823722

INTERPRETATION REPORT
HELICOPTER ELECTROMAGNETIC/MAGNETIC SURVEY
CORPORATION FALCONBRIDGE COPPER
ADAMS PLATEAU AREA, BRITISH COLUMBIA

PROJECT #28H34 82M/4 OCTOBER 1986

Questor Surveys Limited, 6380 Viscount Road, Mississauga, Ontario L4V 1H3

C O N T E N T S

1. INTRODUCTION

This report details the operation and interpretation of a helicopter airborne INPUT electromagnetic and magnetic survey flown for Corporation Falconbridge Copper (CFC). The system used was the Questor/Barringer MK VI, 2 ms, INPUT system. The standard specifications for the INPUT transmitter and receiver are outlined in Appendix A.

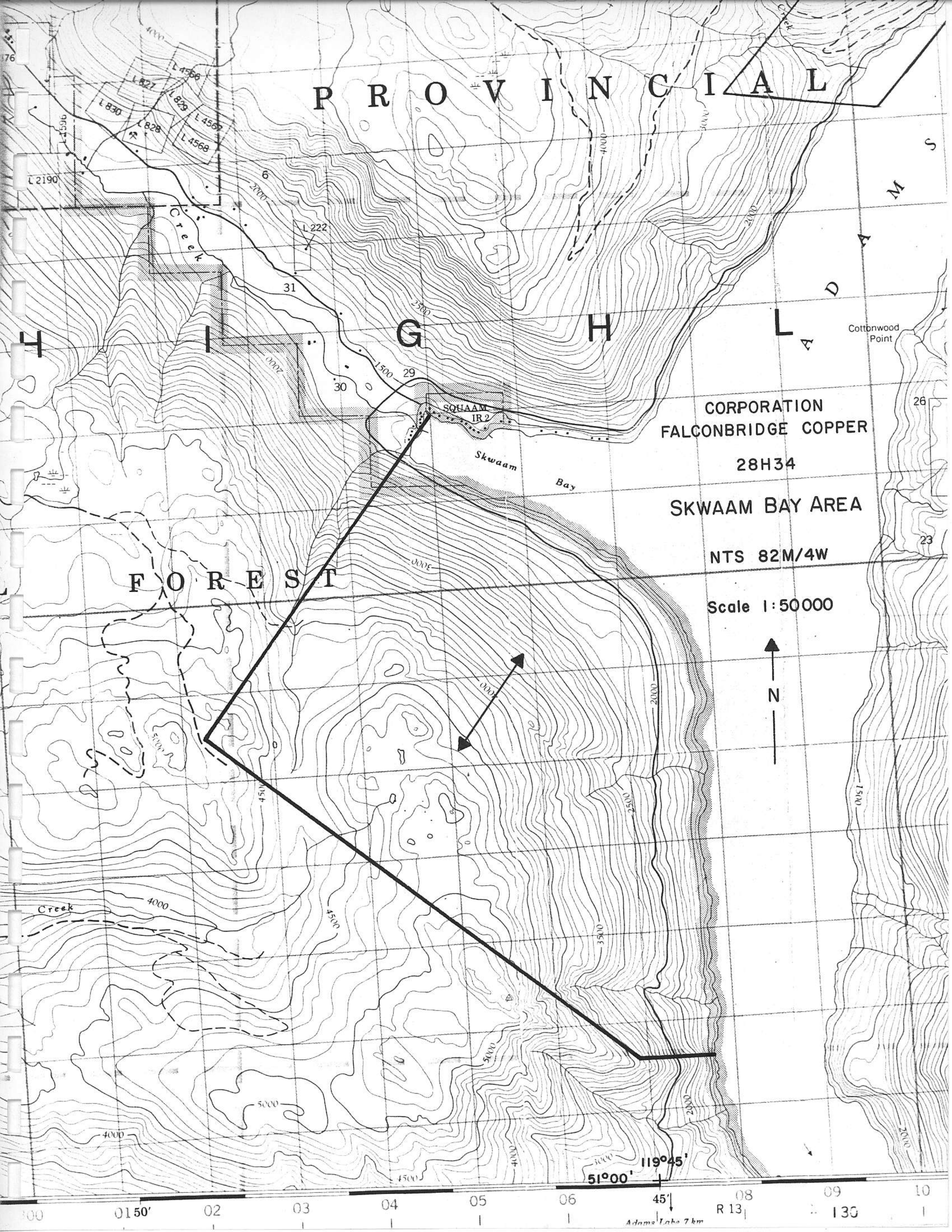
The interpretation was commissioned by Mr. Ian D. Pirie of CFC on September 10, 1986. Marcel Konings, Geophysicist for Questor, supervised the data compilation and interpretation through to the completion of the project in October, 1986.

The survey objective is the detection and location of base metal sulphide conductors as well as any structures and conductivity patterns which could have a positive influence on gold and base metal exploration programme.

The primary survey area consists of 111 line kilometres of traverse and control lines. These were flown in June, 1984 using Sorrento as the survey operations base.

2. PROJECT LOCATION

The survey area lies within the Province of British Columbia, approximately 85 kilometres west of the Town of Revelstoke. The area is located between latitudes $51^{\circ}00'$ and $51^{\circ}05'$ and longitudes $119^{\circ}43'$ and $119^{\circ}50'$ (figure 1). Map sheet Adams Plateau (N.T.S. 82M4,) includes the survey site which is approximately 15 kilometres north of Sorrento, B. C.


PROVINCIAL
HIGHL
FOREST
ADAMS
CORPORATION
FALCONBRIDGE COPPER
28H34
SKWAAM BAY AREA
NTS 82M/4W
Scale 1:50000
N
SQUAAM IR 2
Skwaam Bay
Cottonwood Point
Creek
L 4566
L 827
L 829
L 830
L 828
L 4567
L 4568
L 4596
L 2190
L 222
119°45'
51°00'
R 13
Adams Lake 7 km

3. SURVEY OPERATIONS

3a. Survey Personnel

The survey crew was made up of experienced Questor employees:

Crew Manager/Data Technician	- Dan Martyn
Pilot/Captain of Aircraft	- Bob Masson (Trans Canada)
Navigator	- Bill Smith
INPUT Equipment Technician	- Dan Makos
Aircraft Engineer	- John Caza (Trans Canada)

The flight path recovery was completed at the survey base, while the final data compilation and drafting was carried out by Questor at its Mississauga, Ontario office. The magnetic and electromagnetic processing was carried out using Questor software and computer drafted. The INPUT interpretation and report was completed by M. H. Konings.

3b. Instruments

A, Bell 205A Helicopter (Registration C-GLMC, owned and operated by Trans Canada), equipped with the following instruments was used for the survey:

1. Mark VI INPUT Electromagnetic System;
2. Geometrics G-803 Proton Magnetometer (1 gamma sensitivity);
3. Sonotek SDS 1200 Data Acquisition System;
4. RMS GR33 Analogue Recorder;
5. 35mm Camera, Intervalometer and Fiducial System;
6. Sperry Radar Altimeter.

A Geometrics G-826 Base Magnetometer was used to monitor the diurnal magnetic changes.

The equipment, such as the INPUT system, magnetometer and radar altimeter were regularly calibrated at the beginning and end of each survey flight as well as in mid-flight, whenever necessary. Details of the calibration procedures are given in Appendix C.

The continuous chart speed of the RMS recorder was set at 10 cm./minute.

3c. Production

The flight line spacing over the block was 200 metres. Table 1 summarizes the kilometres flown during the survey operation.

Table 1

Traverse lines	106.0 km.
Control lines	5.7 km.
Total lines	111.7 km.

The survey was completed in three production flights between June 25th and 30th. No days were lost during the survey due to bad weather or magnetic storms.

3d. Products

The products delivered by Questor to Corporation Falconbridge Copper with four copies of the report:

1. one unscreened master orthophoto mosaic, scale 1:10,000;
2. one master orthophoto mosaic with electromagnetic and magnetometer information and interpretation shown thereon, scale 1:10,000;
3. one master orthophoto mosaic with electromagnetic results and magnetometer contours;
4. one magnetics overlay, scale 1:10,000;
5. four white prints of (2);
6. one computer plots of the electromagnetic and magnetometer flight analogues, scale 1:10,000;
7. one set of colour contoured magnetics, scale 1:50,000;
8. interpretation report
9. anomaly data sheets.

3e. Survey Procedure

During the survey, the aircraft maintained a terrain clearance as close to 122 metres as possible, with the receiver coil (bird) at approximately 45 metres above the ground surface. In areas of substantial topographic relief and large population, the aircraft height may exceed 122 metres for safety reasons. The height of the bird above the ground is also influenced by the aircraft's air speed (see figure C1 in Appendix C), which was maintained at 20 to 70 knots, while on survey.

Whenever possible, the traverse lines were flown in alternate flight directions (e.g., north then south) to facilitate the interpretation of dipping conductors. When the traverse line spacing exceeded twice the normal spacing interval over a 2.2 kilometre distance, the gap is normally filled with an appropriately spaced fill-in line at a later date.

The details of each production flight are documented on the flight logs by the equipment technician. The logs include the survey times, line numbers and fiducial intervals, as well as a record of equipment irregularities and atmospheric conditions. One may refer to these logs in order to relate the flight path film to the geophysical data.

During the course of the survey the following data were recorded:

1. INPUT Electromagnetic results represented by six channels of successively increasing time delays after cessation of the exciting pulse (Appendix A);
2. a record of the terrain clearance as provided by radar altimeter;
3. a photographic record of the terrain passing below the aircraft as obtained from a 35 mm. camera;
4. time markers impressed synchronously on the photographic and geophysical records to facilitate accurate positioning on photomosaics;
5. airborne magnetometer data;
6. ground base station magnetometer data.

3f. Magnetic Diurnal

Diurnal variations in the earth's magnetic field had been recorded to an accuracy of ± 1 nT using a base station equipped with a Geometrics G-826 Proton Precession Magnetometer. It was monitored continuously during the day for severe diurnal changes (magnetic storms). A variation of 20 nT over a 5 minute time period was considered to be a magnetic storm.

During such an event, the survey would normally have been discontinued or postponed and the survey data would have been scrubbed.

The base station magnetometer was set up at Shuswap Inn, Salmon Arm, British Columbia.

4. DATA COMPILATION

4a. Data Recovery

The flight path of the aircraft is recorded by a frame camera on black and white, 125ASA, 35mm. film which is exposed during flight at a rate of 1 frame/minor fiducial. The apperture setting on the camera can be manually adjusted by the operator during flight, assuring the proper exposure of the film. The camera is fitted with a wide angle 18 mm. lens. Fiducial numbers are imprinted on the film, marked onto the analogue records and recorded digitally at the same instant.

The flight line headings are opposite on adjacent lines, which are normally flown sequentially in an "S" pattern. The navigation references are flight strips at a scale of 1:20,000 which are made from the base maps. The equipment operator enters the flight details information into the digital data system which are recorded and verified (read-after-write). The information includes line number, time, fiducial range and other pertinent flight information. This information is compared to the film, analogue records and the magnetic base station recording at the completion of the survey flight.

The film and all records are developed, edited and checked at the completion of each flight. Recovery of the flight track is carried out by comparing the negative of the 35mm. film to the topographic features of the base map. Coincident features are picked and plotted on exact copies of the stable mosaic base map on which the final results are drafted. Points are picked at an average interval of 0.5 kilometre. This corresponds to one whole fiducial unit or 20 seconds. The picked points will not necessarily fall on whole fiducial numbers, but on the final presentation, only the first and last whole fiducial numbers on a line are marked on each flight line. By interpolation, the whole numbers are marked as ticks along the flight path while picked points are indicated as solid dots.

These procedures are performed on the survey site daily by the data technician so that the data quality and progress may be measured objectively. Reflights for covering navigational gaps and other deficiencies are usually flown on the following day.

The analogue records are inspected for coherence with specifications, and anomalies are selected for classification and plotting. Selected anomalous conductors are positioned by plotting their fiducial positions, less the lag factor (Appendix C). These resultant positions are located by interpolating between fiducial points established by the flight path recovery process.

The survey results are presented as an INPUT anomaly map with interpretation and a magnetic contour overlay. The following chapters describe the interpretation of INPUT results and present recommendations for ground follow-up surveys. A colour presentation of the magnetic contours was included.

4b. Computer Processing

The completed flight path is accurately digitized on a flat-bed digitizer at Questor using the picked point co-ordinates. The recovery is then routinely verified by a computer programme 'speed check', which flags any abnormalities in the distance per fiducial unit between picked points on a traverse line. As a final check, the rough magnetic contour maps are examined for contour irregularities that could be attributed to recovery errors.

5. INPUT DATA PRESENTATION

The orthophoto base maps for the survey area are photomosaics constructed from 1:55,000 air photographs supplied by British Columbia Ministry of Enrivonment and taken in 1982. The photomosaic was used to construct the navigation flight strips and also the base onto which the flight path was recovered. The mosaics are fully controlled at a scale of 1:10,000.

The INPUT anomaly map presents the information extracted from the analogue records. This consists chiefly of the peak anomaly positions and response characteristics, surficial responses, up-dip responses, and magnetic anomaly locations. In effect, these represent the primary data analysis. The symbols are explained in the map legend, but the following observations are presented:

- position of peak anomaly;
- conductance or conductivity-thickness;
- amplitude of channel 2 response;
- position and peak amplitude of associated magnetic anomalies;
- where present, surficial, up-dip and poorly defined responses have been identified with a unique symbol.

The interpretation maps outline the geophysical-geological interpretation of the INPUT electromagnetic, magnetic, geological and physiographic data. Bedrock conductors have axis locations and dip directions, when they are interpretable. The anomalous zones which are recommended for follow-up have a reference label assigned, to which additional comments and recommendations are directed in the Interpretation Section of this report. Surficial response sources are mapped out by boundaries showing their interpreted lateral extent. The following list summarizes the interpretation presentation:

- bedrock conductor axis, probable and possible;
- conductor dip;
- surficial conductor outlines;
- anomalous conductors selected for ground evaluation with reference number.

6. INTERPRETATION - GENERAL

6a. General Geology

The survey area is located in the Adams Plateau area of British Columbia. It lies on the western side of the Adams Lake, south of Skwaam Bay.

Numerous base metal deposits occur in the Adams Plateau area. Many of which are clearly stratabound massive sulphide deposits and appear to be of syngenetic origin with their host rocks. The host rocks are commonly felsic tuffs and fine-grained cherty tuffs. The deposits are usually localized at volcanic-sedimentary contacts and contain lead-zinc and silver mineralizations. A few of the occurrences show excellent grades. Most are discontinuous, lensy and small in size. A well known example in the area would be the Lucky Coon, which is situated at the head of Spillman Creek. It consists of banded pyrite-arsenopyrite-galena-sphalerite-tetrahedrite-argintite mineralization that occurred parallel to the main foliation in a felsic schist. The mineralized zone was exposed in two areas about 500 metres apart and reportedly had been traced intermittently for more than 1 kilometre.

A recent discovery by Rea Gold Corp. west of Adams Lake has introduced the possibility for significant gold-bearing massive sulphide deposits in the local volcanic rocks, which has not been previously considered to be of economic importance in the region.

6b. Geological Perspective

The bedrock geology in the project area consists of Devonian metavolcanics and metasediments. The units are conformable, strike parallel to the regional WNW trends and dip to the east at 25^{o}-65^{o}. Although overturned sequences have been noted to the west, along strike, the major units in the survey area lie chronologically sequenced, with oldest rocks to the southwest.

The geology, as summarized on Preliminary Map #56; "Geology of the Adams Plateau-Clearwater Area" outlines the major lithologic units. The electrical and magnetic character of these rocks does not support the mineralogical classification with any consistency for the two major rock types that dominate the project block.

The "EBAu" unit has a suggested derivation from intermediate volcanic and volcaniclastic rocks. It is in part, resistive and non-magnetic, but the northern half has a resistivity decrease interpreted from above background amplitudes. The resistivity contrast also matches an increase in the background magnetic levels.

A sericitic quartz feldspar schist (EBAi) is interpreted as a relict felsic intrusive. One band lies along the northern area boundary and a second conductor along the southern end. The northern unit has a conductor and an apparent resistivity similar to the adjacent metavolcanic. The southern band is resistive and magnetically flat, a typical intrusive signature.

Segments of older rock units occur south of the survey boundary. These are mafic schists and calcareous phylitites. The former unit is characterized by a magnetic coincidence and conductors with inconsistent conductive properties.

6c. Conductivity Analysis

The conductivity-thickness products of planar horizontal and thin steeply dipping conductors are proportional to the time constant of the secondary field electromagnetic transient decay. This transient may be closely approximated by an exponential function for which the conductivity-thickness product (TCP) is inversely proportional to the log of the difference of two channel amplitudes at their respective sample times.

These response functions are presented in the form of graphs in which the amplitudes of the 6 channels of INPUT response are plotted on a logarithmic scale against conductivity. The relative amplitudes of the secondary response, at any given conductivity, may be accurately related to the depth of a conductor below the surface. These are typically referred to as Palacky nomograms. These are available for a number of conductor geometries. It has been found that the shape of the decay transient and its amplitude is usually unique to a particular geometry. Therefore, if the origin of a conductive response is in question, a good "fit" of the peak response amplitude to one nomogram will define its origin.

The 45° nomogram was utilized exclusively to determine the apparent conductances of the responses obtained from the survey. This procedure is valid for conductors, within a dip range of 0-180°, relative to the aircraft flight direction.

Although the conductor depth can be interpreted from nomograms, the short strike lengths and the variability of conductor geometry may result in the over-estimation of depths. The INPUT system depth capability is well characterized for a vertical, 200 metres deep and 600 metres strike and 300 metres depth extent target. The effective penetration depth increases for a dipping target and decreases for a smaller size conductor.

Depths were only determined for responses which appear to fit the interpretation model - a thin near vertical plate with a strike length of greater than 500 metres. Qualifications for these determinations are summarized in the interpretation section.

The depths for 5 and 6 channel anomalies were corrected for the interpreted conductor strike intersection relative to the line direction and the effects of aircraft altitude deviations from a flight altitude of 120 metres.

An anomaly listing at the back of this report summarizes each anomalous response in a numerical sequence. In addition to the standard anomaly parameters, an "anomaly type" classification has been added. The letters correlate with the plotted symbols according to the following table.

ANOMALY TYPE	RESPONSE SOURCE	SYMBOL
BLANK	bedrock conductors	circular
S	surficial (overburden or lakebottom) conductivity	diamond
U	up-dip accessory peak to main response	half circular, half diamond, symbolically "pointing" in dip direction
W	down-dip peak	same as up-dip peak
P	poorly defined response	asterisk "*" in lower left quadrant
C	cultural source	square

The "P" poorly defined response may not yield signatures diagnostic of a discrete bedrock anomaly to standard electromagnetic prospecting equipment. Interpreted axis locations may be approximate for these intercepts.

7. INPUT INTERPRETATION METHODOLOGY

During the data analysis, a number of assumptions were made which affect the precision of the quantitative interpretations. As interpretation graphs, nomograms and type curves are available for a limited number of conductor geometries. Our approach is to normalize response amplitudes to a well documented geometry, then carry out the interpretation. This is a time consuming process but the interpretations should be more accurate than carrying out an automatic process which doesn't include the interpreter's observations and experience. The following observations are the most critical to the interpretation.

1) Conductor Axis Location

The helicopter geometry is a pair of dipole coils that produce a two peak amplitude response pair for every conductor geometry, except for a flat-lying zone where a single symmetric response is obtained. The weaker of the two may sometimes be obscured when strong multiple conductors are intersected. The weaker accessory response may be lost in the superposition of higher amplitudes. The conductor axis, as plotted on the map, is the projection to surface of the conductor, at the point where it is exposed, or where it subcrops beneath overburden, weathered soils, alluvium, talus, etc. On the analogue profiles, the location of the axis is defined as the relative minimum between the two peaks, on the latest anomalous decay channel. When response amplitudes decrease to 30-40% of the maximum the conductor is effectively terminated.

2) Dip

The dip of a conductor is defined by three characteristics which in an uncomplicated anomaly support each other. For conductors within a dip range of 45^{o}-135^{o}, the amplitude ratio of the two peaks on the graph at the end of the appendix, yields a formation dip value which is accurate to 5^{o} and independent of topography, conductance, depth or conductor geometry. A shift of the latter time channel peaks in the direction of the dip is a qualitative dip indicator for the higher amplitude conductor of the pair. This is the so called "up-dip" or "down-dip" response, whose symbol "points" out the dip direction. The slope of the response profile is always less on the dipping side of the high amplitude response, steeper by the conductor axis. This is similar to magnetic, gravity and other potential field data. This signature is also visible on an amplitude contour map.

3) Conductor Strike

The angle by which a conductor axis intersects the filght line affects the response amplitudes. At 90^{o} (perpendicular to strike) maximum electromagnetic coupling is obtained. Flying along a vertical conductor axis (0^{o}), no coupling with the conductor is possible. However, for intermediate responses it is possible to correct response amplitude to simulate a normal 90^{o} intersection by multiplying amplitudes by a 1/SIN(ANGLE) factor.

4) <u>Conductor Geometry</u>

For a given depth, conductance and dip, the physical conductor dimensions have a dramatic effect on response amplitudes and conductance. Our interpretation models are based on a 600 x 300 metre plate. Amplitudes decrease dramatically for conductors with less than 300 metre strike length. These situations have been modelled and amplitudes are corrected to emulate an infinite geometry for depth calculations.

5) <u>Conductance</u>

The apparent conductance of any response will vary with the actual geometry. If the geometry (i.e. horizontal, dipping, vertical plate) can be recognized, a suitable nomogram can be utilized to determine conductance. The indicated conductance can vary by ± 50% if the model is not appropriate. A short strike length causes underestimates, while a greater depth causes overestimates. The latter can be corrected for using any appropriate nomogram.

6) Depth

The depth interpretation includes the consideration for all of the variables and the flight altitude. The main corrections are strike angle, dip and geometry. We recommend using the 45° conductor dip nomogram and the horizontal layer model when appropriate.

Referenced Material:

Preto, V.A., (1979): Barriere Lakes - Adams Plateau Area (82L/13E; 82M/4, SW; 92P/1E,8E), B.C. Ministry of Energy, Mines & Pet. Res., Geological Fieldwork, 1978, Paper 1979-1, pp. 31-37.

Preto, V.A., McLaren, G.P., Schiarizza, P.A., (1980): Barriere Lakes - Adams Plateau Area (82L/13E; 82M/4, SW; 92P/1E,8E), B.C. Ministry of Energy, Mines & Pet. Res., Geological Fieldwork, 1979, Paper 1980-1, pp. 28-36.

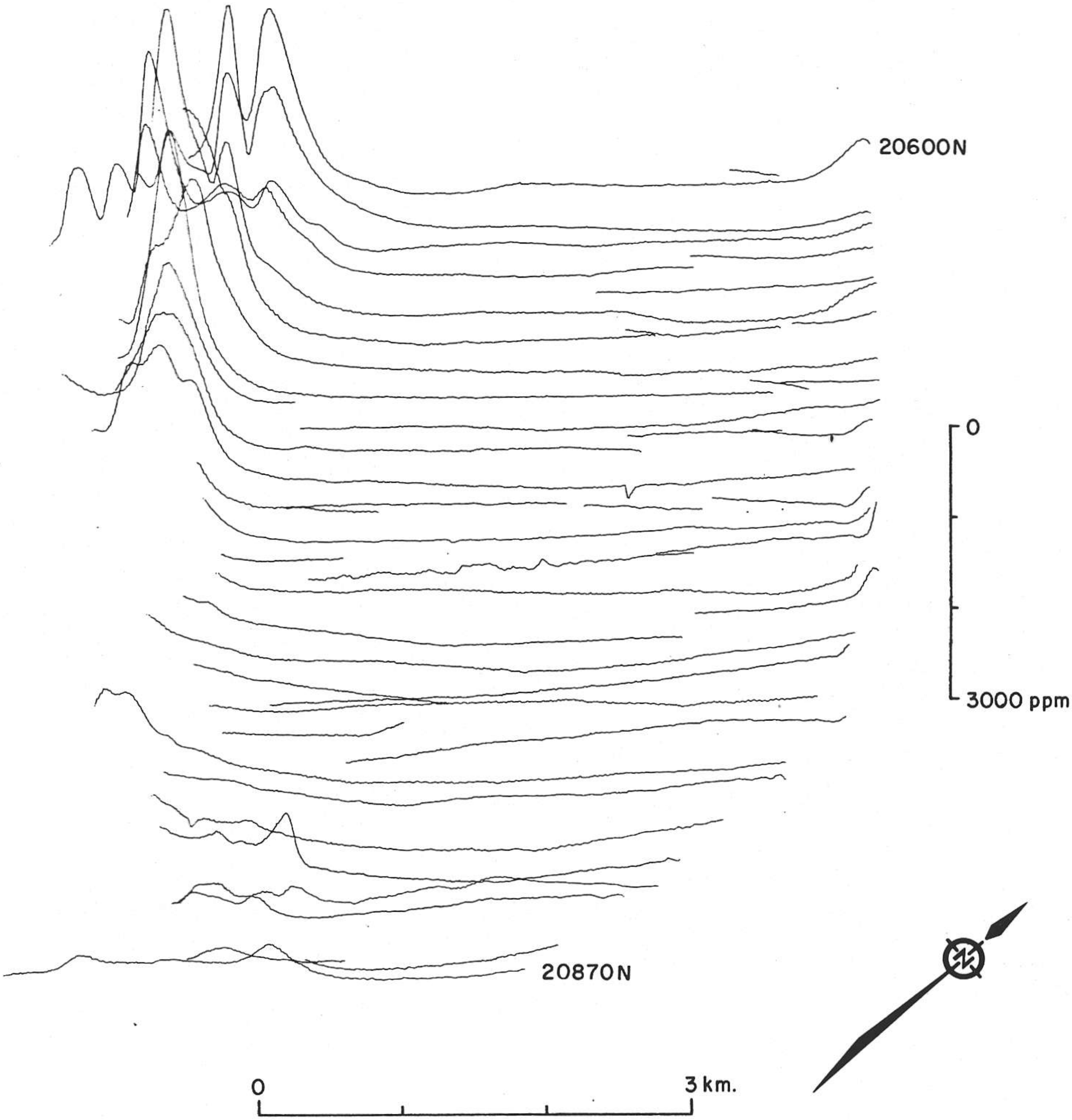
Spencer, B. (1984): New Massive Anomalies Discovered by Adams, North American Gold Mining Industry News, April 27, 1984.

INPUT E.M. PROFILE MAP

28H34

Channel 1 Amplitude

Scale 1:40000 (approx.)



8. INPUT INTERPRETATION

The majority of the project area is devoid of discrete INPUT responses. Several targets which match the classical criterion for base metal discoveries have been selected as starting points for ground evaluations. South of the survey area are conductors which we hesitate to call formational. The variation of apparent conductance, amplitudes and strike directions leaves many interesting possibilities for mineralization, beyond the scope of this interpretation.

All conductors in the survey block occur within geology described as banded actinolite quartz schist and calcareous black phyllite. All dip northward, a conclusion derived from profile shape analyses. It should be noted that the broad responses such as intercept 20600D are the result of the dipping conductor being detected several hundred metres downslope from its axis outcrop or subcrop. The conductors should still be relatively narrow.

The conductor axes provide a degree of conductor discrimination which should be noted for potential ground evaluations. A solid axis represents a dominant conductor, with both high amplitude and conductance parameters. Usually, the zones with longer strike lengths have graphitic sources. The axes which are dashed are weaker conductors that we interpret as less homogeneous conductors whose continuity is often questionable.

Where local improvements in amplitude/conductance occur, these may be favourable targets for sulphide concentrations. Dotted axes are very weak 'conductors', that may only be detected as induced polarization anomalies, or 'quadrature' EM responses.

CONDUCTOR 72A PRIORITY 2

Line	20720N
Terrain Clearance	140m.
Dip	N?
Strike Intersection	90^{o}?
Strike Length	<200m.
Conductance	---
Depth	---
Magnetic Coincidence	---
Related Responses	---

A low amplitude, but persistant response was detected within the resistivity low which dominates the northern half of the survey block. The low amplitudes are consistant with a very short length conductor. Reconnaissance geophysical profiles should be performed in a very limited area, anticipating a small target, with a very high apparent conductance.

CONDUCTOR 78B PRIORITY 1

Line	20780N
Terrain Clearance	120m.
Dip	N
Strike Intersection	90^{O}
Strike Length	300m.
Conductance	75S
Depth	200m.
Magnetic Coincidence	---
Related Responses	20771B, 20780A, 20800E

In profile form, the selected response has a persistance which shows in the latter channels, only marginally on the early channels. The apparent depth may be realistic for this case, but a structural upfolding of the horizon immediately to the south could generate a similar 'anomaly'. Deep penetration ground EM systems may be required to resolve these two conductive responses.

CONDUCTOR 83E PRIORITY 1

Line	20830E
Terrain Clearance	125m.
Dip	45^{o}N
Strike Intersection	90^{o}
Strike Length	700m.
Conductance	14S
Depth	175m.
Magnetic Coincidence	20nT
Related Responses	20840C & D

The addition of a magnetic coincidence greatly enhances the importance of this short strike length conductor. The amplitudes are subdued however, and the conductor lies buried, a significant distance below the surface. The apparent conductance is only moderate, but in the Adam's Lake environment, this is not important.

CONDUCTOR 75A PRIORITY 3

Line	20751S
Terrain Clearance	144m.
Dip	65N
Strike Intersection	90^{o}
Strike Length	100m.
Conductance	5S
Depth	120m.
Magnetic Coincidence	---

The 75A response represents an amplitude improvement in a formational horizon which is located near the shore of Skwaam Bay. With the low conductance, this is a sign of conductor continuity, with a graphitic or disseminated sulphide source being the most likely explanation. A broad regional magnetic coincidence is related to underlying geology and has no local structural complexities.

9. CONCLUSIONS AND RECOMMENDATIONS

The repetition of geological units as depicted on the available regional mapping can not be confirmed by the geophysical signatures of the magnetic and electromagnetic data. We suggest that there may be significant mineralogical differences between the northern and southern half of the block.

Bedrock conductors are rare in the main part of the survey area, and even weak zones have been identified as possible follow-up targets. However, most of the bedrock conductors are concentrated along the southern perimeter of the survey block. Geology and geochemistry results should dictate the priority of these horizons. The interpretation is indicative of structural complexities and non-homogeneous conductor composition. Sulphide mineralization along these horizons should be considered a distinct possibility.

Respectfully submitted,

QUESTOR SURVEYS LIMITED,

Marcel Konings,
Chief Geophysicist.

APPENDIX A

BARRINGER/QUESTOR MARK VI INPUT(R) Helicopter System

The INduced PUlse Transient (INPUT) method is a system whereby measurements are made, in the time domain, of a secondary electromagnetic field while the primary field is between pulses. Currents are induced into the ground by means of a pulsed primary electromagnetic field which is generated from a transmitting loop around the helicopter. By using half-sine wave current pulses (Figure A-1) and a transmitter loop of large turns-area, a high signal-to-noise ratio and the high output power needed for deep penetration, are achieved.

Induced current in a conductor produces a secondary electromagnetic field which is detected and measured after the termination of each primary pulse. Detection of the secondary field is accomplished by means of a receiving coil, wound on an air core form, mounted in a PCV plastic shell called a "bird" and towed behind and below the helicopter on 76 metres (250 feet) of coaxial cable. The received signal is processed and recorded by equipment within the helicopter.

The axis of the receiving coil may be vertical or horizontal relative to the flight direction. In rolling or hilly terrain the standard or horizontal coil axis is preferred, although in steep terrain, the vertical axis coil optimizes coupling with horizontal or dipping stratigraphy. The secondary field is in the form of a decaying voltage transient, measured in time, at the termination of the primary transmitted pulse. The amplitude of the transient is proportional to the amount of measured in time, at the termination of the primary transmitted pulse. The amplitude of the transient is proportional to the amount of current induced into the conductor, the conductor dimensions, conductivity and the depth beneath the aircraft.

The rate of decay of the transient is inversely proportional to conductance. By sampling the decay curve at six different time intervals and recording the amplitude of each sample, an estimate of the relative conductance can be obtained. Transients due to strong conductors such as sulphides and graphite, usually exhibit long decay curves and are therefore commonly recorded on all six channels. Sheet-like surface conductive materials, on the other hand, have short decay curves and will normally only show a response in the first two or three channels.

For homogeneous conditions, the transient decay will be exponential and the time constant of decay is equal to the time difference at two successive sampling points divided by the log ratio of the amplitudes at this point.

TRANSMITTER SPECIFICATIONS

Pulse Repetition Rate	180	per sec
Pulse	Half sine	
Pulse Width	2.0	millisec
Off Time	3.56	millisec
Output Voltage	67	volts
Output Current Peak	200	amperes
Output Current Average	46	amperes
Coil Area	177 $m.^2$	(1,904 $ft.^2$)
Coil Turns	7	
Electromagnetic Field Strength (peak)	247,800	$amp\text{-}turn\text{-}meter^2$

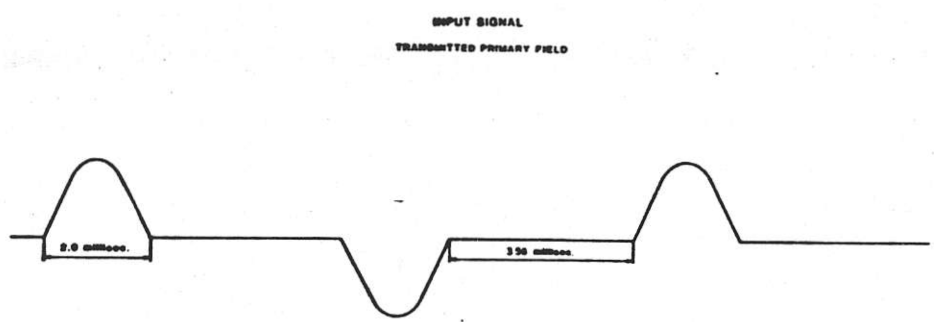


Figure A1

RECEIVER SPECIFICATIONS

Sample Gate	Windows (centre positions)		Widths	
CH 1	340	sec	200	sec
CH 2	540		200	
CH 3	840		400	
CH 4	1240		400	
CH 5	1740		600	
CH 6	2340		600	

Sample Interval	0.5 sec
Integration Time Constant	1.3 sec
Bird Position behind Aircraft (at 40 kt)	19 metres
Bird Position below Aircraft (at 40 kt)	73 metres

Receiver features: Power Monitor 50 or 60 Hz

50 or 60 Hz and Harmonic Filter

VLF Rejection

Spheric Rejection (tweak) Filter

SAMPLING OF INPUT SIGNAL

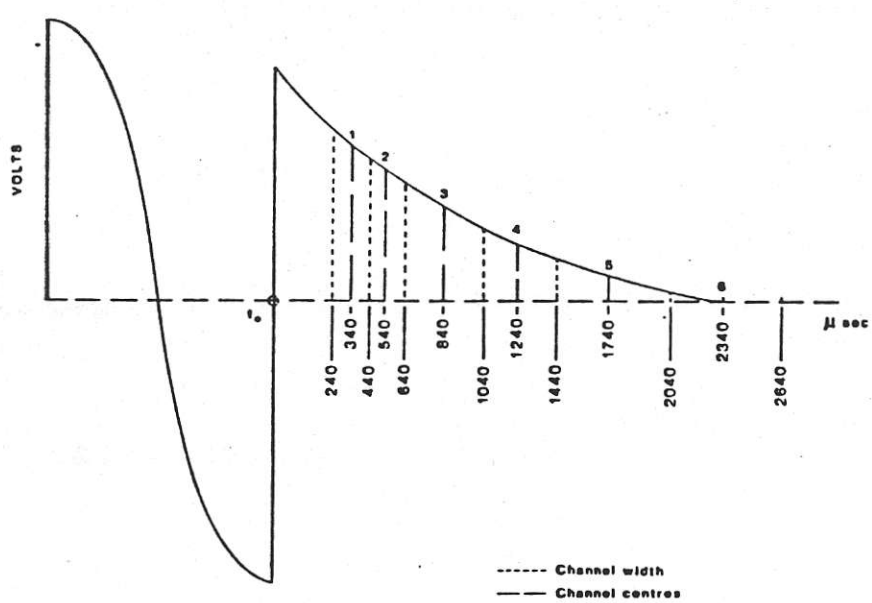


Figure A2

DATA ACQUISITION SYSTEM

Sonotek SDS 1200

Includes time base Intervalometer, Fiducial System

CAMERA

Geocam 75 SF

35 mm continuous strip or frame

TAPE DRIVE

DIGIDATA MODEL 1139

9 TRACK 800 BBI ASCII

OSCILLOSCOPE

Tektronix Model 305

ANALOGUE RECORDER

RMS GR-33

Heat Sensitive Paper (33cm)

Recording 10 Channels: 50-60 Hz Monitor, 6 INPUT Channels, fine and coarse Magnetics and Altimeter. Also, time, fiducial numbers, latitude and longitude (optional), timing lines, centimetre spaced vertical scale marks and line numbers are imprinted on the paper.

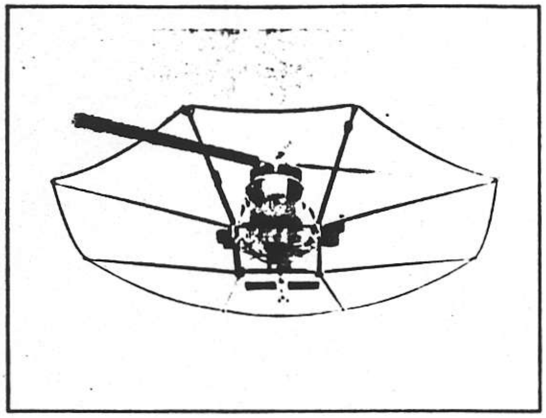
ALTIMETER

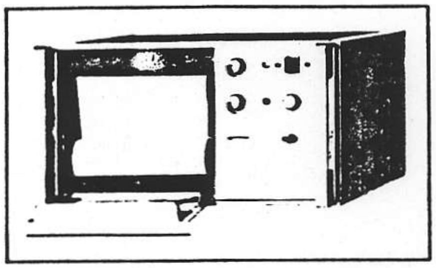
Sperry Radar Altimeter

GEOMETRICS MODEL G-803 PROTON MAGNETOMETER

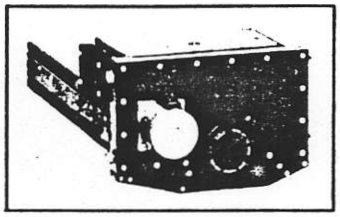
The airborne magnetometer is a proton precession design which operates on the principle of nuclear magnetic resonance to produce a measurement of the total magnetic intensity. It has a sensitivity of 1 nanoTesla and an operating range of 20,000 to 100,000 nanoTeslas. The sensor is a solenoid type, oriented to optimize results in a low ambient magnetic field. The sensor is mounted in a boom offset from aircraft control surfaces and electrical equipment at the rear of the aircraft. A 3-axis compensating coil arrangement and permalloy strips are adjusted to counteract the effects of permanent and induced magnetic fields in the aircraft.

Because of the high intensity electromagnetic field produced by the INPUT transmitter, the magnetometer and INPUT systems are operated on a time share basis. The magnetometer head is polarized while the INPUT transmitter is on, but precession occurs during a short period when the transmitter is off. Using this technique, the sensor head is polarized for 0.80 seconds and the precession frequency is subsequently recorded and converted to nanoTeslas during the following 0.20 seconds when no current is circulating in the INPUT transmitter coil.

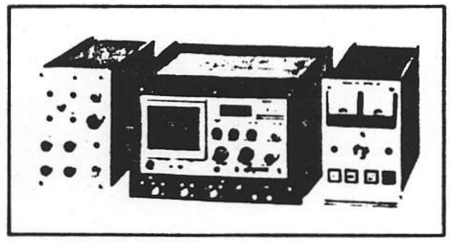




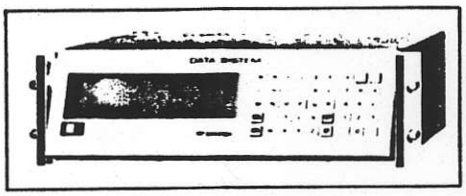
HONEYWELL ANALOGUE CHART RECORDER



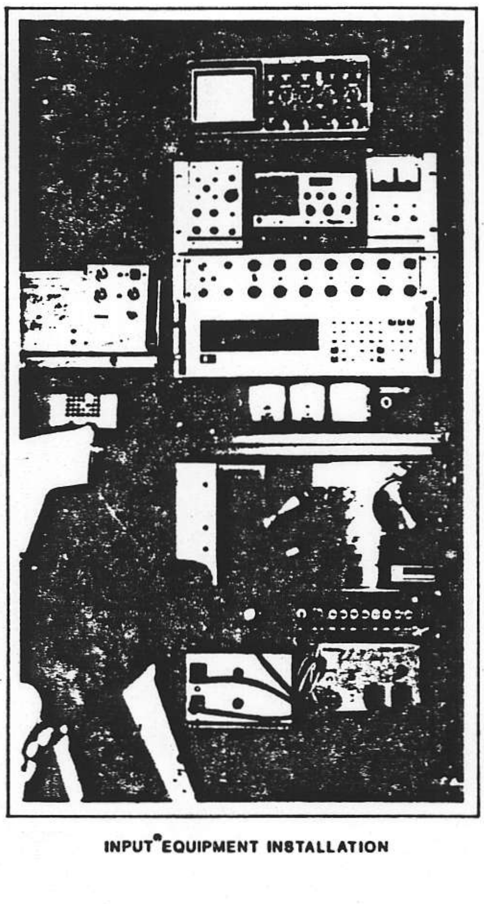
35mm TRACKING CAMERA



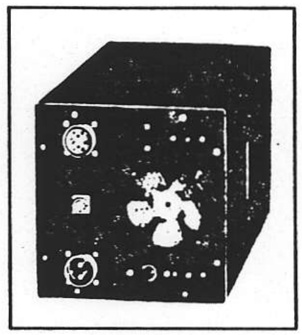
INTERFACE, OSCILLOSCOPE & T.C.U.



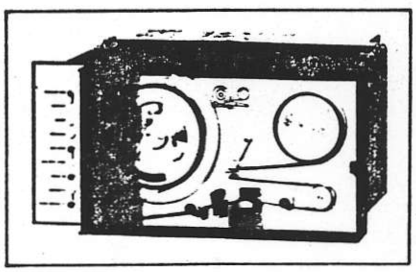
SONOTEK DATA SYSTEM



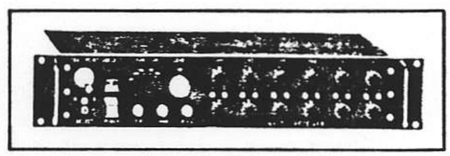
INPUT® EQUIPMENT INSTALLATION



TRANSMITTER

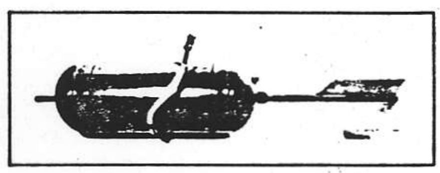


9 TRACK TAPE RECORDER



MK VI INPUT® RECEIVER

RADAR ALTIMETER



TOWED "BIRD" ASSEMBLY

QUESTOR/BARRINGER MARK VI "INPUT"® SYSTEM EQUIPMENT

APPENDIX B

The Survey Helicopter

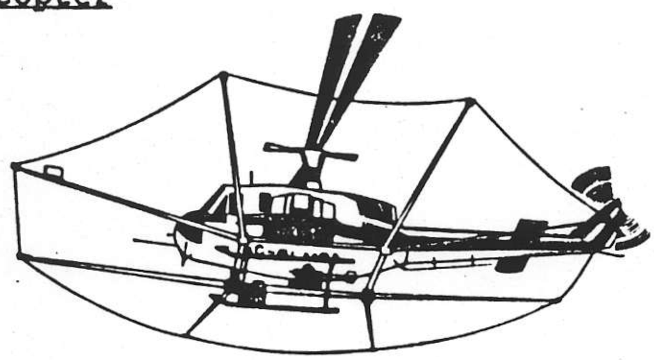


Figure B1

Manufacturer	Bell Helicopter Company
Type	205A-1
Canadian Registration	C-GLMC - present installation
Date of INPUT Installation	May 1982

Modifications:

1) Cradle and wing booms for transmitter coil mounting
2) Camera and altimeter mounting
3) Modified gasoline driven generator system

Any BELL 205-212 airframe can support the QUESTOR Helicopter INPUT system. The 205 is powered by one low maintenance turbine engine. The configuration of the helicopter provides for easy installation of equipment, which can be dissasembled and crated to the survey base. Reassembly takes less than two days. These factors have proven the helicopter to be a reliable and efficient geophysical survey system in areas not suitable for fixed-wing operation.

APPENDIX C

INPUT System Characteristics

a) Geometry

The INPUT system, a time domain airborne electromagnetic system, has the transmitter loop located around the helicopter airframe while the receiver, referred to as the 'bird', typically is towed 19 metres behind and 73 metres below the helicopter at a survey airspeed of 40 knots. The actual spatial position of the bird is dependent on the airspeed of the survey helicopter, as can be seen in Figure C1.

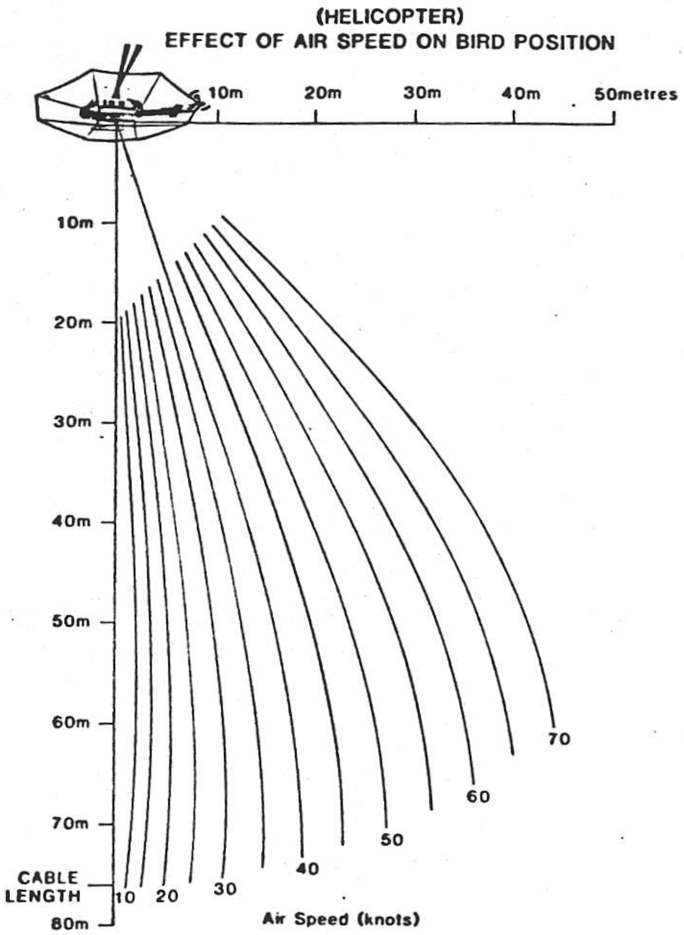


Figure C1

b) The Lag Factor

The bird's spatial position along with the time constant of the system introduces a lag factor (Figure C2) or shift of the response past the actual conductor axis in the direction of the flight line. This is due to fiducial markers being generated and imprinted on the film in real time and then merged with E.M. data which has been delayed due to the two aforementioned parameters. This lag factor necessitates that the receiver response be normalized back to the helicopter's position for the map compilation process. The lag factor can be calculated by considering it in terms of time, plus the elapsed distance of the proposed shift and is given by:us the elapsed distance of the proposed shift and is given by:

$$\text{Lag (seconds)} = \text{time constant} + \frac{\text{bird lag (metres)}}{\text{ground speed (metres/sec)}}$$

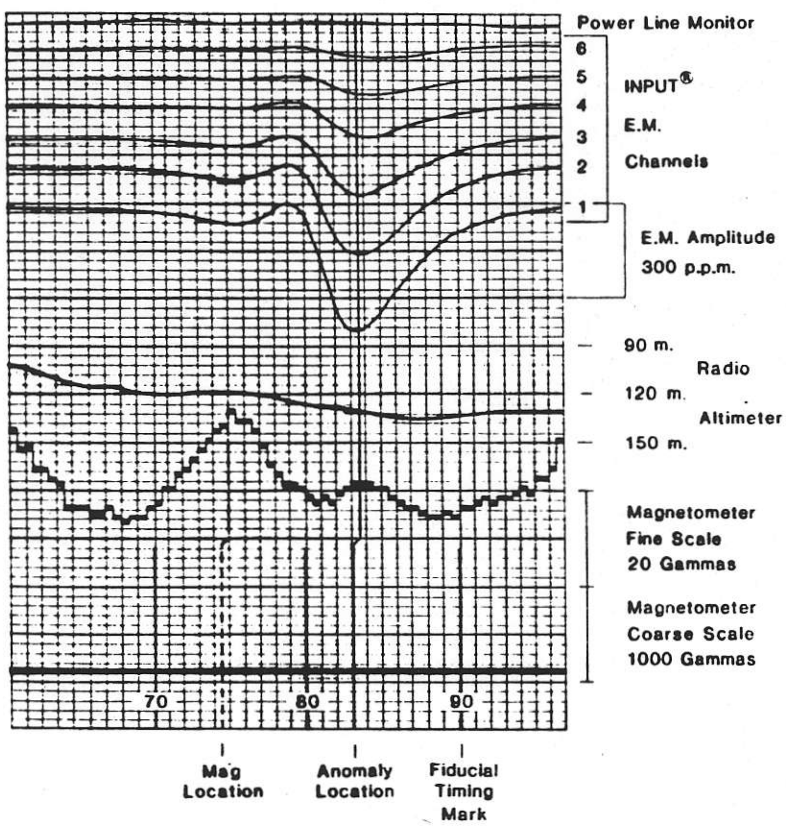


Figure C2

The time constant introduces a 1.3 second lag while, at an aircraft velocity of 40 kt., the 'bird' lag is 1 second. The total lag factor which is to be applied to the INPUT E.M. data at 40 kts. is 2.3 seconds. It must be noted that these two parameters vary within a small range dependent on the helicopter velocity, though they are applied as constants for consistency. As such, the removal of this lag factor will not necessarily position the anomalies in a straight line over the real conductor axis. The offset of a conductor response peak is a function of the system and conductor geometry as well as conductivity.

The magnetic data has a 1.0 second lag factor introduced relative to the real time fiducial positions. This factor is software controlled with the magnetic value recorded relative to the leading edge (left end) of each step 'bar', for both the fine and coarse scales. For example, a magnetic value positioned at fiducial 10.00 on the records would be shifted to fiducial 9.95 along the flight path.

A lag factor of 2 seconds (0.1 fiducial) is introduced to correct 50-60 Hz monitor for the effects of bird position and signal processing. In cases where a 50-60 Hz signal is induced in along formational conductor, a 50-60 Hz secondary electromagnetic transient may be detected as much as 5 km. from the direct source over the conductive horizon.

The altimeter data has no lag introduced as it is recorded in real time relative to the fiducial markings.

c) Calibration

The major advance made during the transition from the INPUT MK V to the INPUT MK VI has been the ability to calibrate the equipment accurately and consistently. Field tests at established test sites are carried out on an average of once every 6 months to check the consistency of the INPUT installations available from QUESTOR.

To calibrate the equipment for a survey operation the following tests are used:

1) "ZERO" the digital and reoord background E.M. levels;
2) magnetometer scale calibrations;
3) altimeter calibration;
4) calibration of INPUT receiver gain;
5) aircraft compensation;
6) record background E.M. levels at 600 m.;
7) survey flight;
8) record background E.M. levels at 600 m.
9) record full scale INPUT receiver gain;
10) record compensation drift;
11) terminate or repeat from step 4.

This sequence of tests may be repeated in midflight given that the duration of the flight is sufficiently long. Typically, this process is conducted every 2 hours of actual flying time and at the termination of every flight.

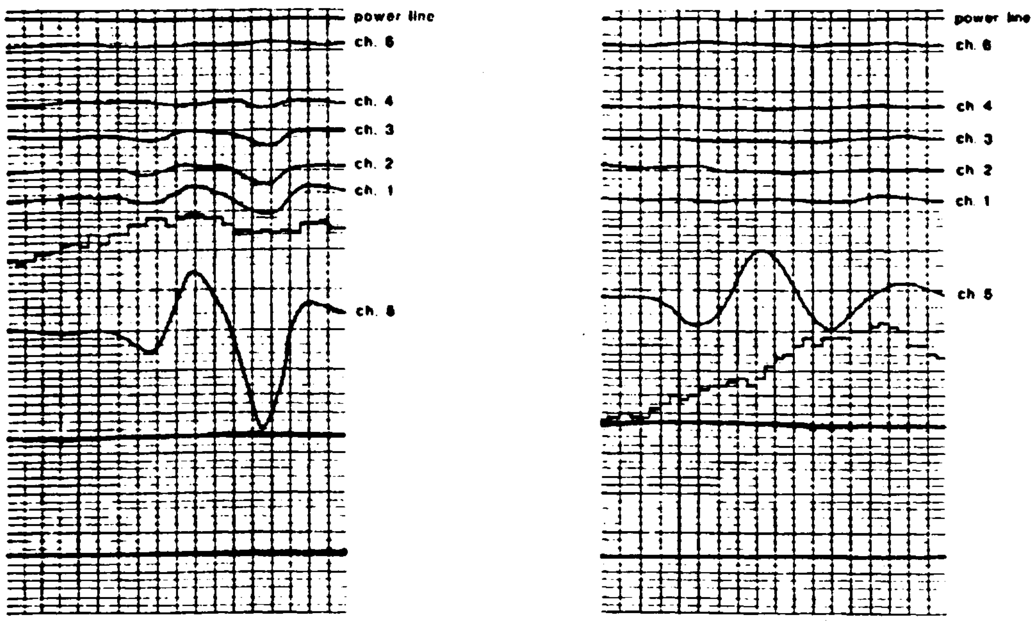
The background levels are recorded and then used to determine the drift that may occur in the E.M. channels during the progression of a survey flight. If drift has occurred, the

E.M. channels are brought back to a levelled position by use of the linear interpolation technique during the data processing.

The primary electromagnetic field generated by the INPUT system induces eddy currents in the frame of the helicopter. This spurious secondary field is a significant source of noise which needs to be taken account of before every survey flight is initiated.

Compensation is the technique by which the effects of this spurious secondary field are eliminated. A reference signal, which is equal in amplitude and waveform but opposite in polarity, is obtained from the primary field voltage in the receiver coil and applied to each channel of the receiver. The compensation signal is not a constant value due to coupling differences induced by 'bird' motion relative to the aircraft. The signal applied is proportional to the inverse cube of the distance between the 'bird' and aircraft. Figure C3 displays the effect of compensation.

Typically, channel 5 is selected for compensation because it is not affected by geological noise due to its sampling location in the transient and then coupling changes are induced by precipitating 'bird' motion. Phase considerations of channel 5, relative to the remaining channels, dictates whether sufficient compensation has been applied. If the remaining channels are in-phase to channel 5 during this procedure, an over-compensated situation is indicated, whereas, out-of-phase would be indicative of an under-compensation case. Normally this adjustment is carried out at an altitude of 600 metres in order to eliminate the influence of external geological and cultural conductors.



Uncompensated Compensated

Figure C3

The magnetometer, altimeter and INPUT receiver gain are also calibrated at the initiation of every survey flight. With the magnetometer, there are two scales, a coarse and a fine scale. The fine scale indicates a 10 gamma change for a 1 cm. change in amplitude (Figure C2). The coarse scale moves 2 mm. (or 1 division) for a 100 gamma change with full scale,2 cm., indicating a 1000 gamma shift.

The altimeter (Figure C4), is calibrated to indicate 400 feet altitude at the seventh major division (7 cm.), read from the bottom of the analog record. This is the nominal flying height of INPUT surveys, wherever relief and aircraft performance are not limiting factors. The eighth major division correlates with 300 feet while the sixth corresponds with 500 feet in altitude.

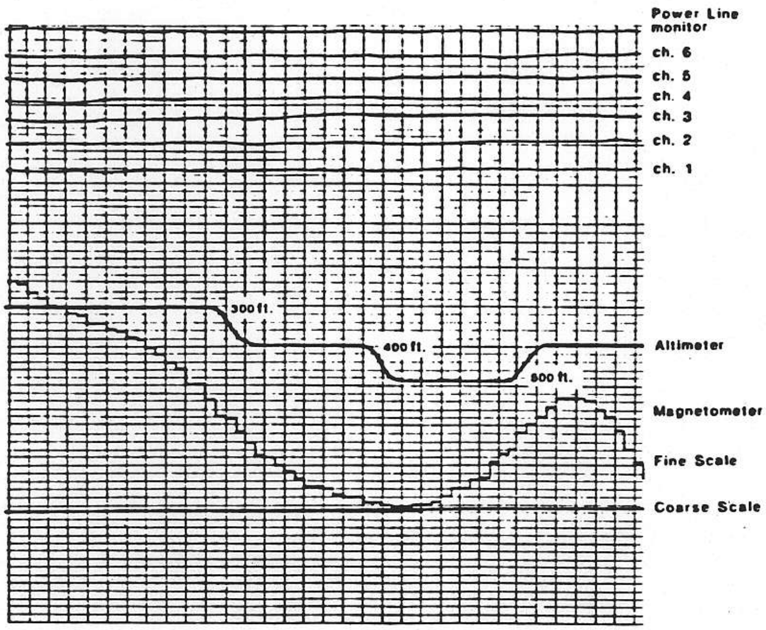


Figure C4

The INPUT receiver gain is expressed in parts per million of the primary field amplitude at the receiver coil. At the 'bird', the primary field strength is 8.5 and 8 volts peak-to-peak, for the vertical and horizontal axis coils respectively or 4.2 and 4.0 volts peak amplitude. The calibration signal introduced at the input stage of the receiver is 4.0 mV. Expressed in parts- per-million, this induces a change of:

$$\frac{4 \times 10^{-3} \times 10^{6}}{4.2} = 1{,}000 \text{ ppm (vertical coil)}$$

These calibration signals (Figure C5) cause an 8 cm. deflection of all 6 traces which translates to a sensitivity of 125 ppm/cm. for the vertical axis receiver coil system.

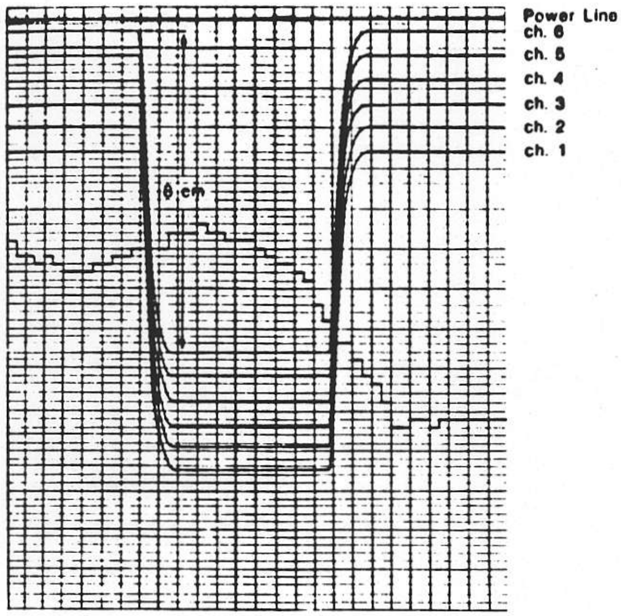


Figure C5

With the chart speed increased from the normal 0.25 cm. to 2.5 cm. per second, the time constant of the system (Figure C6), can be obtained by analysis of the exponential rise of the calibration signal for all 6 traces. The time constant, is defined as the time for the calibrated voltage to build up or decay to 63.2% of its final of initial value. A longer time constant reduces background noise but also has the effect of reducing the amplitude of the signal, especially for near surface responses.

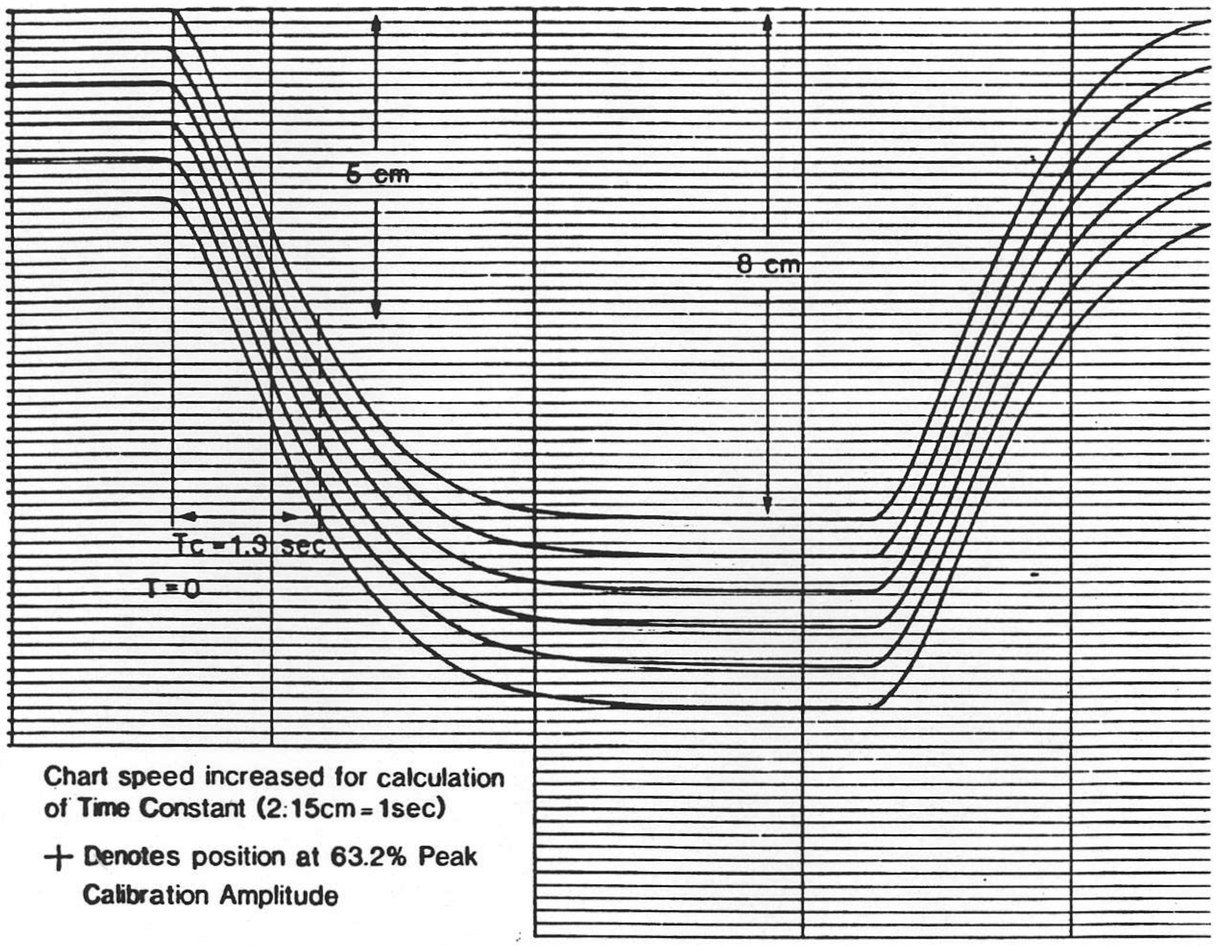


Figure C6

This trade-off indicates the importance of selecting an optimum value for the time constant. Experience and years of testing have indicated that a time constant of 1.3 second does not impede interpretation of bedrock source conductors.

d) Depth Penetration Capabilities

There are many factors which effect the depth of penetration. These factors consist of:

1) altitude of the helicopter above the ground;
2) conductivity contrast between conductor and host rock;
3) size and attitude of conductor;
4) type and conductivity of overburden present.

Of these factors, only the first parameter can be controlled. Typically, a survey altitude of 120 metres (400 feet) or less above the terrain is maintained. At this height, the helicopter INPUT MARK VI system has responded to conductors located at a depth of 200 metres (650 feet) below the surface.

APPENDIX D

INPUT Data Processing

The QUESTOR designed and implemented computer software routines for automatic interactive compilation and presentation, may be applied to all QUESTOR INPUT Systems. The software is compatible with the fixed-wing MARK VI INPUT, and the helicopter MARK VI INPUT. The procedures are all common, however, separate subroutines are accessed which contain the unique parameters to each system. Although many of the routines are standard data manipulations such as error detection, editing and levelling, several innovative routines are also optionally available for the reduction of INPUT data. The flow chart on the following page (Figure D1) illustrates some of the possibilities. Software and procedures are constantly under review to take advantage of new developments and to solve interpretational problems.

a) INPUT Data Entry and Verification

During the data entry stage, the digital data range is compared to the analog records and film. The raw data may be viewed on a high-resolution video graphics screen at any desirable scale. This technique is especially helpful in the identification of background level drift and instrument problems.

b) Levelling Electromagnetic Data

Instrument drift, recognized by viewing compressed data from several hours of survey flying, is corrected by an interactive levelling program. Although only two or three calibration sequences are normally recorded, the QUESTOR technique permits the use of multiple non-anomalous background recordings to divide a possible problematic situation into segments. All 6 INPUT channels are levelled simultaneously, yet independently. The sensitivity of the levelling process is normally better than 10 ppm on data with a peak-to-peak noise level of 30 ppm.

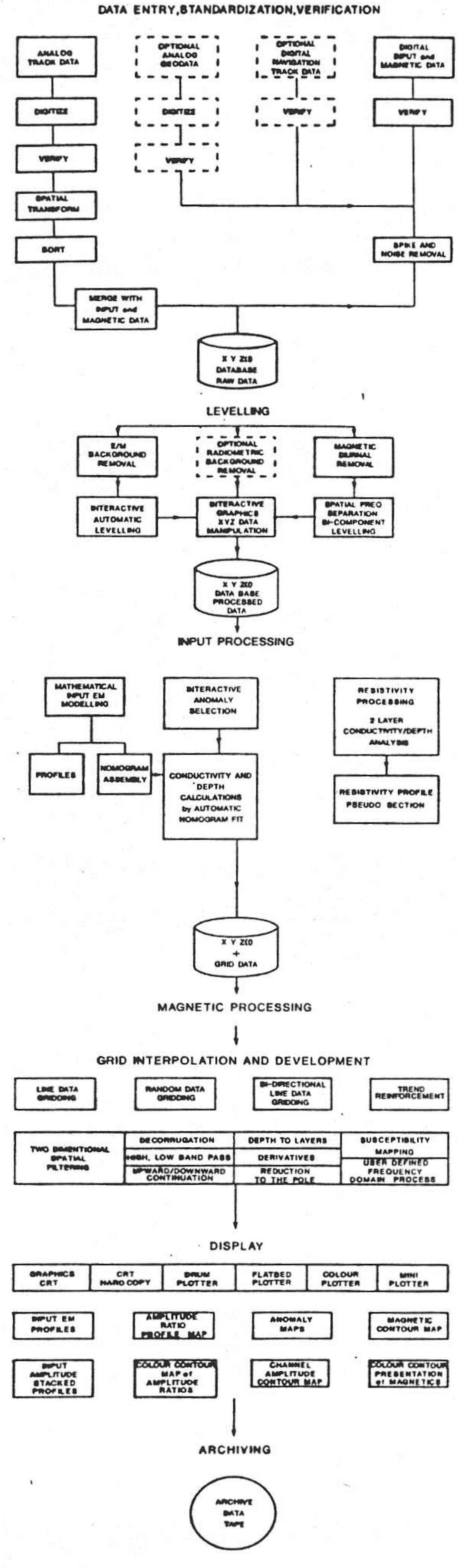
c) Data Enhancement

Normal INPUT processing does not include the filtering of electromagnetic data. The residual high frequency variations often apparent on analog INPUT data, is due almost wholly to "spherics", atmospheric static discharges. In conductive environments, spherics are apparently grounded and effectively filtered. In resistive environments, frequency spectrum analysis and subsequent FFT (Fast Fourier Transform) filters have been applied to data to reduce the noise envelope.

d) Selection of EM Anomalies

The levelled data may be viewed sequentially on a graphics screen for the selection of INPUT anomalies. Anomalies are selected by aligning a cursor to the position of the peaks. Some of the parameters of the response are manually entered during the picking of the response. These include the number of channels above background levels and the type of anomaly, e.g. cultural, bedrock, surficial, up-dip, etc.

QUESTOR INPUT DATA PROCESSING



APPENDIX E

INPUT INTERPRETATION PROCEDURES

The INPUT system is dependent upon a definite resistivity contrast and is most suitable for highly conductive massive sulphides. Differentiation is possible between flat-lying surficial conductors and bedrock conductors.

The selection of anomalies is based on their characteristics and interpretation is sometimes enhanced by analyzing the magnetics. Spherics, due to atmospheric static discharges and lightning storms, are distinguishable from conductive anomalies. In the analysis of each conductor anomaly, the following parameters may be considered: anomaly shape with the conductor pattern, topography, corresponding magnetic features, anomaly decay rate, the number of channels affected, geological environment and strike direction and the interpreted dip relative to structural features.

For each anomaly selected, the following are recorded: location by fiducial, channel amplitudes in parts per million, number of channels, conductivity-thickness in siemens, corresponding magnetic association in gammas, magnetic fiducial location altitude of aircraft above ground in metres and also, the origin of the response (ie. surficial, bedrock, cultural).

Conductive responses are categorized into three main groups. These are bedrock, surficial and cultural.

Bedrock conductors can be sorted into conductive sources which are commonly encountered on INPUT surveys: massive sulphides, graphites, serpentinized peridotites and fault or shear zones. Magnetite and manganese concentrations may also yield INPUT responses in some circumstances. INPUT responses over alkalic intrusives and weathered basic volcanics have been well documented by Macnae (1979) and Palacky (1979).

Massive Sulphides

Massive sulphides occur as both syngenetic and stratified deposits and as vein infilling deposits. Nickel deposits often occur as magmatic injections of massive sulphides. Kuroko-type syngenetic copper-zinc massive sulphides usually occur at an interface of felsic intermediate rocks. In this environment, there are seldom any significant formations of carbonaceous sediments on the same horizon. Often, these deposits are overlain by a silicious zone which may contain stingers of continuous sulphides, which change to disseminated sulphides away from the main deposit. These often give a deposit the appearance of a long strike-length zone which may not fit the explorationist's target model. A careful analysis of conductivities and apparent widths (half-peak-width), will often reveal the geometry and source. Syngenetic deposits of base metal sulphides of up to 2 km strike length are not unknown, although most sizeable deposits have strike lengths between 500 and 1000 m.

The conductivity of most massive sulphide deposits may be attributed to the pyrrhotite and chalcopyrite content, as both minerals form elongated interconnected masses which are most amenable to the induction of electromagnetic secondary fields. Pyrite normally forms cubic crystals which must be interconnected electrically in order to produce a response. Massive pyrite often produces only a moderate response which may be difficult to distinguish from graphite. The in-situ conductivity of massive sulphides, although very high for individual crystals, often falls in the range of 5 to 20 S/m.

Sulphide conductive zones are rare in nature; economic sulphides are even more scarce. Long formational sulphide zones are known, but are not common. More often, sulphide concentrations may occur within formational graphitic zones.

The geometry of many syngenetic and injected sulphide deposits may fall within broad classifications of size, conductivity and magnetization but most of these bodies are anomalous within their local geological environment. There are often changes in dip, conductivity, thickness and magnetization with respect to the regional environment. There are no rules which apply universally to massive sulphide deposits. One observation which has consistently applied to sulphide deposits is that INPUT responses (amplitude and conductivity) are roughly proportional to mineral content.

The INPUT system is capable of detecting disseminated sulphides within zones of resistivity changes. These may have low conductivities and responses will normally be restricted to channels 1 through 4. The response amplitudes will vary with the horizontal and vertical extent of the zone. Gold deposits often fall within this response classification.

The magnetic response of a sulphide deposit is the most deceiving information available to the explorationist. Although many large economic deposits have a strong direct magnetic association, some of the largest base metal deposits have no magnetic association. An isolated magnetic anomaly caused by oxidation conditions at a volcanic vent flanking a conductor, may have more significance than a body which has a uniform magnetic anomaly along its strike length. Differing geochemical environments often results in the zoning of minerals so that non-homogeneous conductivities and magnetic responses may be favourable parameters.

Graphitic Carbonaceous Conductors

Carbonaceous sediments are usually found within the sedimentary facies of Precambrian and Proterozoic greenstone belts. These represent a low energy, sedimentary environment with good bedding planes and little or no structural deformation. Graphites are often located in basins of the sub-aqueous environment, producing the same body shape as sulphide concentrations. Most often however, they form long, homogeneous planar sequences. These may have thicknesses from a metre to hundreds of metres. The recognition of graphites in this setting is normally straightforward.

Conductivities and apparent widths may be very consistent along strike. Strike lengths of tens of kilometres are common for individual horizons.

The conductivity of a graphite unit is a function of two variables:

a) the quality and quantity of the graphite and

b) the presence of pyrrhotite as an accessory conductive mineral

Pyrite is the most common sulphide mineral which occurs within carbonaceous beds. It does not contribute significantly to the overall conductivity as it will normally be found as disseminated crystals. Greenschist facies metamorphosis will often be sufficient to convert carbonaceous sediments to graphitic beds. Likewise, pyrite will often be transformed to pyrrhotite.

Without pyrrhotite, most graphitic conductors have less than 20 S conductivity-thickness value as detected by the INPUT system or 1 to 10 S/m conductivity from ground geophysical measurements. With pyrrhotite content, there may be little difference from sulphide conductors.

It is not unusual to find local concentrations of sulphides within graphitic sediments. These may be recognized by local increases in apparent width, conductivity or as a conductor offset from the main linear trends.

Graphite has also been noted in fault and shear zones which may cross geological formations at oblique angles.

Serpentinized Peridotites

Serpentinized peridotites are very distinguishable from other anomalies. Their conductivity is low and is caused partially by magnetite. They have a fast decay rates, large amplitudes and strong magnetic correlation.

Magnetite

INPUT anomalies over massive magnetites correlate to the total Fe content. Below 25-30% Fe, little or no response is obtained. However, as the Fe percentage increses, strong anomalies result with a distinguished rate of decay that usually is more pronounced than those for massive sulphides.

Contact zones are often predicted when anomaly trends coincide with lines of maximum gradient along a flanking magnetic anomaly.

Surficial Conductors

Surficial conductors are characterized by fast decay rates and usually have a conductivity-thickness of 1-5 siemens. These values will be much higher in saline conditions. Overburden responses are broad, more so than bedrock conductors. Anomalies due to surficial conductivity are not dependent on flight direction. In profile form, surficial responses are symmetrical from line-to-line with the Helicopter INPUT system, and are characterized by a single response rather than a double peak for dipping and vertical conductors. Conductive deposits such as clay beds, may lie in valleys which can be checked on the altimeter trace and with the base maps topography.

Cultural Conductors

Cultural conductors are identifiable by examining the power line monitor and the film to locate railway tracks, power lines, buidings, fences or pipe lines. Power lines produce INPUT anomalies of high conductivity that are similar to bedrock responses. The strength of cultural anomalies is dependent on the grounding of the source. INPUT anomalies usually lag the power line monitor by 1 second, which should be consistent from line-to-line. If this distance between the INPUT response and the power line monitor differs between lines, then there is the possibility of an additional conductor present. The amplitude and conductivity-thickness of anomalies should be relatively consistent from line-to-line.

JOB NO:28H34

INPUT EM LINE	FIDUCIAL	ANOMALY TYPE	CHS	PEAK RESPONSE AMPLITUDES (PPM) CH1	CH2	CH3	CH4	CH5	CH6	TCP (S)	ALT (M)	MAGNETIC FIDUCIAL	VALUE
20600A	291.187	W	5	768	435	210	76	27	-	10	106	-	
20600B	291.625		5	386	221	119	62	24	-	15	142	-	
20600C	291.987	W	6	1453	864	497	260	140	70	21	135	-	
20600D	292.567	W	6	2141	1154	535	206	82	32	11	112	292.30	30
20600E	293.901	P	4	225	143	81	47	-	-	18	113	-	
20600F	294.603	P	3	76	62	33	-	-	-	13	107	-	
20600G	300.602	S	1	37	-	-	-	-	-	NC	128	-	
20611M	277.899		2	162	56	-	-	-	-	NC	145	-	
20611N	278.795		1	30	-	-	-	-	-	NC	122	-	
20611P	287.688	P	3	207	135	75	-	-	-	14	121	-	
20611R	288.892	U	6	1486	901	463	206	86	33	14	102	288.85	24
20611S	289.678	U	6	2368	1395	798	433	245	133	22	119	290.10	4
20620A	218.135		6	586	367	205	108	56	26	19	149	-	
20620B	218.534	W	6	1405	814	440	222	110	49	17	122	-	
20620C	219.018	W	6	1399	777	394	190	96	42	15	124	219.07	13
20620D	219.485	W	6	2588	1396	678	300	132	56	13	120	-	
20620E	220.234		6	969	515	262	130	70	34	16	131	-	
20620F	220.718	W	6	1043	539	265	121	64	32	14	119	220.77	19
20620G	221.202		6	512	305	157	73	35	19	15	125	-	
20620H	221.999		2	80	48	-	-	-	-	NC	99	-	
20620J	227.401	S	1	36	-	-	-	-	-	NC	123	-	
20620K	227.796	S	1	38	-	-	-	-	-	NC	142	-	
20631E	197.341	P	2	95	34	-	-	-	-	NC	151	-	
20631F	197.694	S	1	50	-	-	-	-	-	NC	146	-	
20632A	200.699	S	1	30	-	-	-	-	-	NC	141	-	
20632B	206.337		5	440	259	146	68	35	-	16	128	206.38	16
20632C	206.846	U	6	943	484	242	115	57	26	14	117	206.82	18
20632D	207.313		6	967	506	263	132	75	37	17	117	-	
20632E	208.175	U	6	1626	823	369	144	64	25	11	125	-	
20640A	137.867	W	6	3186	1753	881	396	183	78	14	123	138.15	7
20640B	138.604	W	6	1811	952	472	219	114	49	14	130	-	
20640C	139.130		6	517	293	151	80	47	26	18	117	139.07	4
20640D	146.999	P	2	46	28	-	-	-	-	NC	128	-	
20652A	135.997	P	2	30	23	-	-	-	-	NC	136	-	
20652B	136.983		6	1523	857	444	221	114	65	16	118	136.63	3
20652C	137.476		6	2422	1335	701	339	175	86	16	116	137.40	5
20660A	75.865		6	1282	794	442	236	124	68	20	120	-	

JOB NO:28H34

INPUT EM		ANOMALY		PEAK	RESPONSE		AMPLITUDES		(PPM)	TCP	ALT	MAGNETIC	
LINE	FIDUCIAL	TYPE	CHS	CH1	CH2	CH3	CH4	CH5	CH6	(S)	(M)	FIDUCIAL	VALUE
20660B	76.257	W	6	2059	1106	544	257	123	57	14	110	76.15	19
20660C	77.492	P	2	70	40	-	-	-	-	NC	146	-	
20660D	84.203	P	1	30	-	-	-	-	-	NC	124	-	
20660E	85.003	P	1	30	-	-	-	-	-	NC	146	-	
20671A	58.888	S	1	48	-	-	-	-	-	NC	147	-	
20672A	60.846		1	30	-	-	-	-	-	NC	150	-	
20672B	68.532	U	6	2932	1586	809	379	182	86	15	116	68.10	28
20680A	10.780		5	1443	754	360	163	75	-	12	135	-	
20680B	10.900	W	6	1777	1006	518	249	120	63	15	133	-	
20680C	11.000	W	6	1607	981	545	288	156	83	20	115	11.30	41
20681A	13.996		1	30	-	-	-	-	-	NC	131	-	
20681B	20.049	S	1	32	-	-	-	-	-	NC	125	-	
20681C	22.035	S	1	70	-	-	-	-	-	NC	138	-	
20690A	44.345	U	2	184	67	-	-	-	-	NC	143	-	
20690B	44.901		2	30	15	-	-	-	-	NC	144	-	
20690C	45.200	P	1	30	-	-	-	-	-	NC	125	-	
20692A	51.302	S	1	30	-	-	-	-	-	NC	132	-	
20692B	53.933		2	30	15	-	-	-	-	NC	132	-	
20692C	55.195	U	6	1455	799	421	214	113	55	17	121	54.80	63
20692D	55.405	U	5	1488	802	396	183	86	-	13	136	-	
20700A	56.016		4	453	250	129	82	-	-	15	146	-	
20700B	56.420	U	6	1177	636	333	163	88	44	17	120	-	
20700C	56.744	U	6	1355	714	355	170	82	34	14	138	-	
20700D	57.089	U	6	981	528	285	145	75	41	18	110	57.13	48
20700E	57.798		2	30	24	-	-	-	-	NC	136	-	
20700F	58.299	P	1	30	-	-	-	-	-	NC	124	-	
20700G	59.098	P	1	30	-	-	-	-	-	NC	130	-	
20700H	63.952	P	1	30	-	-	-	-	-	NC	137	-	
20700J	64.807	P	1	30	-	-	-	-	-	NC	133	-	
20700K	65.997		2	45	34	-	-	-	-	NC	131	-	
20711A	67.524	U	3	193	58	19	-	-	-	6	150	-	
20711B	67.949		1	48	-	-	-	-	-	NC	146	-	
20711C	68.795	S	1	30	-	-	-	-	-	NC	126	-	
20714A	119.055		1	30	-	-	-	-	-	NC	116	119.93	95

JOB NO:28H34

INPUT EM		ANOMALY		PEAK	RESPONSE		AMPLITUDES		(PPM)	TCP	ALT	MAGNETIC	
LINE	FIDUCIAL	TYPE	CHS	CH1	CH2	CH3	CH4	CH5	CH6	(S)	(M)	FIDUCIAL	VALUE
20720A	127.601		2	53	20	-	-	-	-	NC	142	-	
20720B	128.792		2	84	39	-	-	-	-	NC	126	-	
20730A	130.096		2	124	55	-	-	-	-	NC	127	-	
20740A	132.247		2	30	15	-	-	-	-	NC	131	131.48	80
20740B	138.495	S	1	65	-	-	-	-	-	NC	135	-	
20740C	138.903	S	1	70	-	-	-	-	-	NC	131	-	
20740D	139.800	S	1	78	-	-	-	-	-	NC	140	-	
20751A	141.803	U	3	468	203	63	-	-	-	5	144	-	
20751B	142.296		2	144	65	-	-	-	-	NC	147	-	
20751C	142.893	S	1	98	-	-	-	-	-	NC	121	-	
20751D	143.507	S	1	82	-	-	-	-	-	NC	133	-	
20751E	144.299	S	1	76	-	-	-	-	-	NC	127	-	
20752A	154.300	U	4	235	123	62	34	-	-	13	106	154.45	91
20760A	155.401	P	3	132	75	42	-	-	-	15	141	155.20	97
20760B	155.645	P	3	88	53	28	-	-	-	13	125	-	
20760C	162.897	S	1	56	-	-	-	-	-	NC	135	-	
20760D	163.297	S	1	70	-	-	-	-	-	NC	116	-	
20760E	164.100	S	1	94	-	-	-	-	-	NC	133	-	
20770A	165.300	S	1	106	-	-	-	-	-	NC	142	-	
20770B	165.801	S	1	89	-	-	-	-	-	NC	118	-	
20770C	167.206	S	1	57	-	-	-	-	-	NC	119	-	
20770D	167.892	S	1	41	-	-	-	-	-	NC	133	-	
20771A	176.752		1	30	-	-	-	-	-	NC	118	-	
20771B	177.396		2	53	25	-	-	-	-	NC	110	-	
20780A	178.200	W	3	99	48	28	-	-	-	17	127	-	
20780B	178.406	P	5	75	49	37	25	21	-	75	120	-	
20780C	184.797	P	2	48	15	-	-	-	-	NC	118	-	
20780D	185.155	P	2	64	20	-	-	-	-	NC	122	-	
20790A	186.596		1	111	-	-	-	-	-	NC	125	-	
20790B	187.387		1	80	-	-	-	-	-	NC	114	-	
20790C	188.611		1	56	-	-	-	-	-	NC	120	-	
20790D	190.592		1	30	-	-	-	-	-	NC	116	-	
20790E	192.991	S	1	30	-	-	-	-	-	NC	133	-	

JOB NO:28H34

INPUT LINE	EM FIDUCIAL	ANOMALY TYPE	CHS	PEAK RESPONSE AMPLITUDES (PPM) CH1	CH2	CH3	CH4	CH5	CH6	TCP (S)	ALT (M)	MAGNETIC FIDUCIAL	VALUE
20800A	199.904	W	6	777	445	244	120	65	32	18	139	-	
20800B	200.254	W	6	776	433	221	106	56	21	15	142	-	
20800C	200.809	W	4	315	160	89	39	-	-	14	101	200.80	218
20800D	201.259		4	186	105	60	33	-	-	18	123	-	
20800E	201.794		3	66	43	29	-	-	-	36	129	-	
20800F	207.851	S	1	41	-	-	-	-	-	NC	123	-	
20810A	209.551		2	96	35	-	-	-	-	NC	111	-	
20810B	209.955		2	71	33	-	-	-	-	NC	131	-	
20810C	210.350		1	60	-	-	-	-	-	NC	122	-	
20810D	213.298		1	30	-	-	-	-	-	NC	127	-	
20810E	219.997	U	2	100	63	-	-	-	-	NC	118	219.98	12
20810F	221.100	U	2	113	73	-	-	-	-	NC	124	-	
20820A	222.095	W	4	174	113	65	30	-	-	15	108	222.02	209
20820B	222.688		2	92	40	-	-	-	-	NC	148	-	
20820C	223.496	W	3	120	64	31	-	-	-	10	143	-	
20820D	224.093		2	33	17	-	-	-	-	NC	144	-	
20820E	226.700	P	1	30	-	-	-	-	-	NC	121	-	
20820F	227.004	P	1	30	-	-	-	-	-	NC	121	227.35	10
20820G	227.703		1	30	-	-	-	-	-	NC	124	-	
20820H	228.203		1	62	-	-	-	-	-	NC	144	-	
20830A	229.501	U	1	65	-	-	-	-	-	NC	123	-	
20830B	230.199		1	61	-	-	-	-	-	NC	109	-	
20830C	230.647	P	1	52	-	-	-	-	-	NC	121	-	
20830D	232.401	P	1	30	-	-	-	-	-	NC	121	-	
20830E	239.108	U	6	583	357	195	90	36	11	14	125	-	
20830F	240.578		2	248	129	-	-	-	-	NC	142	-	
20830G	241.352	U	3	317	170	91	-	-	-	13	133	-	
20840A	242.701	W	5	283	157	85	45	22	-	16	146	-	
20840B	242.996	W	5	233	142	77	39	18	-	15	142	-	
20840C	243.665		5	259	127	70	40	24	-	20	146	-	
20840D	244.022	W	5	254	173	87	43	14	-	13	149	-	
20840E	244.414		4	31	29	17	7	-	-	15	147	-	
20840F	244.906	P	1	30	-	-	-	-	-	NC	140	-	
20840G	245.419		1	30	-	-	-	-	-	NC	146	-	
20840H	246.097		1	30	-	-	-	-	-	NC	145	-	
20840J	246.975	P	2	54	22	-	-	-	-	NC	142	-	
20850A	247.575	U	2	104	44	-	-	-	-	NC	130	-	
20850B	248.012		2	79	32	-	-	-	-	NC	146	-	
20850C	249.965		1	30	-	-	-	-	-	NC	128	-	
20850D	255.710		4	276	144	71	26	-	-	10	147	-	

JOB NO:28H34

INPUT EM		ANOMALY		PEAK	RESPONSE		AMPLITUDES		(PPM)	TCP	ALT	MAGNETIC	
LINE	FIDUCIAL	TYPE	CHS	CH1	CH2	CH3	CH4	CH5	CH6	(S)	(M)	FIDUCIAL	VALUE
20850E	256.489	U	4	390	173	89	37	-	-	12	143	-	
20850F	257.014	U	4	381	186	91	46	-	-	12	127	-	
20861A	136.999	P	3	52	25	12	-	-	-	10	155	-	
20861B	137.773		3	242	125	68	-	-	-	14	146	-	
20870A	122.835	W	5	212	141	85	55	34	-	30	146	-	
20870B	124.106		4	189	116	69	30	-	-	16	116	-	
20870C	125.473	W	5	379	206	109	53	34	-	16	151	-	

CORNER	UTM CO-ORDINATES EASTING	NORTHING
1	88766.98	127891.89
2	95059.03	127326.93
3	94577.75	121098.55
4	88195.86	121828.44

LINE NO.	FIDUCIAL	MAP	UTM CO-ORDINATES EASTING	NORTHING
29010	11.5	2	90600.	122761.
29010	17.2	2	91028.	125655.
29010	18.6	2	91319.	126864.
20592	49.8	2	94419.	127337.
20600	290.7	2	89948.	127720.
20600	291.8	2	90488.	127584.
20600	292.3	2	90779.	127566.
20600	293.8	2	91451.	127511.
20600	294.7	2	91849.	127471.
20600	295.4	2	92236.	127464.
20600	296.2	2	92609.	127494.
20600	300.8	2	94451.	127256.
20600	301.5	2	95015.	127223.
20611	278.5	2	94419.	126935.
20611	283.3	2	93431.	127080.
20611	284.9	2	93010.	127155.
20611	285.8	2	92613.	127203.
20611	286.7	2	92123.	127239.
20611	287.6	2	91502.	127336.
20611	288.6	2	90985.	127411.
20611	289.5	2	90665.	127424.
20611	290.0	2	90289.	127523.
20620	218.1	2	89265.	127086.
20620	219.7	2	90184.	127068.
20620	220.4	2	90656.	127064.
20620	221.4	2	91313.	127042.
20620	222.4	2	91881.	127118.
20620	223.6	2	92491.	127099.
20620	224.8	2	93016.	127009.
20620	225.4	2	93454.	126984.
20620	227.8	2	94429.	126866.
20631	197.9	2	94445.	126722.
20631	199.8	2	93697.	126848.
20632	200.3	2	93749.	126769.
20632	201.2	2	93330.	126803.
20632	202.3	2	93032.	126802.
20632	204.4	2	92460.	126859.
20632	205.2	2	91909.	126933.
20632	205.9	2	91364.	126972.
20632	206.3	2	91087.	127008.
20632	207.0	2	90700.	127094.
20632	207.7	2	90235.	127169.
20632	208.5	2	89764.	127211.
20640	137.7	2	89951.	127011.
20640	138.1	2	90185.	126939.
20640	139.1	2	90740.	126825.
20640	139.9	2	91315.	126717.
20640	140.5	2	91704.	126673.

LINE NO.	FIDUCIAL	MAP	UTM CO-ORDINATES EASTING	NORTHING
20640	141.4	2	92257.	126650.
20640	144.2	2	93230.	126522.
20640	145.1	2	93594.	126405.
20640	146.9	2	94226.	126314.
20643	261.5	2	93060.	126695.
20643	262.6	2	93483.	126628.
20643	264.9	2	94380.	126541.
20650	128.5	2	94388.	126269.
20651	129.7	2	94304.	126284.
20651	130.7	2	93591.	126300.
20651	131.9	2	93232.	126398.
20652	132.5	2	93431.	126341.
20652	135.0	2	91830.	126467.
20652	135.5	2	91438.	126538.
20652	136.9	2	90497.	126695.
20652	137.6	2	90088.	126784.
20660	75.5	2	89687.	126609.
20660	76.2	2	90150.	126501.
20660	76.9	2	90637.	126455.
20660	78.9	2	91643.	126314.
20660	82.3	2	92968.	126138.
20660	83.0	2	93268.	126071.
20660	84.0	2	93648.	126040.
20660	85.0	2	94373.	125984.
20670	57.9	2	94429.	125837.
20670	58.6	2	94230.	125862.
20671	58.7	2	94444.	125809.
20671	59.2	2	94044.	125911.
20672	60.3	2	94195.	125824.
20672	60.9	2	93697.	125870.
20672	62.1	2	92998.	125948.
20672	67.4	2	90895.	126198.
20672	68.1	2	90380.	126241.
20672	68.8	2	89876.	126236.
20672	69.2	2	89574.	126279.
20680	10.0	2	89271.	126200.
20680	10.6	2	89819.	126107.
20680	11.3	2	90376.	126095.
20680	12.1	2	90877.	126143.
20681	13.9	2	90881.	125972.
20681	15.7	2	91924.	125880.
20681	17.6	2	92592.	125761.
20681	18.9	2	93052.	125724.
20681	20.6	2	93691.	125650.
20681	22.2	2	94478.	125655.
20690	44.3	2	94838.	125445.
20690	45.2	2	94475.	125487.
20690	46.3	2	94014.	125599.

LINE NO.	FIDUCIAL	MAP	UTM CO-ORDINATES EASTING	NORTHING
20691	46.5	2	94227.	125530.
20691	47.4	2	93604.	125587.
20691	48.1	2	93159.	125626.
20692	48.8	2	93240.	125557.
20692	49.1	2	93077.	125592.
20692	49.6	2	92783.	125640.
20692	53.0	2	91530.	125768.
20692	54.3	2	90671.	125863.
20692	55.1	2	90085.	125924.
20692	55.5	2	89828.	125957.
20692	55.9	2	89514.	125982.
20700	56.0	2	89411.	125854.
20700	56.9	2	89980.	125811.
20700	57.6	2	90462.	125698.
20700	58.3	2	90893.	125625.
20700	58.7	2	91123.	125594.
20700	61.7	2	92596.	125376.
20700	64.4	2	93582.	125273.
20700	65.8	2	94399.	125211.
20700	66.2	2	94699.	125212.
20700	66.3	2	94742.	125211.
20711	67.5	2	94764.	124972.
20711	67.8	2	94612.	124958.
20711	68.2	2	94364.	125016.
20711	70.0	2	93652.	125165.
20712	70.3	2	93613.	125099.
20712	72.2	2	92760.	125250.
20713	72.7	2	92679.	125277.
20713	75.8	2	91187.	125444.
20713	76.4	2	90739.	125471.
20714	118.3	2	91368.	125338.
20714	118.7	2	91047.	125390.
20714	119.4	2	90548.	125458.
20714	119.9	2	90110.	125549.
20720	121.1	2	90138.	125334.
20720	122.2	2	90772.	125189.
20720	122.9	2	91200.	125150.
20720	125.2	2	92306.	125027.
20720	127.9	2	93625.	124928.
20720	128.7	2	94406.	124844.
20720	129.3	2	94706.	124807.
20720	129.5	2	94810.	124803.
20730	129.6	2	94803.	124661.
20730	129.8	2	94729.	124675.
20730	130.4	2	94396.	124728.
20730	131.0	2	94201.	124769.
20730	132.2	2	93571.	124787.
20730	132.9	2	93203.	124797.

LINE NO.	FIDUCIAL	MAP	UTM CO-ORDINATES EASTING	NORTHING
20731	133.3	2	93516.	124791.
20731	134.0	2	92953.	124806.
20731	136.8	2	90751.	124962.
20735	128.7	2	91084.	125044.
20735	130.2	2	90240.	125101.
20740	131.7	2	90177.	124925.
20740	132.8	2	90858.	124828.
20740	134.2	2	91543.	124771.
20740	139.0	2	93485.	124479.
20740	139.5	2	94062.	124387.
20740	140.8	2	94665.	124380.
20751	141.8	2	94754.	124217.
20751	142.3	2	94546.	124255.
20751	142.9	2	94275.	124274.
20751	143.4	2	94113.	124278.
20751	145.1	2	93473.	124324.
20752	146.8	2	93366.	124209.
20752	150.6	2	91740.	124352.
20752	153.3	2	90626.	124612.
20752	154.7	2	89867.	124740.
20760	154.8	2	89644.	124552.
20760	155.4	2	90049.	124488.
20760	156.3	2	90528.	124391.
20760	158.0	2	91222.	124311.
20760	160.6	2	92260.	124107.
20760	161.1	2	92560.	124081.
20760	162.8	2	93409.	124034.
20760	164.0	2	94190.	124021.
20760	164.5	2	94474.	124020.
20760	164.7	2	94638.	124026.
20770	164.8	2	94507.	123889.
20770	165.2	2	94411.	123888.
20770	166.0	2	94057.	123901.
20770	167.8	2	93357.	123911.
20770	170.6	2	92026.	123968.
20770	174.2	2	90414.	124107.
20771	174.3	2	91694.	123962.
20771	175.1	2	91258.	124064.
20771	176.9	2	90411.	124263.
20771	177.6	2	90100.	124335.
20771	178.0	2	89905.	124378.
20780	178.1	2	90022.	124068.
20780	179.2	2	90552.	124030.
20780	180.6	2	91215.	124007.
20780	183.1	2	92549.	123869.
20780	184.5	2	93307.	123730.
20780	185.2	2	93861.	123666.
20780	185.7	2	94249.	123638.

LINE NO.	FIDUCIAL	MAP	UTM CO-ORDINATES EASTING	NORTHING
20790	186.1	2	94434.	123420.
20790	186.9	2	94127.	123477.
20790	188.1	2	93704.	123562.
20790	189.1	2	93292.	123591.
20790	191.7	2	92273.	123627.
20790	192.4	2	91989.	123652.
20790	194.9	2	91321.	123641.
20790	195.7	2	90886.	123639.
20791	197.0	2	91369.	123863.
20791	197.7	2	91116.	123801.
20791	199.2	2	90104.	123918.
20800	199.8	2	89181.	123828.
20800	200.1	2	89321.	123810.
20800	200.7	2	89650.	123771.
20800	202.5	2	90388.	123637.
20800	204.3	2	90959.	123496.
20800	206.0	2	91923.	123379.
20800	207.5	2	92625.	123313.
20800	208.3	2	93200.	123266.
20800	208.7	2	93498.	123241.
20800	209.3	2	94067.	123205.
20810	209.4	2	93969.	123110.
20810	209.9	2	93826.	123125.
20810	210.7	2	93510.	123157.
20810	212.0	2	92973.	123160.
20810	212.7	2	92653.	123188.
20810	214.8	2	91836.	123290.
20810	215.9	2	91294.	123295.
20810	221.6	2	89625.	123630.
20820	221.7	2	89535.	123376.
20820	222.4	2	89815.	123319.
20820	226.5	2	91250.	122983.
20820	227.6	2	92265.	122845.
20820	228.5	2	93258.	122864.
20820	228.8	2	93608.	122889.
20830	228.9	2	93170.	122652.
20830	229.4	2	93010.	122636.
20830	231.9	2	91923.	122663.
20830	241.6	2	89920.	123059.
20830	242.4	2	89509.	123135.
20840	242.5	2	89665.	122685.
20840	243.6	2	90188.	122639.
20840	246.3	2	91958.	122723.
20840	247.1	2	92794.	122497.
20840	247.4	2	93086.	122443.
20850	247.5	2	92745.	122422.
20850	248.0	2	92511.	122462.
20850	249.0	2	92124.	122515.

LINE NO.	FIDUCIAL	MAP	UTM CO-ORDINATES EASTING	NORTHING
20850	250.0	2	91824.	122560.
20850	255.1	2	90287.	122586.
20850	257.9	2	89582.	122704.
20860	128.5	2	92252.	122136.
20860	129.2	2	92019.	122133.
20860	135.1	2	90805.	122187.
20860	135.9	2	90489.	122184.
20861	136.2	2	90767.	122276.
20861	138.3	2	89616.	122305.
20870	121.7	2	88381.	122451.
20870	126.1	2	90529.	122159.
20870	127.4	2	91291.	122085.
20870	128.2	2	91999.	122039.

INPUT – Helicopter Vertical Axis Coil

SURFICIAL RESPONSE | UP-DIP PEAK RESPONSE | BEDROCK RESPONSE | DECAY INTERVAL CLASSIFICATION

- 1 Channel (300 microseconds)
- 2 Channel (500 microseconds)
- 3 Channel (800 microseconds)
- 4 Channel (1200 microseconds)
- 5 Channel (1700 microseconds)
- 6 Channel (2300 microseconds)

Culture Response

50 Associated Magnetic Response

Anomaly Letter – B 5 – Apparent Conductivity Width (siemens) (N.C. - No Calculation)

Poorly Defined Response – 1800 – Ch. 2 Amplitude (p.p.m.)

MAGNETIC CONTOURS

- 10 Gamma Contour Line
- 50 Gamma Contour Line
- 250 Gamma Contour Line

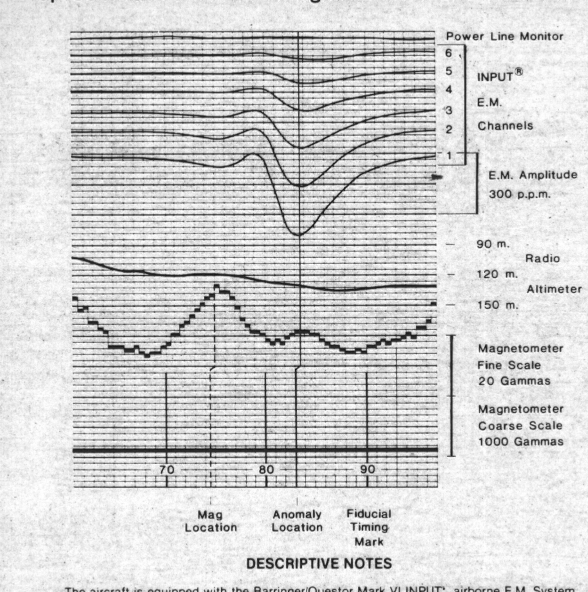
Magnetic Depression

1 Gamma = 1 Nanotesla in SI Units

INTERPRETATION

- 20 Conductor Axis, with reference number (good definition)
- 20 Conductor Axis, with reference number (poor definition)
- Vertical Conductor
- 60° Conductor Dip (magnitude and direction known)
- Conductor Dip (direction known)
- 78B Selected Zone, with reference number
- Conductive Zone
- Fault Zone

Representative INPUT® Magnetometer and Altimeter Recording



DESCRIPTIVE NOTES

The aircraft is equipped with the Barringer/Questor Mark VI INPUT* airborne E.M. System and the Sonotek PMH 5010 Proton Precession Magnetometer and Sonotek SDS-1200 Series Data Acquisition System. The INPUT* system will respond to conductive overburden and near-surface horizontal conducting layers in addition to bedrock conductors. Discrimination of conductors is based on the rate of transient decay, magnetic correlation and the anomaly shape, together with the conductor pattern and topography.

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INTERPRETATION REFERENCES

Becker, A., Gauvreau, C., and Collett, L.S.
1972: Scale Model Study of Time Domain Electromagnetic Response of Tabular Conductors: Canadian Mining and Metallurgical Bulletin, Volume 65, No. 725, p. 90-96.

Dyck, A.V., Becker, A., and Collett, L.S.
1974: Surficial Conductivity Mapping with the Airborne INPUT* System: Canadian Mining and Metallurgical Bulletin, Volume 67, No. 744, p. 104-109.

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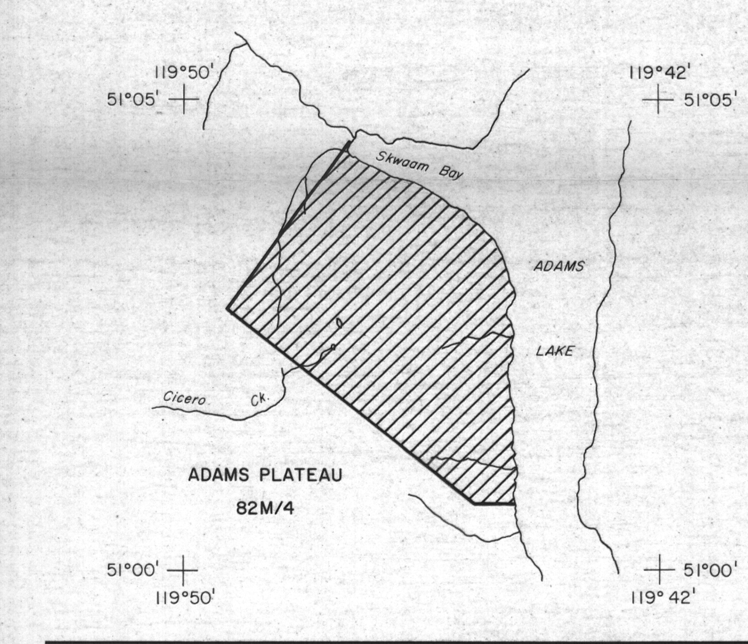
1973: New Developments in the INPUT* Airborne E.M. System: Canadian Mining and Metallurgical Bulletin, Volume 66, No. 732, p. 96-104.



HELICOPTER MK VI INPUT® SURVEY
TOTAL MAGNETIC INTENSITY SURVEY

CORPORATION FALCONBRIDGE COPPER

SWAAM BAY AREA

Province of BRITISH COLUMBIA

inches 0 1
0 1 2 centimetres

Scale 1:10000

1000 0 3000 Ft.

200 0 1000 M

FILE NO.	SHEET NO.	DATE
28H34	1 of 1	May-July 1984

Questor Surveys Limited
Mississauga Ontario Canada