allowing you to look later in time, delete unnecessary leading portions of the signal, and maintain faster sampling rates for later events. CLEAR MEMORY controls erases the data stored in the memory. An interlock is provided (both READ and CLEAR must be used) to prevent accidental erasure of valid data. TEST provides a start command to take a record in lieu of hammer switch or blaster.

The CRT display is five inches (13 cm) diagonal measurement. It displays all 12 channels simultaneously or switch selected combinations of six channels as desired. It has a special light filter to allow direct viewing in sunlight without special hoods. The bezel will fit standard oscilloscope cameras so that photographs may be made of the display if desired. Timing lines may be superimposed on the CRT at will by pulling up on the BRIGHTNESS control. The timing line intervals vary, depending on the record length, so that appropriate resolution and clarity is maintained.

A digital voltmeter is provided to measure the battery voltage, internal power voltages, and individual geophone resistances. The NOISE MONITOR, when selected, couples the amplified geophone signals to the CRT display. This allows monitoring the instantaneous background noise so that records may be made during quiet periods.

The data stored in the memory may be accessed externally. An optional digital tape recorder, the G-724S, is available to provide computer compatible storage of the data. The G-724S will store 10 full records (120 channels) in a reduced resolution, 8-bit format, or you can store 5 records (60 channels) in the full 10-bit format. The G-724S serves as its own playback device, outputting the data in an RS-232 format which is directly interfaceable to most computers including desk top models.

G-724S Digital Recorder

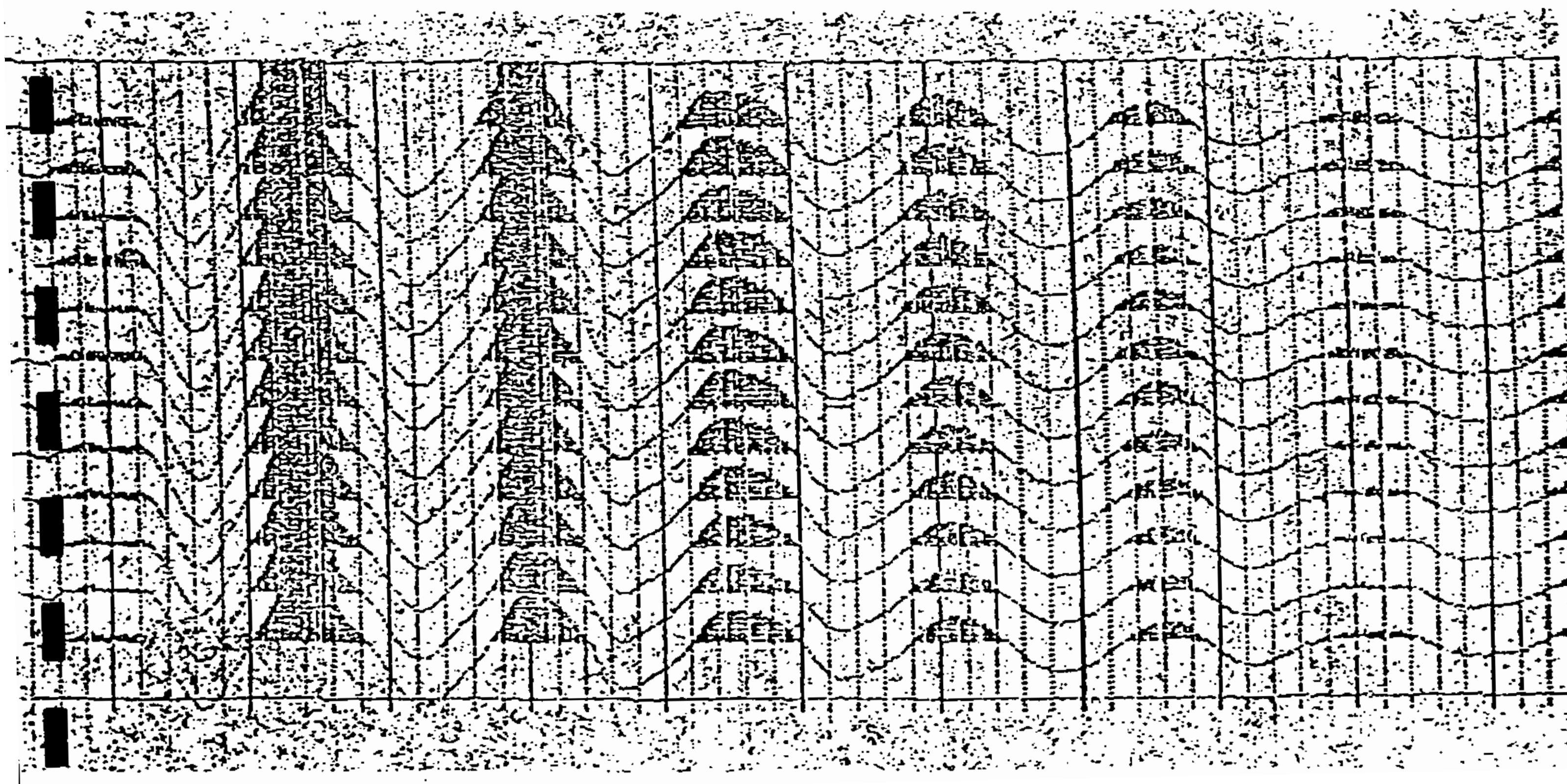


The oscillograph is a rotary scanning dot matrix recorder. The record is composed of a number of closely spaced dots with a resolution of 70 dots per inch (3 dots/mm). The paper width is four inches (10 cm). The record is formed by electrically removing a thin metal layer on the surface of the paper, exposing a black underlayer. The resultant record is of high contrast, and is insensitive to aging or sunlight. It can be reproduced on office copiers, usually better than the original. Because of the way the recorder operates, it is easy to fill in the positive cycles of the signal, thus providing what is known as "variable area" recording. This type of signal presentation produces a record particularly useful in reflection surveys. It makes it easier to recognize reflection signals, and the resultant record resembles geologic structure.

The physical length of the record may be selected as 7½" (19 cm) or 15" (38 cm). In either case, the CRT display changes to a corresponding full record display or an expanded first half with higher resolution. If one of the six channel display functions is selected on the CRT, the corresponding six channels will be on the paper record, providing greater spacing between the lines. Alternate copies of wide space records may be pieced together to provide an effective paper width of 8" (20 cm).

Timing lines are recorded on the paper in either high resolution or low resolution format, depending on the position of the CRT time line switch. The interval between the lines varys with the record time length so that best combinations of time resolution and clutter are maintained. An additional edge time record shows intervals of 100 milliseconds regardless of any control settings. Using this marker, it is easy to determine the time length of the record and the time line intervals.

ES-1210 Record



Nimbus ES-1210

SPECIFICATIONS

Basic refraction and reflection system includes: 12-channel exploration seismograph, 12-volt battery pack, 110/220 volt charger, power cord, hammer switch, and instruction manual.

Signal Enhancement:	samples, digitizes, and stores signal in a random access memory. Repeated signals are added while random noise is cancelled or limited.
Memory Size:	10 bits by 1024 words on each channel.
Sample Interval:	switch selectable 50, 100, 200, 500, 1000, or 2000 microseconds
Record Length:	switch selectable 50, 100, 200, 500, 1000, or 2000 milliseconds
CRT Display:	5" diagonal measurement CRT, daylight visible without hoods, switch selectable time lines, camera compatible, and displays wiggle trace or variable area record display.
Oscillograph:	permanent record of all 12 channels simultaneously on 4" wide electrosensitive paper. Record will not fade in light, and reproduces on copying machines.
Noise Monitor:	ambient vibrations displayed on CRT allowing timing of energy source during quiescent periods and the optimization of gain adjustments.
Timing:	crystal controlled, .01% accurate, time lines are switch selectable on CRT and high or low resolution on oscillographic record.
Precision Delay:	postpones start of record up to 9.999 seconds in one millisecond increments.
Digital Meter:	indicates battery voltage, geophone resistance on each channel, power supply voltages.
Digital Output:	a panel connector to allow digital recording of signal stored in memory on optional digital recorder Model G-724S.
Record Initiation:	by contact closure, saturated NPN transistor, or negative 5-volt pulse.
Standard Size/Weight: (seismograph)	14 X 15 X 15 inches (36 X 38 X 40 cm) lid closed 38 pounds (17 kg)
Power Requirements:	12 volts, 3.5 amperes
Seismograph Case:	Heavy duty aluminum with lid and water tight seal.