MAR 19790011: RICHARDSON RIVER

Received date: Dec 31, 1979

Public release date: Jan 01, 1981

UTAF-161 (3)

GEOPHYSICAL REPORT

ON 19790011

RICHARDSON RIVER PROPERTY

Northeastern Alberta

for

NORCEN ENERGY RESOURCES LTD.

Toronto, Ontario, Canada
June, 1979

D. Jones, M.Sc.
M P H CONSULTING LIMITED

TABLE OF CONTENTS

Page

LIST OF MAPS:

SUMMARY

During the winter of 1979, a programme of linecutting, magnetics, MaxMin II horizontal loop electromagnetics, Vertical loop electromagnetics and VLF electromagnetics was completed on Norcen Energy Resources' property holdings in northern Alberta.

The geophysical work was conducted on three grids situated in Quartz Mineral Exploration Permits Nos. 687612005 and 687612002 for the purpose of following up airborne INPUT conductors and outlining favourable structures that could contain economic concentrations of uranium mineralization.

Several structural features have been interpreted which are potential drill targets. Their location has been outlined on compilation maps. (see Maps Nos. 1 and 2).

1. INTRODUCTION

During the period from March 6, 1979 to April 7, 1979 a geophysical programme consisting of linecutting, horizontal loop EM, vertical loop EM, VLF-EM and magnetics was carried out by M P H Consulting Limited on Norcen Energy Resources' Richardson River property. The property is situated 140 km northeast of Fort McMurray in the Richardson River area of northeastern Alberta and is covered by Alberta Quartz Mineral Exploration Permits Nos. 6876120005 and 6876120002.

The purpose of the surveys was to locate and detail on the ground airborne geophysical anomalies that represented features commonly associated with economic concentrations of uranium mineralization.

The field programme was carried out under the direct supervision of D. Jones, M.Sc. of M P H Consulting Limited. Overall direction was provided by P. G. Schoch, P.Eng. of M P H Consulting Limited and Mr. L. Smith, senior geologist of Norcen Energy Resources Ltd.

Preliminary interpretation of the geophysical data was undertaken in the field by M P H Consulting Limited so that the winter drill programme could be initiated at the earliest possible time. Three drill targets were chosen to test electromagnetic conductive zones, interpreted to represent favourable geological structures.

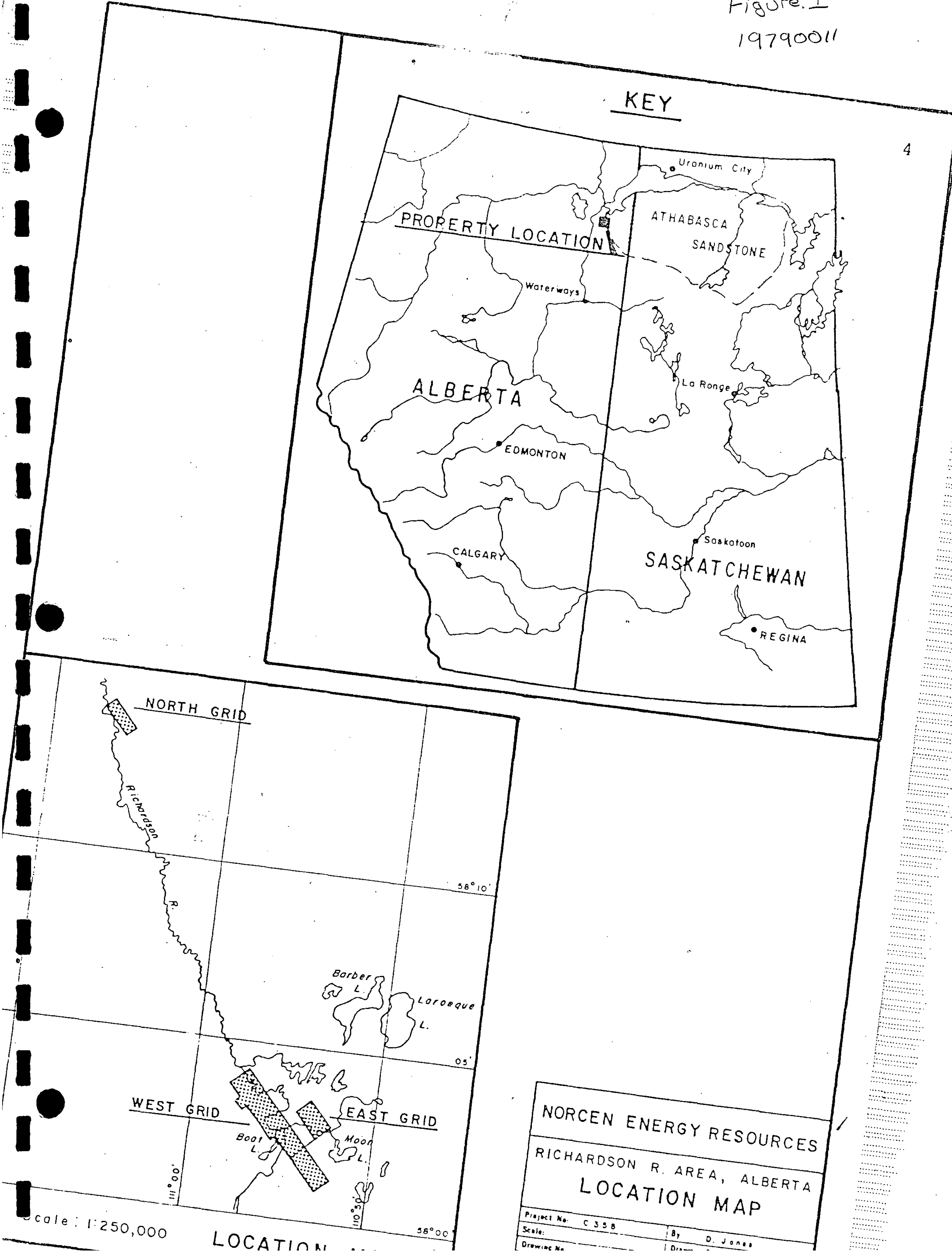
2. LOCATION AND ACCESS

The project area is located within the Fort Chipewyan topographic sheet (NTS 74L) and is bounded by longitudes 110°W and 112°W and latitudes 58°N and 59°N.

Figure 1 shows the property location and the areas covered by geophysical surveys.

The most convenient access to the area is by fixed wing aircraft based at Fort McMurray 140 km to the southeast and Uranium City 230 km to the northeast.

Figure. 1
19790011



LINECUTTING

The linecutting for the project was subcontracted to Shearcroft Mining and Exploration Company Ltd., Yellowknife, who commenced work approximately February 20th. This portion of the programme was completed March 25, 1979.

Of the 62 miles originally contracted a total of 47 linemiles were cut. The linecutting on the north grid was cancelled by Norcen and approximately 9 miles on the west grid could not be cut because of open water on the Richardson River. Crosslines were cut at 150 meter intervals with picketed stations established every 25 meters.

The northern grid and a few lines on the west grid were established using compass and chain.

4. INSTRUMENTATION AND SURVEY PROCEDURE

4.1 MaxMin II Horizontal Loop Electromagnetic System

The system makes use of moving transmitter and receiver coils at a constant coil separation. The coils are horizontal and coplaner and are connected by a reference cable. The inphase and out-of-phase components of the generated secondary field (from electrically conductive zones) are measured at the receiver coil. These are expressed as percentages of the primary transmital field.

Five frequencies of primary field varying from 222 Hz to 3555 Hz are available for use on the MaxMin II. Two frequencies are usually read during a horizontal loop survey. A set of 6 cable lengths are also available. One length is used to survey a given area, with a shorter cable usually used to detail any anomalies of interest. For this survey, lines were spaced at 150m intervals and stations were read every 25 meters. A coil separation of 200 meters and frequencies of 444 Hz and 1777 Hz were used for the initial survey. A 150m cable and the same two frequencies were used for the detailed work.

The area was not secant chained prior to the survey. In areas of rough terrain the secant chaining was carried out as the line was read. No tilt corrections were attempted, however, the topographic data was then available to correct the MaxMin data for short cable effects. (In accordance with the client's instructions the original data was plotted on the maps, in addition a set of profiles were prepared with the data corrected using the secant notes (see Section 10).

Specifications of the MaxMin II horizontal loop system and secant chaining techniques are given in Appendix A.

4.2 Vertical Loop EM Fixed Transmitter, McPhar SS15

This system uses a large vertical triangular loop, 15 ft to the side as a transmitter with a motor generator as a power source. The receiver is a search coil whose axis is placed vertical and perpendicular to the transmitter loop. In an area with no conductors this geometry produces a null or minimum. In the presence of a conductor (usually found by a reconnaissance survey) the transmitter is set up directly over the conductor and orientated so that the point of observation is contained within the plane of the coil. As the receiver is moved from point to point the transmitting coil must be rotated about a vertical axis to follow it.

At the receiver, the search coil is rotated in the vertical plane which is perpendicular to the plane of the transmitter coil. At some particular rotation angle the voltage induced in the receiving coil is a minimum. The angle of this rotation is measured as a dip angle.

For this project the vertical loop EM was used to confirm the horizontal loop conductor axis location prior to drilling. The transmitter was set up on the conductor axis (found by the horizontal loop survey) and approximately 300 meters away from the area of interest. Readings were then taken over the area of interest at 25 meter intervals and 400 meters on either side of the suspected conductor axis.

Specifications for this unit are given in Appendix B.

4.3 VLF Electromagnetic Method

The VLF-EM method employs as a source, one of the numerous submarine communications transmitters in the 15 to 25 KHz band located throughout the world. At the surface of the earth these radio waves propogate predominantly in a single mode along the earth-air interface. This mode is known as the "surface wave". Over flat homogeneous ground in the absence of vertical conductive discontinuities the magnetic field component of this radio wave is horizontal and perpendicular to its direction of propogation.

Where non-horizontal structures such as faults, contacts, conductors give rise to change in ground conductivity, secondary modes are generated which produce a vertical component of the magnetic field. This produces an elliptical polarization of the total field in a plane perpendicular to the direction of propogation.

Commercial VLF instruments enable detection of disturbing structures by measuring the tilt angle of the major axis of the polarization ellipse. On flat homogeneous ground the tilt angle will be zero, but in the vicinity of conducting disturbances will acquire a finite value. Direction of tilt indicates direction of the disturbing structure. Ability to deduce such parameters as depth, depth extent, dip, and width of anomalous structures is minimal. Fortunately, this does not seriously affect location of points where VLF profiles cross the upper limit of dipping structures which can be identified as areas of greatest change in tilt angle per unit of distance.

The transmitting station used during the survey was Cutler, Maine.

The data is read as percentage of the incline from the horizontal, i.e. ($100 \times \tan \theta$), where θ is the tilt angle of the major axis of the polarization ellipse in degrees.

The data is presented as profiles with positive to the right, negative to the left. The instruments specifications are given in Appendix C.

4.4 Magnetics

Two proton precession (Geometrics Model G816) magnetometers (Geometrics Model G-816).

were used on the project. The G816 magnetometer utlizes ~~the precession of spinning~~ protons of a hydrogen atom within a hydrocarbon fluid. These spinning magnetic dipoles are polarized by applying a magnetic field using a current within a coil of wire. Discontinuing the current the proton precess about the earth's magnetic field and in turn generate a small current in the wire. This current is proportional to the precession frequency which in turn is proportional to the earth's total magnetic field.

The instrument reading unit is the gamma and the reading is the absolute value of the earth's total field for that station. Repeatability is usually within two gammas for a particular station. Magnetic data was corrected for diurnal variations using a Barringer M123 base station magnetic recorder.

Deviations from a chosen base value (60500 gammas) were measured every ten seconds throughout the day. These deviations were then used to reduce field survey results to a constant datum plane.

The instruments specifications are presented in Appendix D.

5. RESULTS AND INTERPRETATION

5.1 Airborne Surveys

The airborne INPUT EM surveys covering the west and east grids have outlined two distinct conductive anomalies. The shorter eastern conductor appears to reflect a wide body however, the anomalies show a sawtooth effect which is probably due to the flight directions alternating for each line over this anomaly. Thus the anomaly could be due to a series of parallel conductors with the first conductor seen on each flight line being responsible for the airborne anomaly. The proximity of the other conductors would prohibit their being detected individually.

The western conductor is a long linear conductor paralleling the Richardson River for most of its length. It shows as a weak conductor - its strongest portion being at its northern end, which also shows as a possible multiple zone.

The airborne magnetics mapped a northwest-southeast trend in the area. Two strong magnetic units were found being separated by an area of little magnetic relief.

From the shape and truncations of the magnetic contours an interpreted fault can be located in the magnetic low. Several cross structures can also be seen.

The ground survey area is situated in this magnetic low.

The airborne magnetic survey outlined a linear feature on the north grid. No conductors were detected with the INPUT EM survey.

5.2 Ground Surveys General Comments

MaxMin II Horizontal Loop Electromagnetic System - the interpretation of horizontal loop EM data is based on the classical interpretation curves calculated from model studies of thin tabular conductive bodies. From these curves information concerning the nature of the conductor i.e. its depth, dip and quality can be extracted.

Phenomenon described in the literature such as thickness effect and current gathering result in the decrease of the inphase/quadrature ratio and consequently in an underestimation of both the conductor depth and the conductivity thickness product.

There is a critical conductor thickness at which the conductor response does not behave as in a thin dyke model. This critical thickness which is not exceeded when constructing the model curves is given by the formula.

$$\text{Critical thickness} = \frac{300}{\sqrt{\text{frequence} \times \text{conductivity}}} \text{ meters}$$

Considering the two frequencies used in this survey 444 Hz and 1777 Hz we can write (Ct (444 Hz) = 2 x Ct (1777 Hz).

This indicates that when using the MaxMin II at 444 Hz the conductor can be twice as thick as when employing the 1777 Hz before the response recorded deviates from a thin dyke model. This is one of the main reasons why the interpretation at the higher frequencies tend to give lower estimates of both the conductivity thickness product and depth to the top of the conductor, than those found with lower frequency data.

Vertical Loop - EM - Interpretation for the vertical loop fixed transmitter was done using the interpretation curves and high to low frequency ratio curves to obtain the depth, dip and conductivity thickness parameters of the conductor. Use was also made of the slope and profile shapes.

The majority of the anomalies found in the area were very weak quadrature conductors. This resulted in the null reading found with the vertical loop being extremely broad, and in most cases the points used to enter into the characteristic curves fell outside the useful portion of those curves. Thus the vertical loop surveys were used mainly to confirm the location of conductor axis prior to drilling.

VLF-EM - The VLF survey is usually used in a uranium search as a method of structural analysis. The best method is to use two transmitting directions with an angle as close as possible to 90° between them since the maximum range of sensitivity is commonly quoted as 45° from the propogation direction. Contour maps of Fraser Filter data from the two surveys can then be overlaid and a structural interpretation made.

In northern Alberta and northern Saskatchewan the VLF transmitting stations situated at Seattle, Washington and Cutler, Maine have a receiving angle of approximately 120° between their propogation directions and could be used as described above.

In this project the VLF was done on the north grid using Cutler, Maine. Unfortunately the lines were too widely spaced to extrapolate the conductor traces and the conductors were very weak.

Magnetics

The magnetic pattern is obtained from contouring the total field magnetic data. This has been used mainly to correlate the EM conductor trends. For long linear features curve matching techniques, based on a dyke model, can be employed to obtain estimates of dip, depth, width and magnetic susceptibilities.

The interpretation o- faults is based primarily on the distortion and truncation of magnetic trends within the survey grid.

Difficulty was found when conducting the magnetic survey due to severe magnetic storms. Completion of the magnetic survey on the west grid was postponed to a later date.

Compilation Maps 1 and 2

These maps show a compilation of surveys carried out on the east and west grids. A discussion of the interpretation is given in Sections 5.3 and 5.4 respectively.

5.3 East Grid (see Maps 3-6, Volume 1

The magnetic survey carried out on this grid outlines a regional northwest-southeast trend (see Map No. 6) within which two distinctive features can be seen.

A linear magnetic high is located on the eastern edge of the survey area which shows a possible westward dip. This feature appears to pinch out at line 54 ≠ 00S and reappear at Line 57 ≠ 00S.

Insufficient data coverage of this feature prevents a comprehensive analysis of its parameters although possible faults have been outlined. (see Map No. 1).

The anomaly could result from a change in lithology or an upthrust in the basement topography resulting in a thinning of the overburden cover.

A magnetic anomaly was found approximately in the centre of the grid area. As this feature is of short strike length, no theoretical compensations for the end effects of magnetic features is possible thus making accurate depth interpretations impossible. Qualitatively the gentle gradients associated with the flanks of this feature suggest a deep structure.

The remainder of the grid showed very little magnetic relief. The truncation and deviation of the magnetic contours suggest possible faults as shown in compilation map (see Map No. 1).

Conductor 'A'

Of the conductors outlined by the MaxMin II survey Conductor 'A' extends the length of the grid.

The conductor shows a fairly steep westward dip. There was poor correlation between the results from the high and low frequency. This is interpreted to be due to the conductors exceeding the critical thickness for the frequencies used. Using the low frequency 444 Hz survey as a data base an average depth of 90 meters and a westward dip of 75° was found for this conductor. The conductivity thickness product for the conductor was low (0.5 mhos) resulting from a mostly out-of-phase anomaly. The strongest (0.7 mhos) and best defined portion of the anomaly was between lines 48 ≁ 00S and 49 ≁ 50S.

A vertical loop survey carried out over the strongest portion of the anomaly confirmed the MaxMin II conductor axis. The weak conductors reflected mainly as quadrature anomalies with the horizontal loop system are not conducive to mapping by the vertical loop as the vertical loop system is not designed to balance out the quadrature component of a secondary field. This results in very large nulls which in this case were ± 10 to 20 degrees. Other than confirming the conductor axis location as defined by the horizontal loop survey no significant additional information on the conductor parameters was obtained from the vertical loop survey.

<u>Conductor 'B'</u> (see Maps 3 and 4)

This conductor parallels the magnetic trend in the southeast corner of the grid. Interpretation of the conductor results in a depth estimate of about 110 meters and the conductivity thickness product of approximately 0.5 mhos. These values were similar to that found for conductor 'A'. No vertical loop survey was conducted on this anomaly.

<u>Conductor 'C'</u>

This anomaly is situated on the flank of the magnetic linear in the eastern section of the grid. It appears to be discontinuous with an apparent break between Lines 45 ≠ 10S and 48 ≠ 00S. This conductor is very weak and interpretation is difficult due to interference from adjacent conductors. However, it appears to be similar in character to Conductors 'A' and 'B'. This conductor may be coincident with the magnetically interpreted fault outlined on compilation map No. 1 but there is no evidence of a one to one relationship.

Conductor 'D'

Is an extremely weak quadrature anomaly which flanks the magnetic expression in the centre of the grid. No depth or conductivity thickness values were extracted from this anomaly due to interference from Conductor 'C'.

5.4 West Grid (see Map Sheets 7 - 11 in Pocket - Volume 1)

The MaxMin II Survey outlined a series of linear conductors running approximately parallel to the baseline.

The main conductor 'A' runs the length of the grid and is open at either end. It was previously detected by the Questor INPUT airborne survey.

The interpretation of the horizontal loop MaxMin II profiles are presented on the Maps No. 7 through 10. The depth estimates for the conductor gave consistently deeper values, with the lower frequency than with the higher frequency. This phenomena has been attributed to the conductor exceeding the critical thickness as discussed in Section 5.1. For this reason the interpretation at the lower frequency gives the most accurate value and should be used, however it is possible that even at this frequency the critical thickness has also been exceeded and the depth and conductivity thickness values extracted from these profiles should be regarded as minimum estimates.

The conductivity thickness product varies from 0.5 to 7 mhos along the conductor strike length with the strongest portion lying between Lines 19 + 50S and 25 + 50S. Here an inphase/out-of-phase ratio of approximately 3.5 was found which indicates a good conductor and probably reflects graphite and/or sulphides.

Over the remainder of its strike length the anomaly is mainly an out-of-phase anomaly, a signature that is characteristic of a fault or chloritized shear zone. There is an apparent discontinuity between lines 7 + 50S and 10 + 50S. A very wide conductor which appears to be striking parallel to the crossline was outlined along the baseline. A projection of this strike direction would intersect Conductor 'A' at the discontinuity, and is probably responsible for the discontinuity.

The airborne magnetic survey shows the major magnetic trend in the area to be northwest-southeast. The MaxMin II showed a similar direction to the magnetics. Of interest is the portion of the magnetics on Flight Line 260E and 270W close to Tie Line 9010S. This area shows a local trend perpendicular to the northwest-southeast regional direction. This coincides with and probably reflects the discontinuous section of Conductor 'A' and the baseline conductor.

Unfortunately no ground magnetic data is available yet for this grid.

Nine fixed transmitter vertical loop lines were run over various portions of the conductor with transmitter location at Line 40 ≁ 50S, Station 4 ≁ 12, Line 25 ≁ 50, Station 3 ≁ 70E and Line 7 ≁ 50S, Station 3 ≁ 62E.

The vertical loop survey was used primarily to confirm the MaxMin II conductor axis prior to drilling. The conductor axes from both surveys coincided.

The profile interpretations are shown on Map 11. The data was fairly noisy with very wide nulls due to the large quadrature components to the anomalies. Fairly good correlation was found between the vertical loop and horizontal loop depth estimates. Dip values were not consistent between the two surveys, but were in the same direction.

Conductor 'B' which is located on the eastern side of 'A' (see Maps 7 and 9) is characterized by a strong out-of-phase expression striking north-south and appears to intersect 'A' at approximately 21 ≁ 00S 3 ≁ 50E. Interpretation at the higher frequency was difficult due to the interference from 'A'. Where interpretation was possible the depth estimates were approximately 100 meters to the top of the conductor which are similar or slightly deeper than those found for Conductor 'A'.

A fixed transmitter vertical loop EM Survey conducted on the anomaly (see Map 11) found a broad flat crossover with very wide nulls, due mainly to the conductor being weak and mainly a quadrature anomaly. The geologic noise associated with the anomaly can probably be attributed to overburden.

The vertical loop interpretation correlated well with the horizontal loop MaxMin II interpretation, its main purpose being to confirm the conductor axis location prior to drilling.

Conductor 'C' mapped by the MaxMin II parallels conductor 'B' and appears to intersect 'A' on Line 43 ≁ 0S at 25 ≁ 00E. It shows as a moderate conductor (approximately 3 mhos) on Line 37 ≁ 50S and weakens as it approaches Conductor 'A'. Depth estimate for this anomaly is 100 meters.

Unfortunately, this conductor was not fully traced due to inability to cross the Richardson River on Lines 30 ≠ 00S to 36 ≠ 0S inclusive.

The other conductors found in the area are all very weak out-of-phase anomalies which parallel Conductor 'A' and probably reflect structural features.

5.5 <u>North Grid</u> (see Maps 12 and 13)

This grid was of a reconnaissance nature. The purpose of the survey was to attempt to outline an electromagnetic response which could coincide with the strong magnetic linear outlined by the airborne survey.

Five VLF EM profiles, each 1500 meters long were read along flagged and compassed lines spaced 850 meters apart. Line 17 ≠ 00S was extended to 4000 meters and was surveyed using the MaxMin II horizontal loop.

Although several weak VLF conductors were detected the wide line spacing was such that correlation could not be made from line to line.

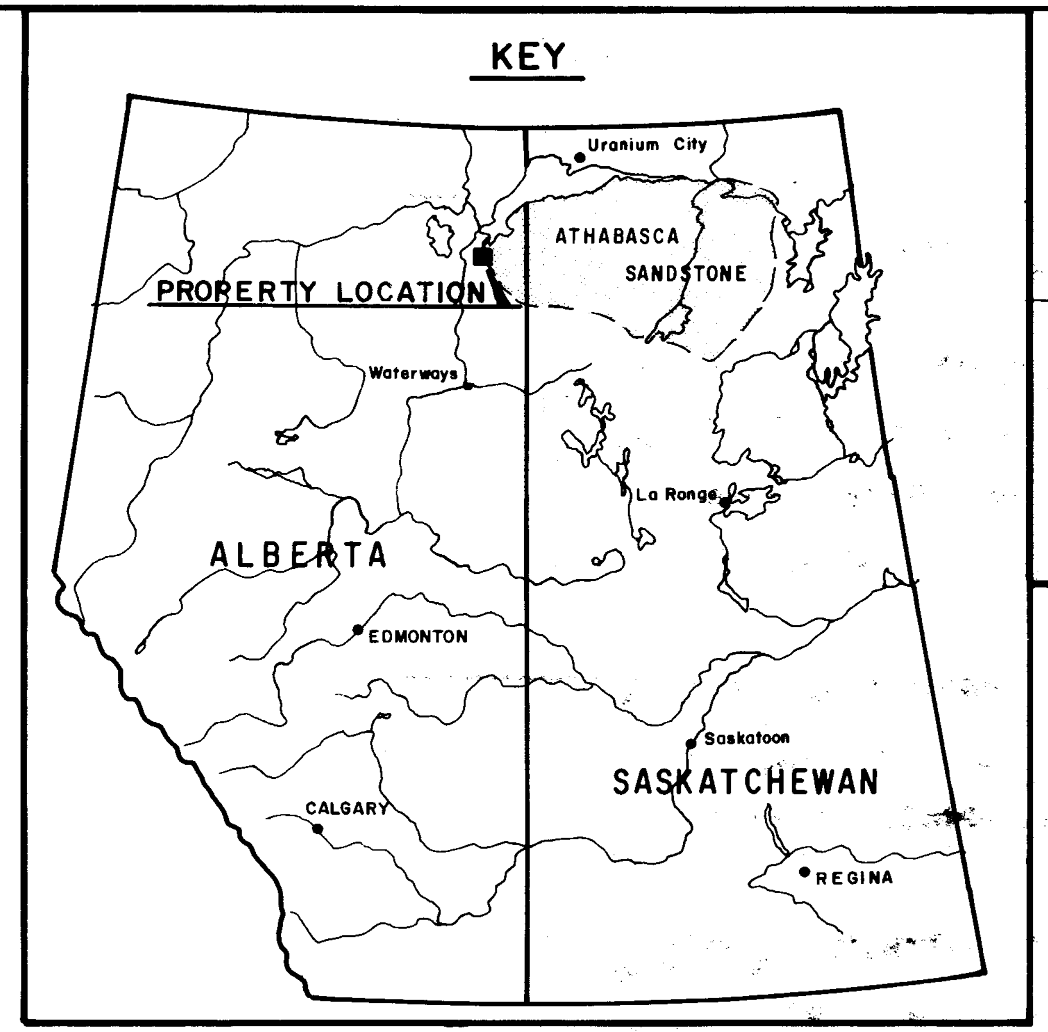
LEGEND

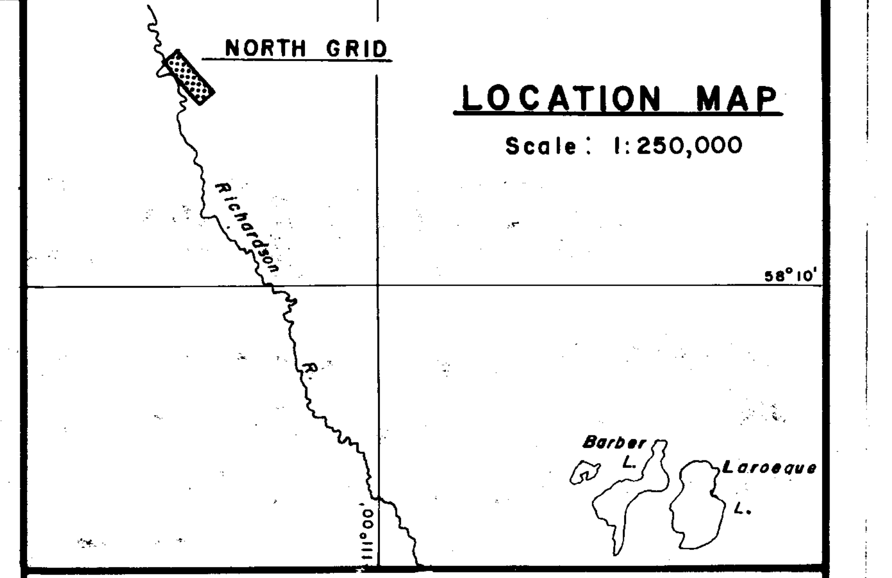
VLF-EM SURVEY

Cuttler, Maine 17·8 kHz

—·—·— Dip Angle Profile

Profile Scale: 1cm = 10%





LINE SPACING NOT TO SCALE

HORIZONTAL SCALE

0 100 200

METRES

NORCEN ENERGY RESOURCES

RICHARDSON RIVER AREA, ALBERTA
PERMIT No. 6876120002

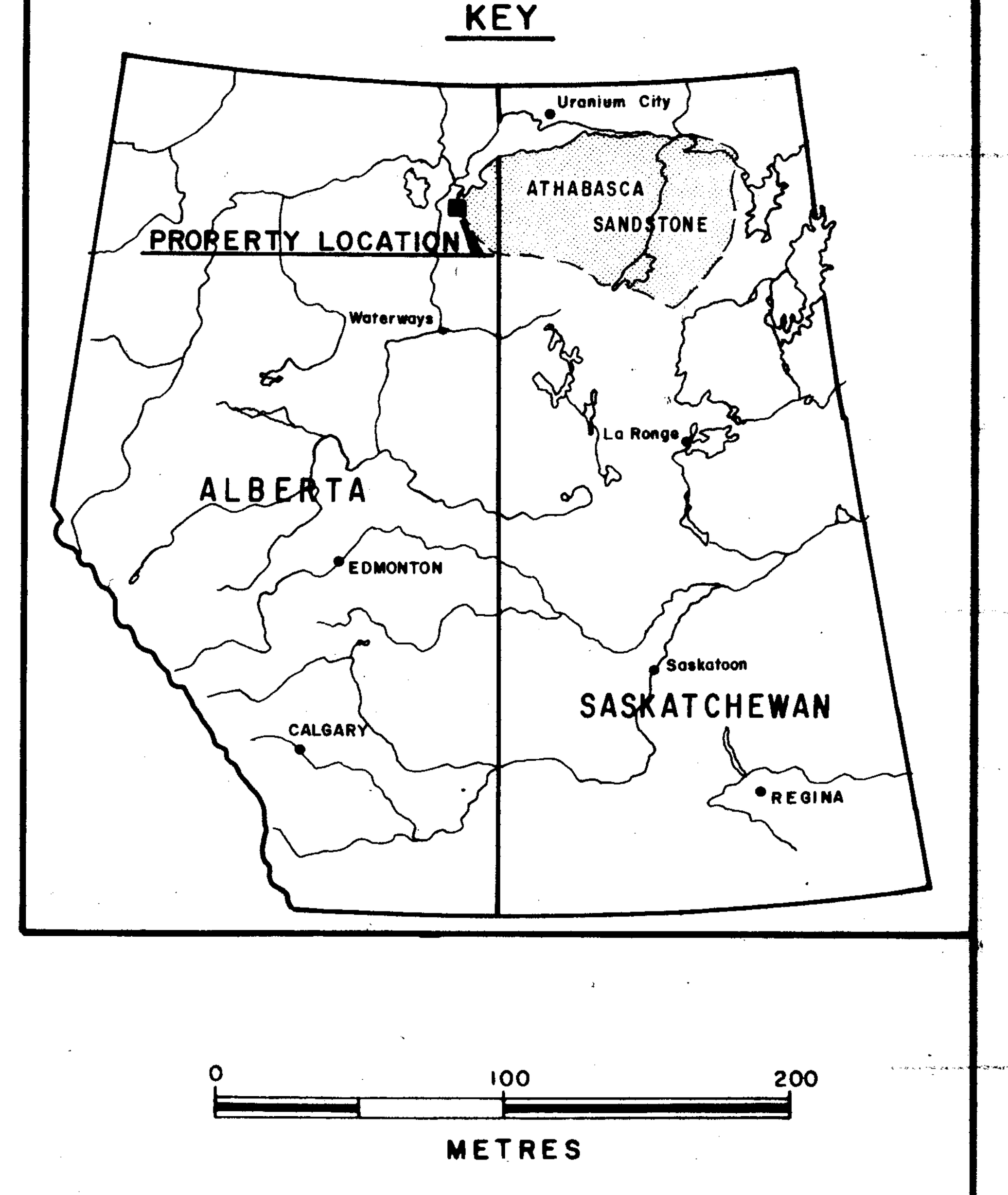
VLF-EM SURVEY

NORTH GRID

Project No: C 358	By: D. Jones
Scale: 1:2500	Drawn: gmes
Drawing No: 12	Date: April, 1979

MPH Consulting Limited

19790011



NORCEN ENERGY RESOURCES

RICHARDSON RIVER AREA, ALBERTA
PERMIT No. 6876120002

HORIZONTAL LOOP SURVEY

NORTH GRID

Project No: C 358	By: D. Jones
Scale: 1: 2500	Drawn: gmes
Drawing No: 13	Date: April, 1979

MPH Consulting Limited

19790011

6.0 CONCLUSIONS AND RECOMMENDATIONS

The detailed geophysical surveys conducted on the grids have successfully outlined on the ground the airborne INPUT anomalies and have assisted in discriminating further between the various conductors present in the area.

Most of the conductors outlined were weakly conducting out-of-phase anomalies and differed only in relative amplitude. These conductors probably represent fault or shear zones.

The most reliable interpretation of a conductor characteristic was obtained from the lower frequency (444 Hz) horizontal loop data. The higher (1777 Hz) data consistently gave shallower depths.

The geophysical surveys carried out on this project are not direct surveys for uranium deposits and as such drill hole recommendations to intersect uranium mineralization cannot reasonably be made.

The intent has been to outline possible favourable bedrock structures which could act as mineralization traps. Not knowing the exploration model for the survey area the weak conductors have been interpreted to be shear zones or faults and the stronger conductors to be caused by graphites or sulphides.

East Grid - On the east grid the electromagnetic conductors found were extremely weak (1 mho) and deep features (100 meters) which are interpreted to represent shear features.

These showed no direct correlation with the magnetic anomalies. There was no apparent structural intersections involving the electromagnetic anomalies. Fault structure interpreted from the magnetics showed a possible fault or shear zone (see Map No. 1) with which Conductor 'C' may be associated.

West Grid - One fairly strong (5-7 mho) conductor was mapped on this grid. It was a 600 meter section contained within the long Conductor 'A'. This section could represent a graphitic and/or sulphide assemblage. It was intersected by two weaker conductive zones which probably indicate structural features such as chloritized shear zones. From airborne magnetics and airphoto analysis several linear structures were found to crosscut Conductor 'A' which in some cases affects the conductor trace. (see Compilation Map No. 2).

Completion of the ground magnetic survey on this grid is strongly recommended to provide greater control on the structural interpretation put forward to date. Several possible structural features have been outlined which warrant further investigations. These areas are shown on Map No. 2.

North Grid - No conductors were outlined and based on the data at hand no further work can be recommended.

The above areas outlined as possible zones warranting further investigation are based on a geophysically-oriented exploration approach, and should be re-evaluated with all other information that is available from the area.

Respectfully submitted,

[redacted]

DJ:g

D. Jones

CERTIFICATE

I, David Jones of Toronto, Ontario hereby certify that:

1) I hold a Bachelor of Technology degree in Applied Physics from the University of Bradford, England and a Master of Science degree in Applied Geophysics from McGill University in Montreal.

2) I have practised my profession in exploration continuously since graduation.

3) I have based conclusions and recommendations contained in this report on my experience and knowledge of the area and on observations made while on the property during March, 1979. All field work conducted on the property during March, 1979 was carried out under my direct supervision.

4) I hold no interest, directly or indirectly in this property other than professional fees, nor do I expect to receive any interest in the property or in Norcen Energy Resources Ltd. or any of its subsidiary companies.

[redacted]

Toronto, Ontario, Canada

David Jones

NOTE: On Secant corrected data:

Map 14 shows some of the MaxMin II data from Grid No. 2 before and after data reduction was carried out to eliminated short cable effects.

As can be seen from these profiles the short cable affects both inphase and out-of-phase data, but to different degrees. Both readings are moved positively relative to their correct values with the inphase data being more severely affected.

A programme written by the author has been used which, from the secant notes, automatically gives the correction to be applied to restore the data. The secant notes used were then taken by the author in conjunction with the MaxMin data.

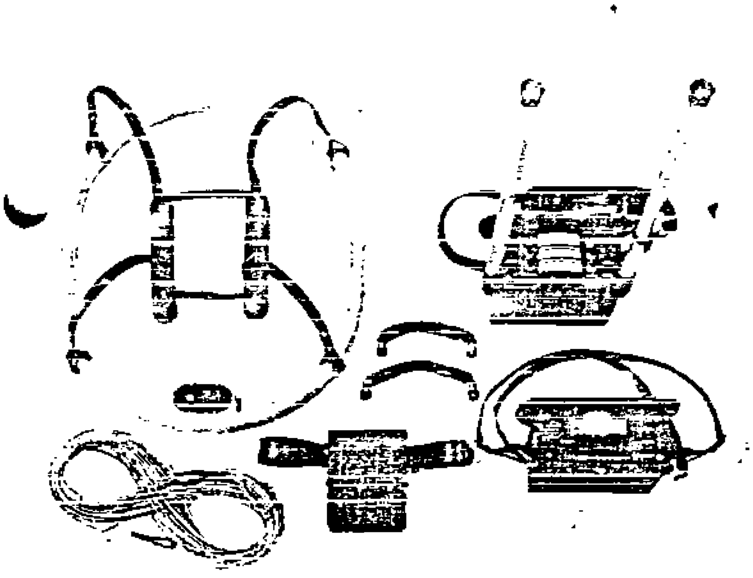
Correction of the data has improved the interpretation of the conductors, and in high terrain where grades of 10% or greater are encountered secant corrected data should be used to interpret the anomalies.

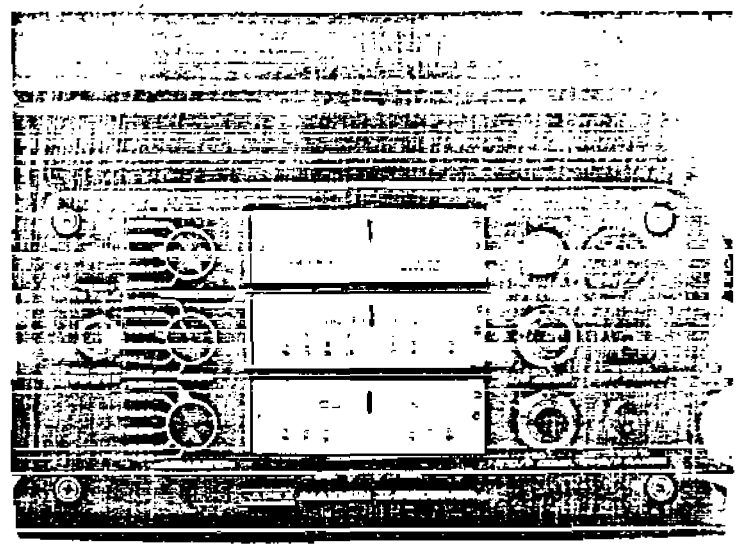
APPENDIX A

Specifications for Apex MaxMin II Horizontal Loop and Secant Chaining

APEX MAXMIN II PORTABLE EM

- Five frequencies: 222, 444, 888, 1777 and 3555 Hz.
- Maximum coupled (horizontal-loop) operation with reference cable.
- Minimum coupled operation with reference cable.
- Vertical-loop operation without reference cable.
- Coil separations: 25, 50, 100, 150, 200 and 250 m (with cable) or 100, 200, 300, 400, 600 and 800 ft.
- Reliable data from depths of up to 180 m (600 ft).
- Built-in voice communication circuitry with cable.
- Tilt meters to control coil orientation.





SPECIFICATIONS :

Frequencies: 222, 444, 888, 1777 and 3555 Hz.

Modes of Operation:
MAX: Transmitter coil plane and receiver coil plane horizontal (Max-coupled; Horizontal-loop node) Used with refer cable.
MIN: Transmitter coil plane horizontal and receiver coil plane vertical (Min-coupled mode). Used with reference cable.
V.L. : Transmitter coil plane vertical and receiver coil plane horizontal (Vertical-loop mode). Used without reference cable, in parallel lines.

Coil Separations: 25, 50, 100, 150, 200 & 250 m (MMII) or 100, 200, 300, 400, 600 and 800 ft. (MMIIF). Coil separations in V.L. mode not restricted to fixed values.

Parameters Read:
- In-Phase and Quadrature components of the secondary field in MAX and MIN modes.
- Tilt-angle of the total field in V.L. mode.

Readouts:
- Automatic, direct readout on 90 mm (3.5") edgewise meters in MAX and MIN modes. No nulling or compensation necessary.
- Tilt angle and null in 90 mm edgewise meters in V.L. mode.

Scale Ranges:
In-Phase: ±20%, ±100% by push-button switch.
Quadrature: ±20%, ±100% by push-button switch.
Tilt: ±75% slope.
Null (V.L.): Sensitivity adjustable by separation switch.

Readability: In-Phase and Quadrature: 0.25% to 0.5%; Tilt: 1%.

Repeatability: ±0.25% to ±1% normally, depending on conditions, frequencies and coil separation used.

Transmitter Output:
- 222 Hz : 220 Atm²
- 444 Hz : 200 Atm²
- 888 Hz : 120 Atm²
- 1777 Hz : 60 Atm²
- 3555 Hz : 30 Atm²

Receiver Batteries: 9V trans radio type batteries (4). Life: approx. 35 hrs. continuous duty (alkaline, 0.5 Ah), less in cold weather.

Transmitter Batteries: 12V 6 Ah Gel-type rechargeable battery. (Charger supplied).

Reference Cable: Light weight 2-conductor teflon cable for minimum friction. Unshielded. All reference cables optional at extra cost. Please specify.

Voice Link: Built-in intercom system for voice communication between receiver and transmitter operators in MAX and MIN modes, via reference cable.

Indicator Lights: Built-in signal and reference warning lights to indicate erroneous readings.

Temperature Range: -40°C to +60°C (-40°F to +140°F).

Receiver Weight: 6 kg (13 lbs.)

Transmitter Weight: 13 kg (29 lbs.)

Shipping Weight: Typically 60 kg (135 lbs.), depending on quantities of reference cable and batteries included. Shipped in two field/shipping cases.

Specifications subject to change without notification.

APEX PARAMETRICS LIMITED
200 STEELCASE RD. E., MARKHAM, ONT., CANADA, L3P 1G2

Phone: (416) 495-1612 Cables: APEXPARA TORONTO Telex: [illegible] NUMBER: [illegible] APEXPARA MKHM

5. SECANT CHAINING AND SUBSEQUENT DATA REDUCTION

5.1. The secant method of chaining has been devised for acquiring clean in-phase data in choppy and mountainous terrain, i.e. in terrain where marks on a taut cable will no longer serve as a guide to an accurate coil spacing. Secant chaining is done with a Suunto PM5/SPC inclinometer, which has a "%grade" and a 'Modified Secant" scale (secant x 100) -- hereafter called the "Secant" scale. The latter scale states the number of units along a slope per 100 units of horizontal distance. The "%grade" scale is visible simultaneously with the "Secant", and it states the number of units along the vertical per 100 units of horizontal distance. Other features of this inclinometer are that it is very small, single-hand-held, self-levelling, and oil-damped, with an optically magnified scale.

5.2. The Suunto inclinometer is not a precision instrument in the sense of a surveyor's level. The true "zero" position is usually within ½% grade of "zero" on the scale, but each operator introduces his own bias to the instrument. This bias relates to superimposing the horizontal reading line, seen with one eye, onto an object seen with the other eye. Even with both eyes on the same horizontal plane, superimposition errors still occur. These errors vary from person to person.

It has been found that the cumulative error is generally in the positive direction at the rate of ½ to 1 unit per 100. In the light of this, any inclinometer operator using one of these inclinometers for the first time should make a reversed - position shot on his chaining partner over the distance of a station interval. With this, the inclinometer operator will know whether or not he should be aiming above or below the equi-height mark on his chaining partner.

5.3. The specific procedure in the secant method of chaining depends upon the desired end result. For an accurate MaxMin II survey, it is only necessary to secant chain along the traverse lines. If an accurate plan of the grid with topo contours is desired, then it is necessary to secant chain between the ends of the lines. No specifics will be given here on making topographic contour maps from chaining data, other than to say that the chaining must be done in closed loops and accumulated errors corrected back through the loops. Infact, the procedure is akin to that for a controlle magnetic or gravimetric survey, except that corrections are pro rated by distance rather than time.

5.4. The accuracy of the MaxMin in-phase results depend upon the accuracy of the chaining along the traverse lines; whereas, the accuracy of the grid plan depends also on the accuracy of the chaining between the ends of the lines. A random chaining error of a percent or two will have a perceptible effect on the MaxMin II in-phase results, whereas it will not on the grid picture. So, the chaining along the traverse lines must be quite accurate while the chaining between them can be less accurate. In fact, cut lines are not required for chaining between traverse lines. With a good compass course, it is easy to keep the chain reasonably straight. However, the inclinometer operator does require a line of sight to his helper on the chain.

5.5. A good compass course between the ends of the traverse lines will permit back-chaining without large misclosures at the other end of the line. In fact, misclosures of greater than one meter will not be due to deficiencies in the secant chaining method but to errors in the course followed between the lines. Nonetheless, misclosures at the end of a line -- or in the center, if the baseline is located there -- need not be a cause for subsequent mapping problems if shown in plan as they occur in the field. As far as accurate MaxMin II data is concerned, it is only necessary to know the horizontal-plane position and the elevation of each station along the traverse line.

5.6. A practical example of using the Suunto PM5/SPC inclinometer follows: The inclinometer operator sighting on his helper up a slope reads "105" on the "Secant" scale. This means that he should pay out 1.05 times the desired chaining interval.If this interval is 100 feet, he should simply pay out 105 feet of chain. He holds the "105" mark vertically above the bottom of the picket at which he is standing, while the helper puts in his picket vertically below the "0" mark on the chain. The picket should be driven well or there's little point to this type of chaining. While the helper is writing co-ordinate information on the picket, the inclinometer operator records in his notebook both the secant reading and the corresponding % grade reading (+32).

In this way there is no "dead" time and the chaining goes quickly. Recording each secant reading may appear redundant after it has been applied to the chain. However, a quick visual check of the two recorded readings in the book, against a reference "secant-%grade" table clipped into the book, will alert the operator to the inevitable reading error. An example of this type of table is shown below:

Secant:	%Grade:	Secant:	%Grade:
100	0	118	63
100½	10	119	64½
101	14	120	66½
102	20	122	69
103	24½	124	73
104	28½	126	77
105	32	128	80
106	35	130	83
107	38	132	86
108	41	134	89
109	43½	136	92
110	46	138	95
111	48½	140	98
112	50½	142	101
113	52½	144	104
114	55	146	107
115	57	148	109
116	59	150	112
117	61		

5.7. During the distance measurement, the chain is always held parallel to the slope, e.g. head-to-head, waist-to-waist, hip-to-hip, at a constant tension. On steep slopes, a piece of talus dropped from the mark on the chain will improve the precision of the measurement on the ground.

5.8. Where obstructions in the line impede a full 100ft measurement with the chain, then only a fraction of the secant value seen on the inclinometer scale should be given on the chain. Suppose for instance, that the operator at the "0" end of the chain can only get 3/4 of the way to his next position before passing out of sight, and at this time the secant scale reads "105"; then, the trailing operator should hold the chain at "105 x 0.75 = 78.8", making for an exact 75ft (horizontal) shot. The corresponding %grade value (i.e. +32) seen on the inclinometer scale is recorded directly into the book, as well as the horizontal distance of the shot. Then an additional 25ft horizontal must be chained from the 75 ft mark to reach the next station. If for this step the secant reading is "108" for instance, then the trailing operator should hold the chain at "108 x 0.25=27", making for an exact 25ft horizontal shot. The corresponding %grade value (-41) is recorded together with the distance in the note book.

5.9. If when backchaining to the base line, the final shot from picket 1+00 (N,S,E or W) to the base line picket is on a slope, then an inverse calculation is required to get the horizontal distance to the base line. For example, if the distance on the chain is 128.5ft and the inclinometer shows secant and %grade values of 107 and -38 respectively, then the true horizontal distance is given by the expression 128.5/1.07 =120ft, and the elevation difference is given by the expression -38 x 1.2= -46ft. Of course, the foregoing calculations are only necessary when closing a chaining loop at the base line.

When chaining past the base line, it is best to continue the chaining from the "0" picket and not the base line picket, so that all stations are 100 ft apart. Although the base line picket would not be used during EM coverage in a situation like this, it is a good practice to note its location on the way by. With this, the stations on the line can be accurately plotted with respect to the base line.

5.10. In the metric system, there are usually 25 meters horizontally between stations, which means that an extra calculation must be made on the inclinometer data. One way around this is to subdivide 25 meters of distance on the chain into 100 equal parts numbered 1 to 100. So, a 50 meter chain would be subdivided into 200 equal parts numbered 1 to 200. With this, the inclinometer is used directly, and the operator turns grey less rapidly.

5.11. The most efficient way to reduce the chaining notes is to calculate first the topographic elevations from the % grade values. To start with, a quick perusal should first be made through the notes for all chaining intervals of other than 100 feet before any other calculations are made. For instance, the +32 & -41 % grade figures of sub-secti 5.8. would convert to +24 & -10 feet over the 75 feet and the 25 feet horizontal distance of the two shots. Of course, when the shots are a full 100 ft, the % grade figure is the vertical distance between stations in feet, and the %grade can be used without conversion.

5.12. It is an easy matter to derive the mean slope between the coils from the topo elevations. If a nominal coil spacing of 600ft is to be used, then the elevation difference between stations 600ft apart is divided by "6". For instance if the leading coil in the procession is at station 6+00N on a line while the trailing coil is at the base line station, and the elevation of station 6+00N is 54ft while that of the base line station is 100ft, then the mean slope between the coils is given by the expression (54-100)/6 = -8 % grade.

5.13. If due to a back chaining error, the distance between the base line and station 1+00 (N,S,E or W) is 120ft --- and the chaining has been continued to the other side of the base line from the base line picket rather than the "0" picket---then the distance between the coils will be 620ft when they are straddling the chain error . This distance will have to be taken into account when calculating the mean slope between coils, and also in correcting for the large-coil-spacing error. The calculation for the mean slope in the above becomes (54-100)/6.2=-7% gra

5.14. The initial corrections to the in-phase reading, for the slope of -7% grade and the 620 ft horizontal distance between the coils, are +0.5 and +9.5%, respectively. These values are taken from the correction table on the following page.

5.15. An additional correction is required for the in-phase and out-of-phase readings, but it is only of consequence if an anomaly is present. This correction is in the form of a multiplication factor, which can be found in the table on the next page. The multiplication factors, for the slope of -7% grade and the 620 ft horizontal distance between the coils, are x 1.007 and x 1.103, respectively.

5.16. The widely varying in-phase readings, associated with a widely varying secant chained slope, will reflect in the out-of-phase reading, if there is appreciable phase mixing in the system. This of course can be corrected arithmetically. But, it's much less time consuming to open the receiver can and remove the problem as per subsection 2.4.3, than to correct the phase mixing errors.

APEX PARAMETRICS LIMITED
200 STEELCASE RD E., MARKHAM, ONT CANADA L3R 1G2

Phone: (416) 495-1612
Cables. APEXPARA TORONTO
Telex. 06-986773 NEW TELEX NUMBER: 06-956775 APEXPARA MKHM

CORRECTION TABLES

Rough Terrain Table:

Mean % Grade Between Coils:	In-Phase (only) Correction for Coplanar Coils:	In-Phase & Out-of-Phase Correction:
±0	+0	
1	0	
2	0	
3	0	
4	0	
5	0.5	x 1.004
6	0.5	x 1.006
7	0.5	x 1.007
8	1	x 1.009
9	1	x 1.013
10	1.5	x 1.014
11	1.5	x 1.018
12	2	x 1.021
13	2.5	x 1.025
14	3	x 1.030
15	3.5	x 1.034
16	3.5	x 1.039
17	4	x 1.044
18	4.5	x 1.049
19	5	x 1.054
20	5.5	x 1.061
21	6	x 1.066
22	7	x 1.073
23	7.5	x 1.080
24	8	x 1.087
25	8.5	x 1.096
26	9	x 1.102
27	10	x 1.111
28	10.5	x 1.120
29	11	x 1.128
30	12	x 1.139
31	13	x 1.147
32	13.5	x 1.158
33	14.5	x 1.168.
34	15	x 1.178
35	16	x 1.189
36	16.5	x 1.200
37	17.5	x 1.213
±38	+18.5	x 1.225
39	19	x 1.136
40	20	x 1.249
41	21	y 1.263
42	21.5	x 1.275
43	22.5	x 1.289
44	23.5	x 1.305
45	24	x 1.318
46	25	x 1.334
47	26	x 1.348
48	27	x 1.365
49	27.5	x 1.381
50	28.5	x 1.398
51	29.5	x 1.415
52	30	x 1.433
53	31	x 1.450
54	32	x 1.467
55	32.5	x 1.486
56	33.5	x 1.505
57	34.5	x 1.526
58	35.5	x 1.545
59	36	x 1.566
60	37	x 1.586
61	38	x 1.607
62	38.5	x 1.630
63	39.5	x 1.650
64	40	x 1.669
65	41	x 1.697
66	42	x 1.719
67	42.5	x 1.744
68	43.5	x 1.768
69	44.5	x 1.794
70	45	x 1.820
71	46	x 1.844
72	46.5	x 1.871
73	47.5	x 1.897
74	48	x 1.925
75	49	x 1.953

In-Phase Correction = $+\left[1-\left\{\cos.\tan^{-1}\left(\frac{\%\,\text{Grade}}{100}\right)\right\}^{3}\right]\times 100$ = always positive, no matter the slope sign.

In-Phase & Out-of-Phase Correction = $\times\left\{1/\cos\left(\tan^{-1}\frac{\%\,\text{Grade}}{100}\right)\right\}^{3}$

Short and Long Coil Spacing Table:

Nominal Coil Spacing: 600-400-300-200

Actual Coil Spacing:	In-Phase (only) Correction:	In-Phase & Out-of-Phase Correction:
580 290	-10.5	x 0.906
582-388-291-194	- 9.5	x 0.915
584 292	- 8.5	x 0.924
586 293	- 7.5	x 0.933
588-392-294-196	- 6	x 0.942
590 295	- 5	x 0.952
592 296	- 4	x 0.961
594-396-297-198	- 3	x 0.971
596 298	- 2	x 0.980
598 299	- 1	x 0.990
600-400-300-200	± 0	x 1.000
602 301	+ 1	x 1.010
604 302	+ 2	x 1.020
606-404-303-202	+ 3	x 1.030
608 304	+ 4	x 1.041
610 305	+ 5	x 1.051
612-408-306-204	+ 6	x 1.061
614 307	+ 6.5	x 1.072
616 308	+ 7.5	x 1.082
618-412-309-206	+ 8.5	x 1.093
620 310	+ 9.5	x 1.103

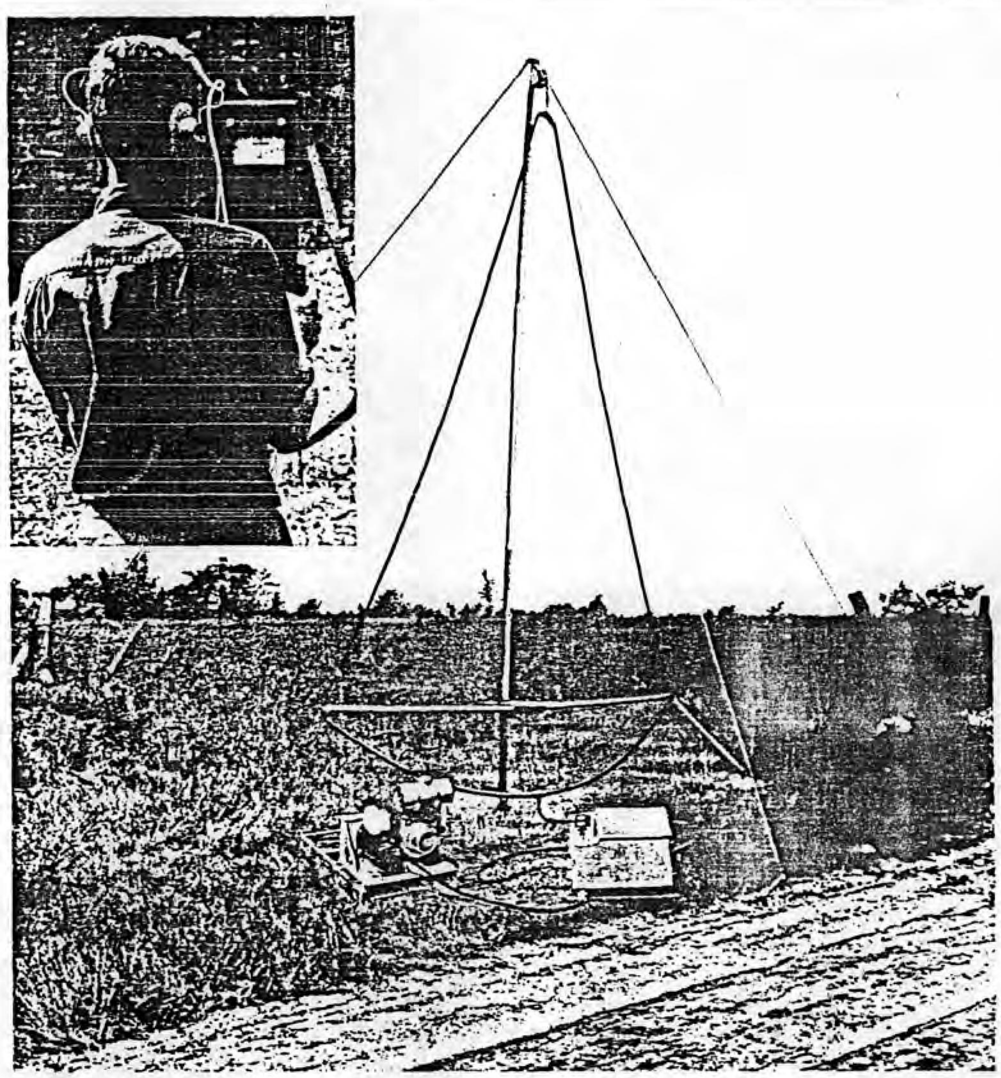
In-Phase Correction = $+\left[1-\left(\frac{\text{Nominal Coil Spacing}}{\text{Actual Coil Spacing}}\right)^{3}\right]\times 100$

In-Phase & Out-of-Phase Correction = $\times\left(\frac{\text{Actual Coil Spacing}}{\text{Nominal Coil Spacing}}\right)^{3}$

APPENDIX B

McPhar SS15 Vertical Loop Specifications

Generator powered for depth in detailed EM surveying



Operates up to 2,000 foot (610 meters) separations

Vertical loop, dip-angle measurement

Simultaneous dual frequency operation, 1000 Hz and 5000 Hz

300 watt engine generator

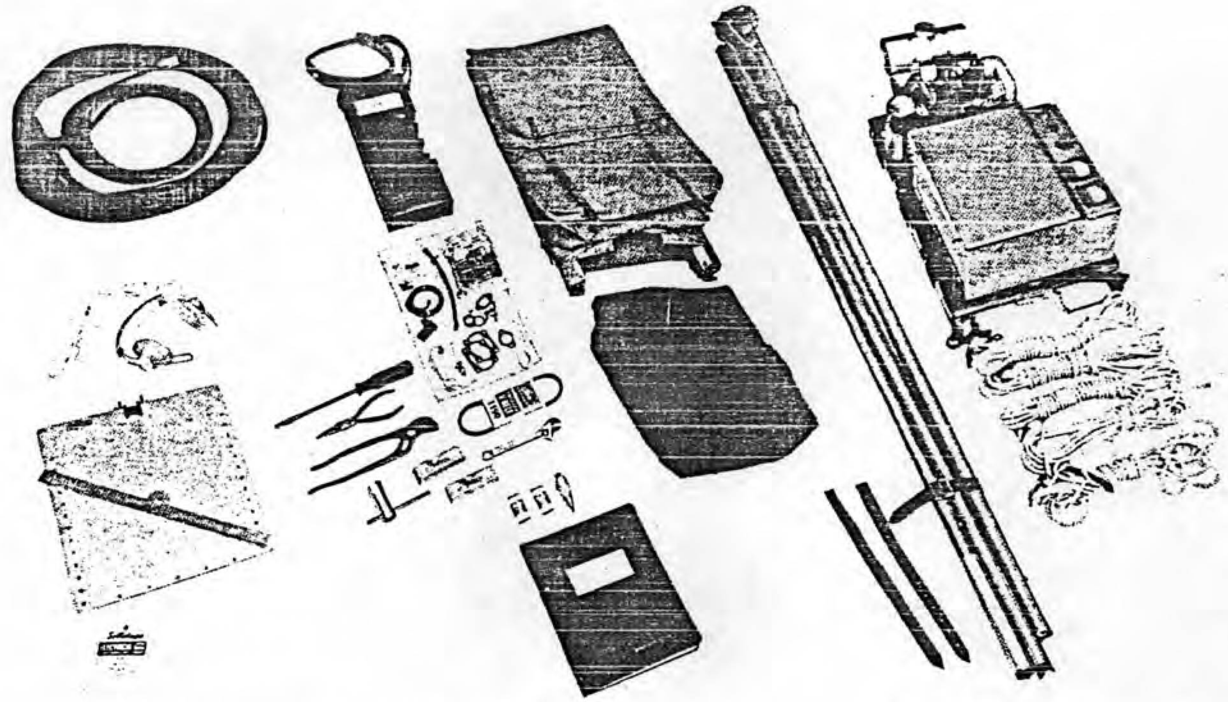
Automatic frequency switching on transmitter

McPhar Model SS 15 vertical loop EM system provides a high powered unit suitable for good depth penetration. This dip-angle system can operate at distances of up to 2,000 feet (610 meters) and the vertical loop method provides maximum discrimination against conductive overburden.

The dual frequency system employing 1000 Hz and 5000 Hz is a powerful tool for the evaluation of anomalies. The in-phase response of any conductive body is a product of the conductor size, its conductivity and the frequency employed. The magnitudes of the responses over a conductor at 1000 Hz and 5000 Hz provides an estimate of the relative conductivity of anomalous sources.

The SS 15 transmitter has been designed to speed surveying through its features and compactness. It can be operated at 1000 Hz or 5000 Hz in the single frequency mode, but for faster surveying it can be switching to an alternate mode, where transmission consist of alternating bursts of signal at each of the frequencies.

The transmitter power supply consists of a 1⅓ hp engine generator supplying 24 V. The Triangular transmitter coil is suspended from a light aluminum mast. The flexible coils rolls up for packing and the mast and spreader



bar disassembles into 5½ feet sections.

For field transport the transmitter and power supply unit are pack-board mounted.

The receiver is an all-transistorized unit that features a sensitive pick-up coil and high gain amplifier. A meter clinometer indicates the angle of tilt from vertical, while the null point is determined on the headphones. The receiver is operated on internal batteries.

SS 15 comes complete with pack-board mounted engine generator, transmitter console, receiver, transmitter coil with orienting board, plumb bob, guy ropes, packsack, packboard, receiver headphones, and spare parts.

Specifications:

Operating frequencies: 1000 Hz and 5000 Hz.

Transmitter operation: one-frequency continuous or alternate frequency transmission.

Range: 2,000 foot (610 meters) separation between transmitter and receiver for a ± 10 degree null width.

Transmitter:

Power supply: 300 watt, 1⅓ hp motor generator.

Receiver:

Batteries: 2 type "E" 146 Eveready Batteries.

Operating temperatures: −35°F to 120°F (−37°C to 49°C).

Weights: Engine generator and transmitter console: 52 lbs. (23.6 kg.)
Transmitter coil, packsack and packboard: 25 lbs. (11 kg.)
Coil mast and spreader bar: 18 lbs. (8 kg.)
Receiver: 5½ lbs. (2.5 kg.)

McPhar Instrument Corporation

Head Office:

Tempo Avenue,
Willowdale, Ontario, Canada M2H 2R9
Tel: (416) 497-1700 Telex: 0623541
Cable: McPHAR TOR

Sales agents in:

Africa, Asia, Australia, Europe, North & South America

Contact McPhar Instrument Corp. head office for the agent in your area.

APPENDIX C

Specifications for Geonics EM16 VLF-EM

EM16

VLF Electromagnetic Unit

Pioneered and patented exclusively by Geonics Limited, the VLF method of electromagnetic surveying has been proven to be a major advance in exploration geophysical instrumentation.

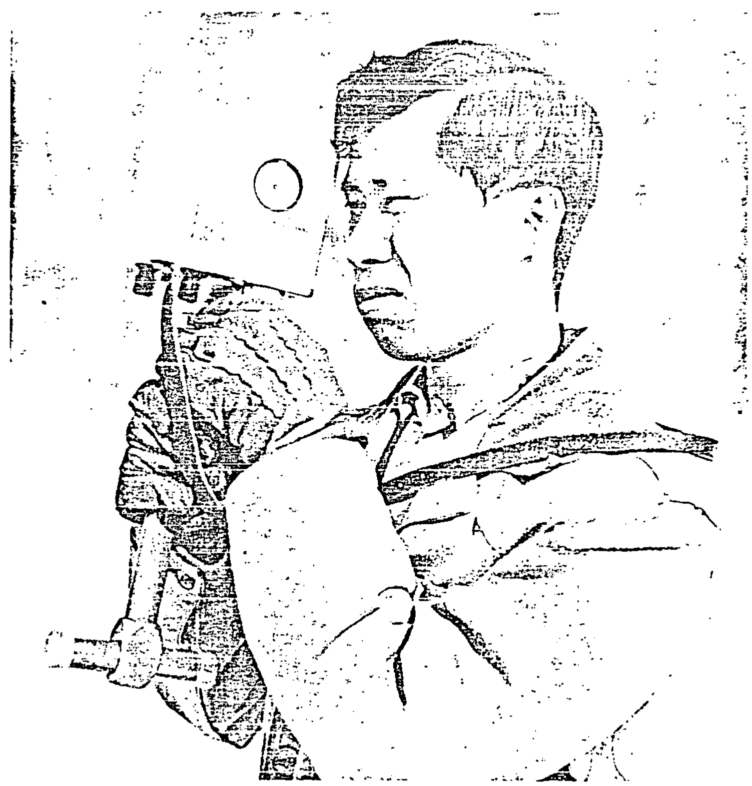
Since the beginning of 1965 a large number of mining companies have found the EM16 system to meet the need for a simple, light and effective exploration tool for mining geophysics.

The VLF method uses the military and time standard VLF transmissions as primary field. Only a receiver is then used to measure the secondary fields radiating from the local conductive targets. This allows a very light, one-man instrument to do the job. Because of the almost uniform primary field, good response from deeper targets is obtained.

The EM16 system provides the *in-phase* and *quadrature* components of the secondary field *with the polarities indicated.*

Interpretation technique has been highly developed particularly to differentiate deeper targets from the many surface indications.

Principle of Operation
The VLF transmitters have vertical antennas. The magnetic signal component is then horizontal and concentric around the transmitter location.



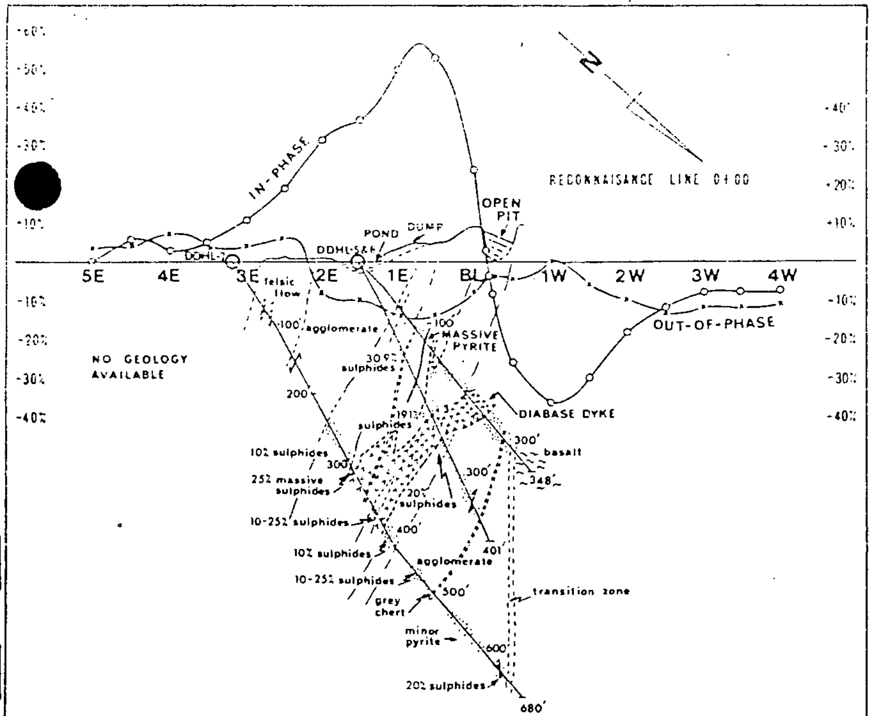
Specifications

Source of primary field	VLF transmitting stations.
Transmitting stations used	Any desired station frequency can be supplied with the instrument in the form of plug-in tuning units. Two tuning units can be plugged in at one time. A switch selects either station.
Operating frequency range	About 15-25 kHz.
Parameters measured	(1) The vertical in-phase component (tangent of the tilt angle of the polarization ellipsoid). (2) The vertical out-of-phase (quadrature) component (the short axis of the polarization ellipsoid compared to the long axis).
Method of reading	In-phase from a mechanical inclinometer and quadrature from a calibrated dial. Nulling by audio tone.
Scale range	In-phase ± 150%; quadrature ± 40%.
Readability	± 1%.
Reading time	10-40 seconds depending on signal strength.
Operating temperature range	−40 to 50° C.
Operating controls	ON-OFF switch, battery testing push button, station selector, switch, volume control, quadrature, dial ± 40%, inclinometer dial ± 150%.
Power Supply	6 size AA (penlight) alkaline cells. Life about 200 hours.
Dimensions	42 x 14 x 9 cm (16 x 5.5 x 3.5 in.)
Weight	1.6 kg (3.5 lbs.)
Instrument supplied with	Monotonic speaker, carrying case, manual of operation, 3 station selector plug-in tuning units (additional frequencies are optional), set of batteries.
Shipping weight	4.5 kg (10 lbs.)

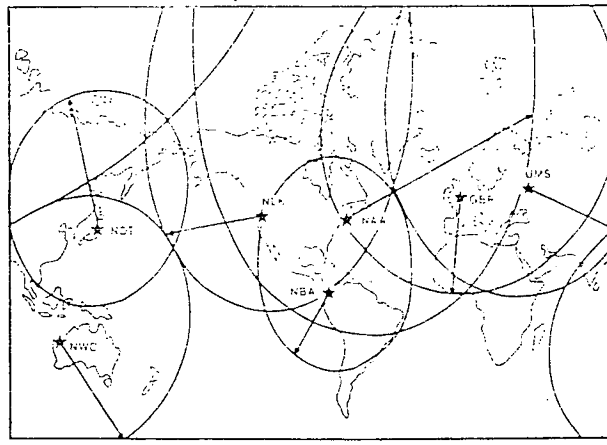
GEONICS LIMITED
Designers & manufacturers of geophysical instruments

subsidiary of
Deering Milliken Inc.

2 Thorncliffe Park Drive,
Toronto/Ontario/Canada
M4H 1H2
Tel: 425-1624
Cables: Geonics

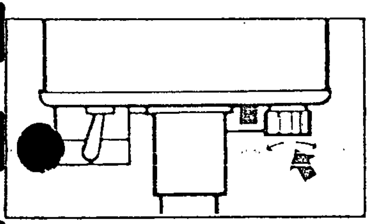


Courtesy of Newfoundland & Labrador Corp. Ltd.

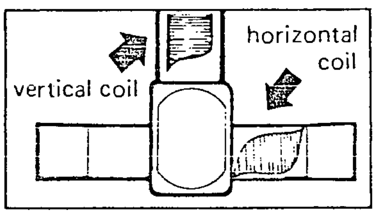


Areas of VLF Signals
Coverage shown only for well-known stations. Other reliable, fully operational stations exist. For full information regarding VLF signals in your area consult Geonics Limited. Extensive field experience has proved that the circles of coverage shown are very conservative and are actually much larger in extent.

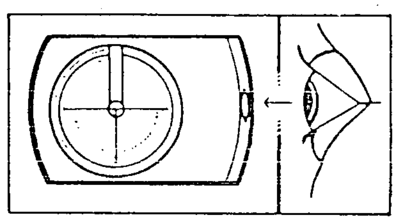
EM 16 Profile over Lockport Mine Property, Newfoundland
Additional case histories on request.



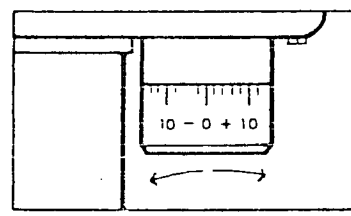
Station Selector
Two tuning units can be plugged in at one time. A switch selects either station.



Receiving Coils
Vertical receiving coil circuit in instrument picks up any vertical signal present. Horizontal receiving coil circuit, after automatic 90° signal phase shift, feeds signal into quadrature dial in series with the receiving coil.



In-Phase Dial
shows the tilt-angle of the instrument for minimum signal. This angle is the measure of the vertical in-phase signal expressed in percentage when compared to the horizontal field.



Quadrature Dial
is calibrated in percentage markings and nulls the vertical quadrature signal in the vertical coil circuit.

By selecting a suitable transmitter station as a source, the EM 16 user can survey with the most suitable primary field azimuth.

The EM 16 has two receiving coils, one for the pick-up of the horizontal (primary) field and the other for detecting any anomalous vertical secondary field. The coils are thus orthogonal, and are mounted inside the instrument "handle".

The actual measurement is done by first tilting the coil assembly to minimize the signal in the vertical (signal) coil and then further sharpening the null by using the reference signal to buck out the remaining signal. This is done by a calibrated "quadrature" dial.

The tangent of the tilt angle is the measure of the vertical in-phase component and the quadrature reading is the signal at right angles to the total field. All readings are obtained in per centages and do not depend on the absolute amplitude of the primary signals present.

The "null" condition of the measurement is detected by the drop in the audio signal emitted from the patented resonance loudspeaker. A jack is provided for those preferring the use of an earphone instead.

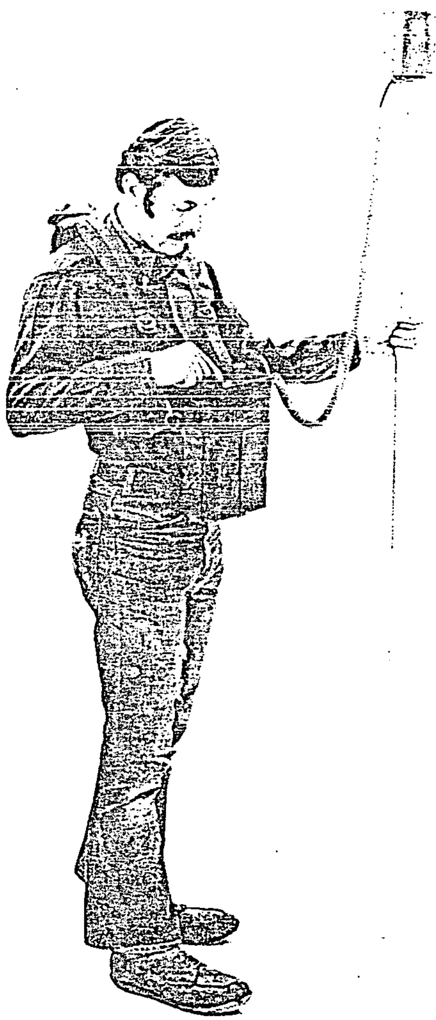
The power for the instrument is from 6 penlight cells. A battery tester is provided.

APPENDIX D

Specifications for Proton Precession Magnetometer Geometrics G816 and Barringer Base Station Magnetometer M 123 geoMetrics

Instrument Division

PORTABLE PROTON MAGNETOMETER
MODEL G-816



- ★ 1 gamma sensitivity and repeatability
- ★ Very small size and weight: less than 12 lbs complete with batteries and sensor
- ★ Over 10,000 readings per set of alkaline "D" cell (flashlight) batteries
- ★ Provision to attach sensor to carrying harness for use without staff
- ★ Pushbutton operation—numeric display directly in gammas
- ★ Total field measurements—independent of orientation—no calibration—no leveling

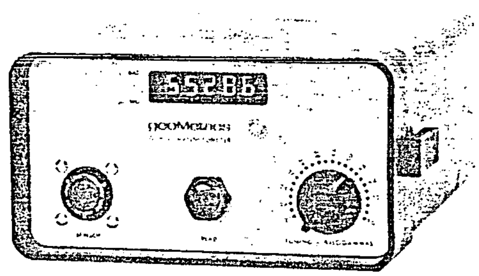
The Model G-816 is a complete portable magnetometer for all man-carry field applications. As an accurate yet simple to operate instrument, it features an outstanding combination of one gamma sensitivity and repeatability, compact size and weight, operation on standard universally available flashlight batteries, ruggedized packaging and very low price.

The G-816 magnetometer allows precise mapping of very small or large amplitude anomalies for ground geophysical surveys, or for detail follow-up to aeromagnetic reconnaissance surveys. It is a rugged, lightweight, and versatile instrument, equally well suited for field studies in geophysics, research programs or other magnetic mapping application where low cost, dependable operation and accurate measurements are required.

For marine, airborne or ground recording systems consider GeoMetrics Models G-801, G-803, and G-826A.

"Hands-free" Back Pack Sensor

Based upon the principle of nuclear precession (proton) the G-816 offers absolute drift-free measurements of the total field directly in gammas. (The proton precession method is the officially recognized standard for measurement of the earth's magnetic field.) Operation is worldwide with one gamma sensitivity and repeatability maintained throughout the range. There is no temperature drift, no set-up or leveling required, and no adjustment for orientation, field polarity, or arbitrary reference levels. Operation is very simple with no prior training required. Only 6 seconds are required to obtain a measurement which is always correct to one gamma, regardless of operator experience. Only the Proton Magnetometer offers such repeatability—an important consideration even for 10 gamma survey resolution.



Complete Field Portable System

The Model G-816 comes complete, ready for portable field operation and consists of:

1. Electronics console with internally mounted and easily replaced "D" cell battery pack.
2. Proton sensor and signal cable for attachment to carrying harness or staff.
3. Adjustable carrying harness.
4. 8 foot collapsible aluminum staff.
5. Instruction manual, complete set of spare batteries, applications manual, and rugged field suitcase.

Price and lease rates on the G-816 magnetometer are available upon request.

SPECIFICATIONS

Sensitivity: ±1 gamma throughout range

Range: 20,000 to 100,000 gammas (worldwide)

Tuning: Multi-position switch with signal amplitude indicator light on display

Gradient Tolerance: Exceeds 800 gammas/ft

Sampling Rate: Manual push-button, one reading each 6 seconds

Output: 5 digit numeric display with readout directly in gammas

Power Requirements: Twelve self-contained 1.5 volt "D" cell, universally available flashlight-type batteries. Charge state or replacement signified by flashing indicator light on display.

Battery Type	Number of Readings	
Alkaline	over	10,000
Premium Carbon Zinc	over	4,000
Standard Flashlight	over	1,500

NOTE: Battery life decreases with low temperature operation.

Temperature Range: Console and sensor: −40° to +85°C

Battery Pack: 0° to +50°C (limited use to −15°C; lower temperature battery belt operation—optional)

Accuracy (Total Field): ±1 gamma through 0° to +50°C temperature range

Sensor: High signal, noise cancelling, interchangeably mounted on separate staff or attached to carrying harness

Size:
Console: 3.5 x 7 x 10.5 inches (9 x 18 x 27 cm)
Sensor: 3.5 x 5 inches (9 x 13 cm)
Staff: 1 inch diameter x 8 ft length (3 cm x 2.44 m)

Weight:

	Lbs.	Kgs.
Console (w/batteries):	5.5	2.5
Sensor & signal cable:	4	1.8
Aluminum staff:	2	0.9
Total:	11.5	5.2

All magnetometers and parts are covered by a one year warranty beginning with the date of receipt but not to exceed fifteen months from the shipping date.

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

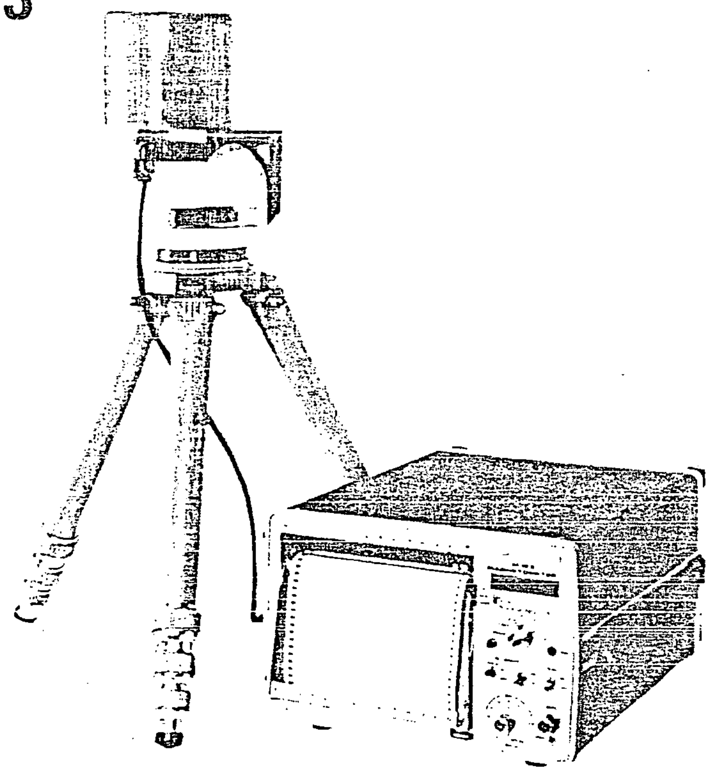
geoMetrics SERVICES (CANADA) LTD.
436 LIMESTONE CRESCENT
DOWNSVIEW (TORONTO),
ONTARIO, CANADA
TEL: (416) 661-1966
TELEX NO: 06-22694

geoMetrics INTERNATIONAL CORP.
60 ALFRED ST.,
MILSON'S POINT
SYDNEY NSW 2061
AUSTRALIA
TEL: 929-9942
TELEX NO: 790-22624

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

BARRINGER RESEARCH

BASE STATION MAGNETOMETER
Model BM-123



DESCRIPTION

The Barringer BM-123 magnetometer system uses the proton precession principle to measure the earth's total magnetic field intensity. There is no need for levelling or calibration of the sensor and it is unaffected by external influences such as temperature, etc.

FEATURES

- Magnetometer neatly combined with analog recorder in console measuring only 17" x 12" x 8" (43.2 cm x 30.5 cm x 20.3 cm)
- powered by mains AC or 24 Volts DC
- Full 1 gamma or 0.5 gamma sensitivity
- Fully adjustable cycling rate from 2 seconds to 99 minutes in 1 second stages
- BCD output readily adaptable to digital cassette or other magnetic type recording
- To save power chart recorder can be made to operate only when magnetometer cycles

APPLICATIONS

- Storm monitoring
- Diurnal variation monitoring
- Observatory measurements including three component measurements with the use of Helmholtz coils

TYPICAL SYSTEM COMPONENTS

- Magnetometer console, including 5-inch chart recorder
- Toroidal sensor
- Connecting cable
- Tripod
- Power supply (optional)

SPECIFICATIONS

CONSOLE MODEL M-123-1

Sensitivity	1 gamma throughout the range
Accuracy	± 1 gamma at 24 volts dc
Range	20,000 to 100,000 gammas in 12 overlapping settings
Cycle Rates:	
Continuous Cycling	0.6, 0.8, 1.2 and 1.9 seconds
Automatic Cycling	2 seconds to 99 minutes in 1 second steps
Manual Cycling	pushbutton single cycling at 1.9 seconds
External Cycling	actuated by a 2.5 to 12 volt pulse longer than 1 millisecond
Outputs:	
Analog	front panel select 0 to 99 gammas or 0 to 990 gammas
Fiducial Marker	internal selection of 1 second to 99 minutes in 1 second steps
Visual	5 digit numeric display directly in gammas
External Outputs:	
Analog	2 channels, 0 to 99 gammas and 0 to 990 gammas at 1 milliamp or 1 volt Full Scale Deflection
Digital	BCD 1, 2, 4, 8 code, TTL compatible 0 State — 0 to 0.5 volts 1 State — 2.5 to 5 volts
Fiducial Mark	Relay closure or open state selected internally from 1 second to 99 minutes
Size	8" x 12" x 17" (20.3 cm x 30.5 cm x 43.2 cm) (fits under a commercial airline seat)
Weight	20 lbs (9.1 kg)
Operating Temperature	−28°C to +65°C
Power Requirements	Magnetometer 12 to 30 volts dc 60 to 200 milliamps maximum Recorder 12 to 30 volts dc 0.5 to 0.9 amps maximum
Options	Component Spares Kit — a selection of critical solid state components and fuses required for general console maintenance Board Spares Kit — a complete selection of plug-in PC boards for maintenance of the console on longer term surveys

HIGH SENSITIVITY CONSOLE MODEL M-123-2

Sensitivity	0.5 gammas at 1.9 seconds
Accuracy	±0.5 gammas at 1.9 seconds

All other specifications the same as Model M-123-1

MAGNETOMETER ELECTRONICS ONLY MODEL M-123-3

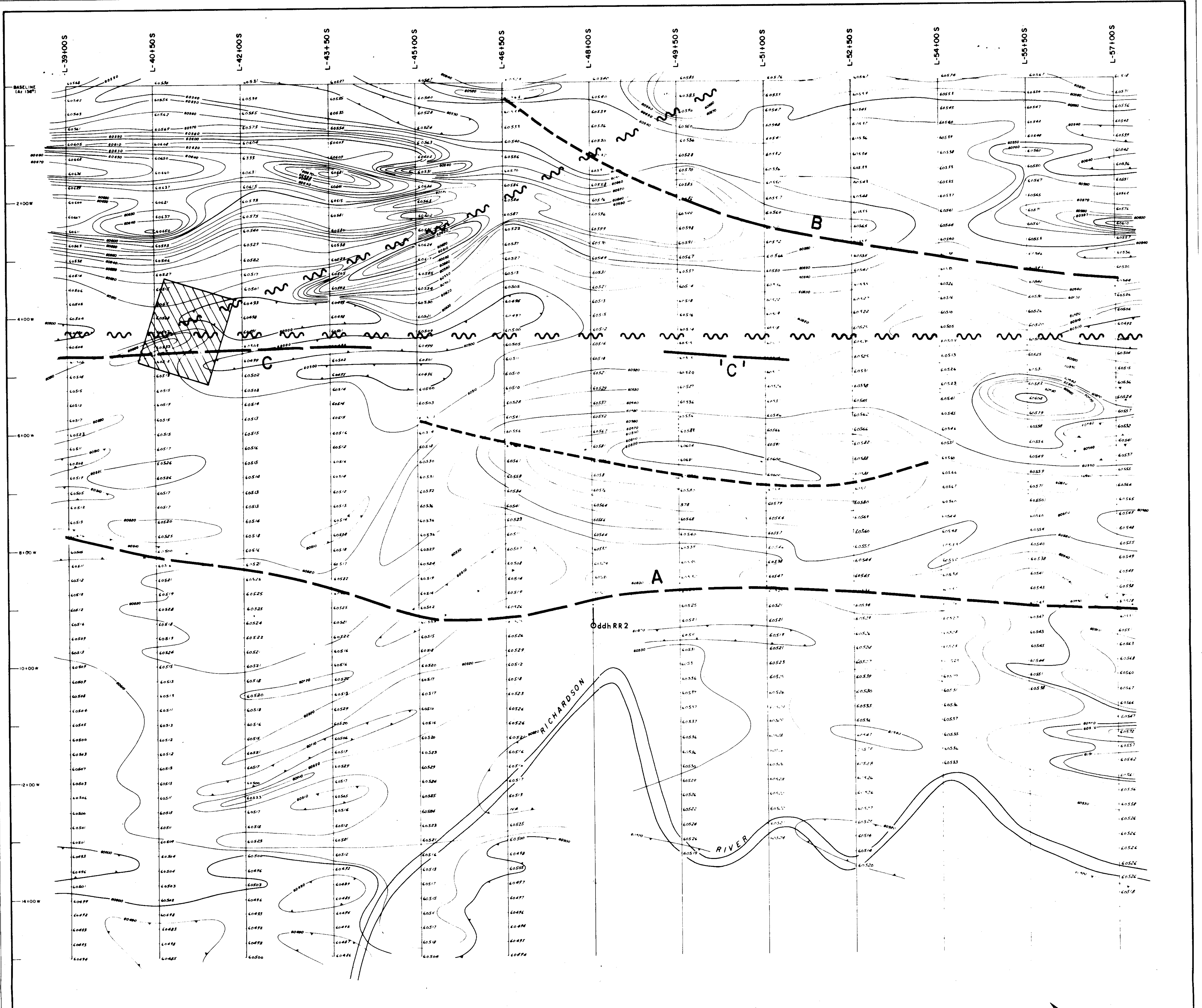
Size	6" high x 7" wide x 6" deep (15.2 cm x 17.8 cm x 15.2 cm) can fit a standard 19" (48.3 cm) rack
Weight	approximately 5 lbs (2.3 kg)
Outputs	5 digit display in gammas
External Outputs	same as model M-123-1 above

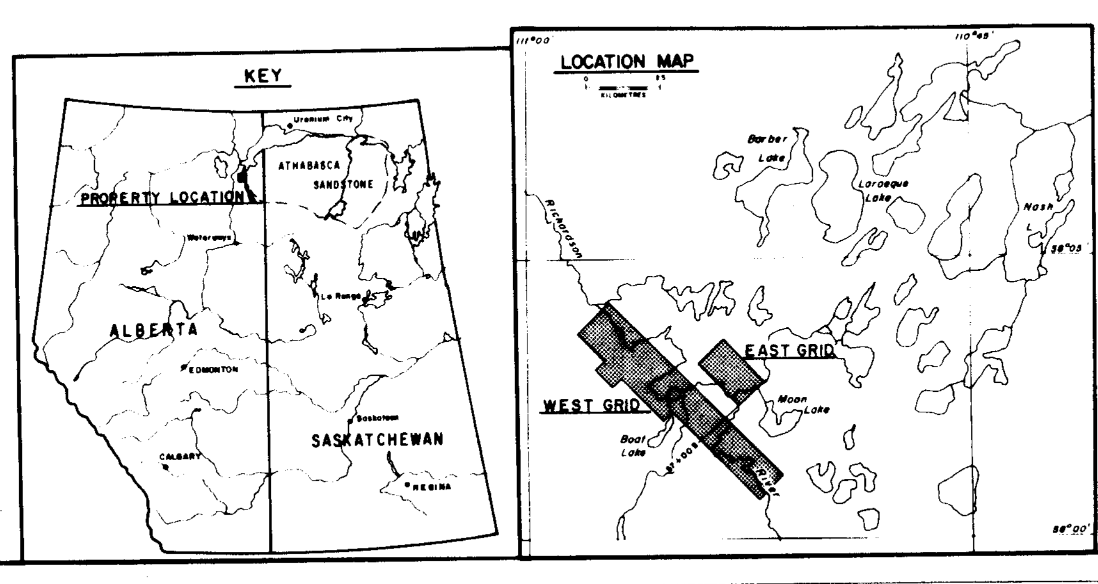
CONSOLE OPTIONS

Digital Cassette Recording — various systems available, details on request
Hewlett-Packard Recorder Spares
Hewlett-Packard Recording Supplies — chart paper and disposable pens

Barringer Research Limited
304 Carlingview Drive
Metropolitan Toronto
Rexdale, Ontario, Canada M9W 5G2
Phone: 416-675-3870
Telex: 06-968743

Representative:





LEGEND

HORIZONTAL LOOP
1777 DATA BASE
CONDUCTOR
POSSIBLE STRUCTURE
INTERPRETED FAVOURABLE STRUCTURE
EXPLORANIUM GEOMETRICS (MODEL G-816)
60480 MAGNETIC VALUES IN GAMMAS (CORRECTED)
60500 MAGNETIC CONTOURS
CONTOUR INTERVAL 10 GAMMAS
MAGNETIC LOW
FAULT INTERPRETED FROM MAGNETICS

0 100 200
METRES

NORCEN ENERGY RESOURCES

RICHARDSON RIVER AREA, ALBERTA
PERMIT No. 6876120005

COMPILATION MAP

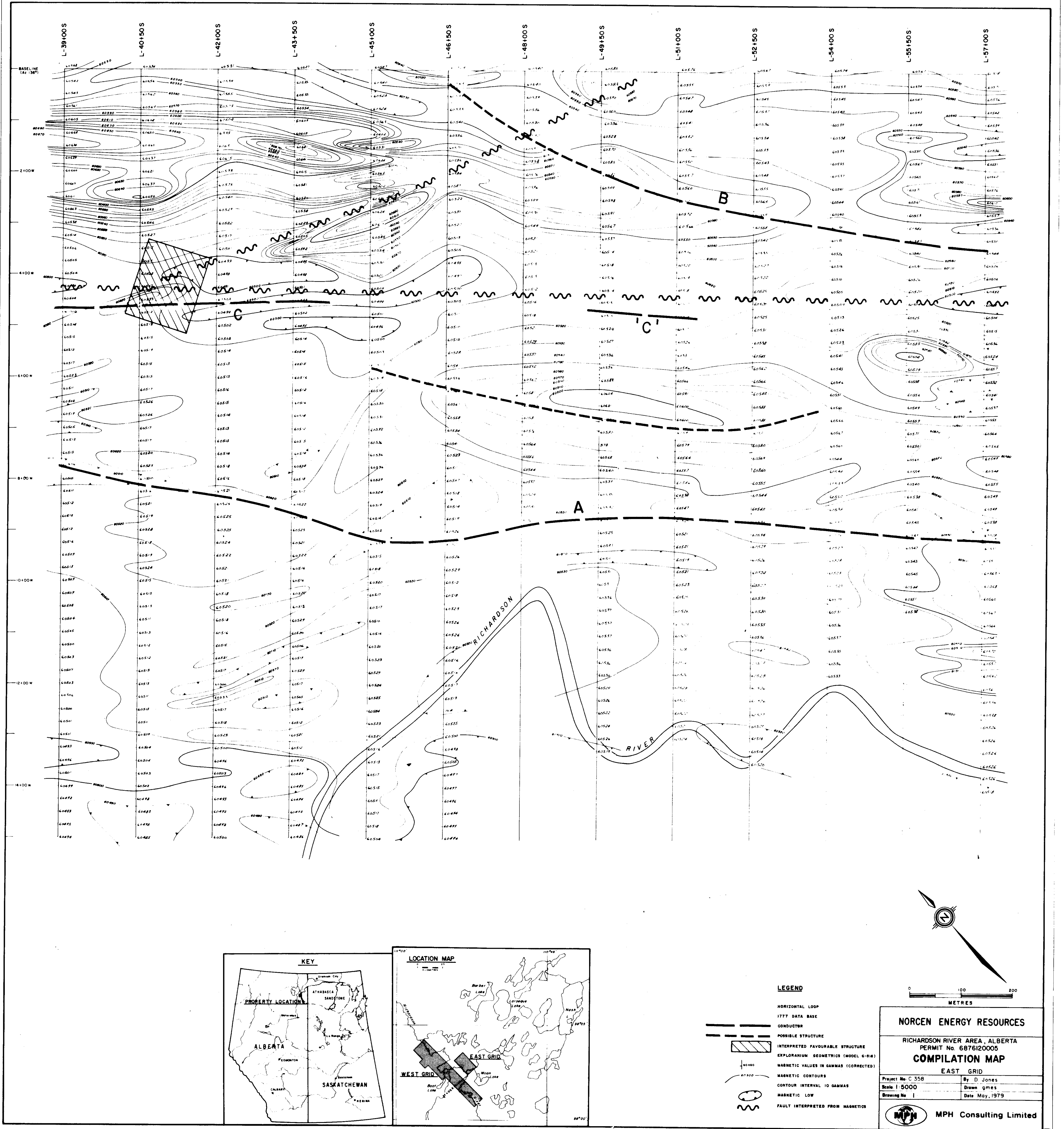
EAST GRID

Project No: C 358	By: D Jones
Scale: 1:5000	Drawn: gmes
Drawing No: 1	Date: May, 1979

MPH Consulting Limited

19790011 51


RICHARDSON
RIVER
'A'
'B'
'C'
BOAT LAKE
BASE LINE
KEY
ALBERTA
SASKATCHEWAN
PROPERTY LOCATION
LOCATION MAP
WEST GRID
EAST GRID
Nash L.
LEGEND
POSTULATED FAULT INTERPRETED FROM AIRBORNE MAGNETIC AND AIR PHOTO ANALYSIS
INTERPRETED FAVOURABLE STRUCTURE
APEX PARAMETRICS MAX MIN II
1777 Hz
200 Meter Cable
In Phase Profile
Quadrature Profile
Profile Scale: +20% 0 -20%
Width Estimate
60°/80/0·6 Dip (Degrees) / Depth (Meters) / Conductivity Thickness (Mohs)
Conductor Axis
Possible Conductor (Fault / Shear Zone)
Plotting Designation
19790011
0 100 200
METRES
NORCEN ENERGY RESOURCES
RICHARDSON RIVER AREA, ALBERTA
PERMIT No. 6876120005
COMPILATION MAP
WEST GRID
Project No: C 358
By: D. Jones
Scale: 1:5000
Drawn: gmes
Drawing No: 2
Date: May, 1979
MPH Consulting Limited
35


L-39+00S
L-40+50S
L-42+00S
L-43+50S
L-45+00S
L-46+50S
L-48+00S
L-49+50S
L-51+00S
L-52+50S
L-54+00S
L-55+50S
L-57+00S
BASELINE (Az 136°)
2+00W
4+00W
6+00W
8+00W
10+00W
12+00W
14+00W
A
B
C
'C'
RICHARDSON
RIVER
KEY
PROPERTY LOCATION
ATHABASCA
SANDSTONE
ALBERTA
SASKATCHEWAN
EDMONTON
CALGARY
REGINA
LOCATION MAP
Barber Lake
Laroque Lake
EAST GRID
WEST GRID
Moon Lake
Boot Lake
LEGEND
HORIZONTAL LOOP
1777 DATA BASE
CONDUCTOR
POSSIBLE STRUCTURE
INTERPRETED FAVOURABLE STRUCTURE
EXPLORANIUM GEOMETRICS (MODEL G-816)
MAGNETIC VALUES IN GAMMAS (CORRECTED)
MAGNETIC CONTOURS
CONTOUR INTERVAL 10 GAMMAS
MAGNETIC LOW
FAULT INTERPRETED FROM MAGNETICS
0 100 200
METRES
NORCEN ENERGY RESOURCES
RICHARDSON RIVER AREA, ALBERTA
PERMIT No. 6876120005
COMPILATION MAP
EAST GRID
Project No. C 358
By D. Jones
Scale 1:5000
Drawn gmes
Drawing No 1
Date May, 1979
MPH Consulting Limited

19790011

36


LEGEND
POSTULATED FAULT INTERPRETED FROM AIRBORNE MAGNETIC AND AIR PHOTO ANALYSIS
INTERPRETED FAVOURABLE STRUCTURE
APEX PARAMETRICS MAX MIN II
1777 Hz
200 Meter Cable
In Phase Profile
Quadrature Profile
Profile Scale +20% 0 -20%
Width Estimate
60°/80/0·6 Dip (Degrees) / Depth (Meters) / Conductivity Thickness (Mohs)
Conductor Axis
Possible Conductor (Fault / Shear Zone)
Plotting Designation
0 100 200
METRES
NORCEN ENERGY RESOURCES
RICHARDSON RIVER AREA, ALBERTA
PERMIT No. 6876120005
COMPILATION MAP
WEST GRID
Project No: C 358
By D. Jones
Scale: 1:5000
Drawn: gmes
Drawing No · 2
Date: May, 1979
MPH Consulting Limited

19790011

49