ARIS SUMMARY SHEET

District Geologist, Prince George | Off Confidential: 92.03.15

ASSESSMENT REPORT 21440 | MINING DIVISION: Omineca

PROPERTY:	Phil				
LOCATION:	LAT	55 04 00		LONG	123 50 00
	UTM	10	6102312	446780	
	NTS	093O04W			
CLAIM(S):	Phil 1-4				
OPERATOR(S):	Peters, E.S.				
AUTHOR(S):	Poloni, J.R.				
REPORT YEAR:	1991, 88 Pages				
COMMODITIES SEARCHED FOR:	Copper,Gold				
KEYWORDS:	Triassic,Takla Group,Volcanics				

WORK DONE: Geophysical,Physical
EMAB 140.0 km;VLF
Map(s) - 1; Scale(s) - 1:27 000
EMGR 58.8 km;VLF
Map(s) - 1; Scale(s) - 1:5000
LINE 62.0 km
MAGA 140.0 km
Map(s) - 1; Scale(s) - 1:27 000
MAGG 58.8 km
Map(s) - 1; Scale(s) - 1:5000
REST 140.0 km
Map(s) - 1; Scale(s) - 1:27 000

Assessment Report

on the

Phil 1-4 Mineral Claims

Long. 123° 50'W Lat. 55° 05'N

Ominica Mining Division

British Columbia

for

E.S. Peters

by

John R. Poloni, B. Sc., P. Eng.

March 11, 1991

John R. Poloni
1524-56th Street, Suite 102
Delta, B.C.
V4L 2A8

<u>**TABLE OF CONTENTS**</u>

1.0 SUMMARY AND CONCLUSIONS

The Phil Claims totalling 68 units are located in the Mount Milligan area in the Ominica Mining Division of north central British Columbia.

During 1990, field surveys consisting of airborne geophysical surveys by Dighem, ground VLF-EM, magnetometer surveys, and geochemical soil surveys were completed over the claim block. Assay data for the soil geochemistry has not been received.

Positive response was obtained by the Dighem Surveys and the follow-up ground work, indicating that further exploration is required for the claims.

2.0 INTRODUCTION

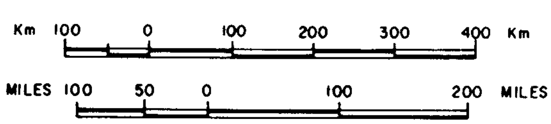
The writer was requested by Mr. E.S. Peters to review all available information and physical work undertaken on the Phil (1-4) Mineral Claims (68 units), located in the Mount Milligan area of the Ominica Mining Division of Central British Columbia.

The property was located on April 8-10, 1990 to cover aeromagnetic anomalies, situated southeasterly of the Mount Milligan deposit. This deposit controlled by Continental Gold/Placer Dome has reported drill reserves of 440 million tons containing 6.35 million ounces of gold and 1.8 billion pounds of copper as reported in George Cross Newsletters Oct 3, 25, 1990.

Field work completed on the Phil claims during the period May to November 1990 included geochemical, geological, and geophysical surveys at an expenditure of $59,586.33.

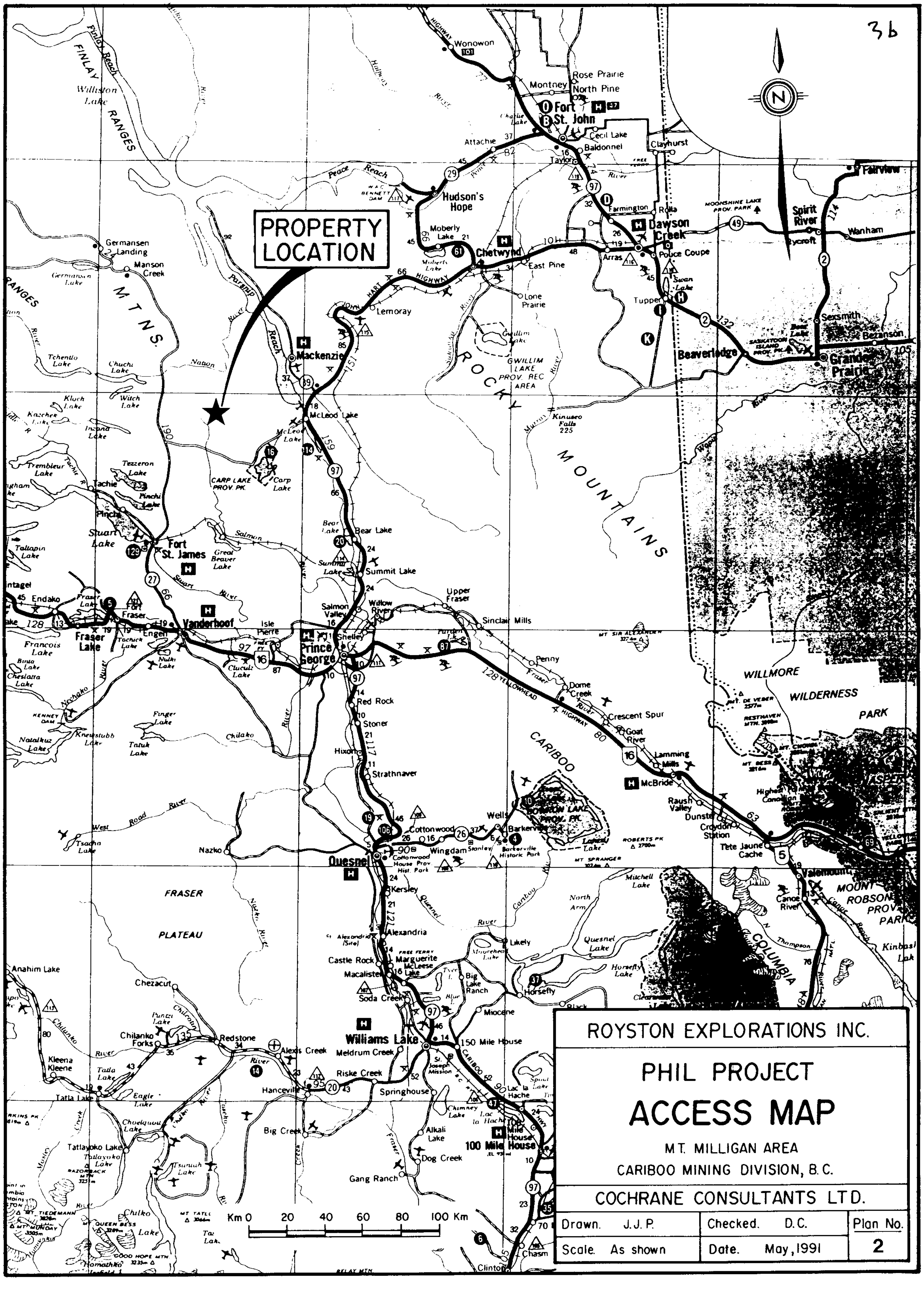
Property Location Map

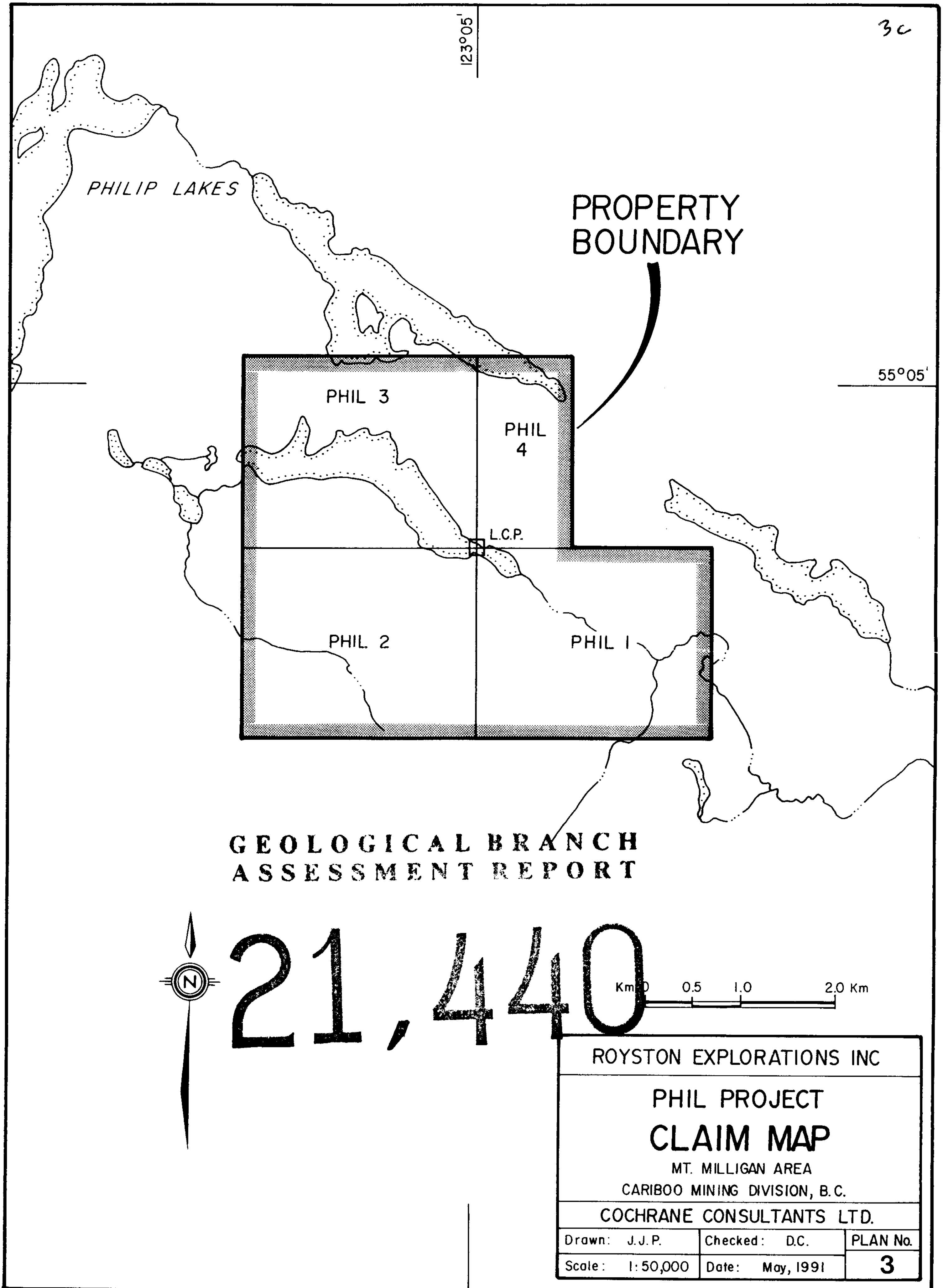
Plan No. 1



ROYSTON EXPLORATIONS INC.		
PHIL PROJECT **PROPERTY LOCATION** MT. MILLIGAN AREA CARIBOO MINING DIVISION, B.C.		
COCHRANE CONSULTANTS LTD.		
Drawn: J. J. P.	Checked: D.C.	PLAN No.
Scale: As shown	Date: May, 1991	1

3b


PROPERTY LOCATION
ROCKY MOUNTAINS
FRASER PLATEAU
CARIBOO
WILLMORE WILDERNESS PARK
Fort St. John
Hudson's Hope
Chetwynd
Dawson Creek
Mackenzie
McLeod Lake
Fort St. James
Vanderhoof
Prince George
Quesnel
Williams Lake
100 Mile House
McBride
Fraser Lake
Wells
Barkerville
Alexis Creek
Clinton
Km 0 20 40 60 80 100 Km
ROYSTON EXPLORATIONS INC.
PHIL PROJECT
ACCESS MAP
MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.
COCHRANE CONSULTANTS LTD.
Drawn. J.J.P.
Checked. D.C.
Plan No. 2
Scale. As shown
Date. May, 1991


3c
123°05'
55°05'
PHILIP LAKES
PROPERTY BOUNDARY
PHIL 3
PHIL 4
L.C.P.
PHIL 2
PHIL 1
GEOLOGICAL BRANCH
ASSESSMENT REPORT
21,440
N
Km 0 0.5 1.0 2.0 Km
ROYSTON EXPLORATIONS INC
PHIL PROJECT
CLAIM MAP
MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.
COCHRANE CONSULTANTS LTD.
Drawn: J.J.P.
Checked: D.C.
PLAN No. 3
Scale: 1:50,000
Date: May, 1991

3.0 LOCATION AND ACCESSIBILITY

The Phil claims are located about 600 air kilometers north of Vancouver, and 80 kilometers north of Fort St. James. Access from Prince George is north via Provincial Highway #97 for approximately 100 km to Windy Point, then westerly on the Philip Lakes logging road to km 57.5, at the northeast corner of the Phil #4 claim.

For the exploration program a field camp was located approximately 2.5 km south and west of the main haulage road.

4.0 CLAIM INFORMATION

The Phil property consists of four claims, Phil #1, #2,, #3, and #4 totaling 68 units, in the Ominica Mining Division of the Province of British Columbia. The NTS area code is 93 O - 4W, Long 123$_o$,50W; Lat 55^o, 05N.

Claim data is as follows:

Claim Name	Record No.	Units	Record Date
Phil #1	11739	20	Mar 15/91
Phil #2	11740	20	" "
Phil #3	11741	20	" "
Phil #4	11742	8	" "

5.0 PHYSICAL FEATURES

The Fort St. James - Mount Milligan area lies within the central interior physiographic region of the Western Cordilleran, with northwesterly trending valleys and bounding mountain ranges of relatively moderate relief. Elevations range from approximately 670 meters at Fort St. James jot peaks of 1550 meters. Vegetation varies depending on elevation, with willows and birch in lower valleys and spruce, pine and fir at higher elevations.

Fort St. James is the closest town with complete services including fixed wing aircraft and helicopter available for charter.

6.0 HISTORY

The claims were located on the strength of the government airborne magnetic results obtained in the Fort St. James - Mount Milligan area.

In the summer of 1990 the claims area was flown by Dighem Surveys of Mississauga, Ontario as part of an airborne geophysical reconnaissance as reported for Jeffco Holdings Ltd. September 13, 1990. A total of approximately 140 line Km of survey was flown.

During September and October a ground reconnaissance survey was completed by a field crew consisting of five technicians and one cook.

7.0 GEOLOGY

The Phil claims are situated within the Ominica Arch, a geologically complex region consisting of Upper Triassic and later, Takla Group Volcanics, intruded by Upper Jurassic (Ominica) intrusives extending through central British Columbia.

The Takla rocks consist of andesitic and basaltic flows, tuffs, volcanic breccias, agglomerates, and intervolcanic sediments, including conglomerates, limestone, slates, greywacke, and coal. These rocks have been intruded by stocks, sills and dikes of the Ominica Intrusions, consisting of granodiorite, quartz diorite, diorite, granite, gabbro and minor pyroxenite.

On the phil claims outcrop frequency appears to be approximately 10% over the grid area surveyed with only Takla volcanics being observed.

8.0 SURVEY PROGRAMS - 1990

The Dighem airborne geophysical survey was carried out over the RB and Phil claim blocks during the period June 20 to June 25, 1990. Approximately, 140 line kms of airborne covered the Phil claims as described in a report for Jeffco Holdings Ltd. dated Spet 13, 1990. Survey results are reported in section 4 of the report with the Phil Block anomalies being described in some detail in section 4-13. Recommendations are submitted in section 6 with further detailed surveys being required for the Phil claims.

To complement the airborne survey, a ground reconnaissance survey was undertaken by a six man field crew, during the period September 14 to October 10, 1990. This program consisted of 150 man days of field work, with 8.4 km of base line, 61.8 km of survey grid. Geophysical surveys, VLF-EM, and magnetometer, covered 58.8 kms over a grid pattern of 100 meter line interval and 50 meter station interval.

Equipment used was a Geonic EM-16 unit and GFM-8 Magnetometer unit with the VLF-EM and magnetometer surveys being completed by J.J. Poloni and C.R. Poloni.

As described by David E. Pritchard, Geophysist for Dighem Surveys and Processing Inc., September 13, 1990, section 4-12, "The Phil Block also has several anomalies indicated as "S?" which sould be looked at in greater detail. There are four anomalies which exhibit characteristics of bedrock conductors. They are indicated by "B" and "B?" and are located on line 20270 at fiducial 2868, line 20370 at fiducial 1065 and line 20390 at fiducials 1480 and 1494. These are relatively weak conductors but do have some inphase response.

The ground magnetic survey shows as gradation of 58100 gammas to 59000 gammas with the strongest responses being near Phil Lake, (59000 Gammas).

Ground filtered VLF-EM survey data indicates four linear east-west trends with values of 30 MOHS. Dighem IV survey results are shown on Plan No.6 with ground filtered results shown on Plan No 5 included in appendix C.

As stated on pages 4-12 of the Dighem report by David E. Pritchard Sept. 13, 1990 "the R-B Block contains no bedrock conductors. There are several anomalies indicated by "S?" which may be related to subsurface strata, but these are not discrete".

9.0 RECOMMENDATIONS

Follow up field work is recommended on the Phil claims as suggested by the Dighem Survey. Soil samples collected in the field program should be analyzed for copper, and gold. Additional detailed work will follow.

Appendix A

Cost Statement

COST STATEMENT

Period:	Sept 14 to Oct 10, 1990		
Personnel:	J.J. Poloni	Field Mang/VLF	$ 6750.00
	A.R. Raven	Surveying/Expediting	3000.00
	C.R. Poloni	Mag/Line Cutting	4725.00
	E. Raven	Cook	3825.00
	J. Aurundel	Line Cutting/Soils	3375.00
	J. Carmichael	Line Cutting/Soils	3375.00
		Total	$25,050.00
Airgeophysics:	Dighem 140 LIne Km @ $80.00		11,200.00
Report:	J. R. Poloni, P. Eng.		2,200.00
Camp:	144 Man Days @ $75.00		10,800.00
Equipment Rental:	Boat, Trucks, etc.		6,580.00
Transport.:	Mob & Demob		3,156.33
Drafting - Sec & Misc.			600.00
			$59,586.33

Respectfully submitted,

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J. R. POLONI

John R Poloni, P. Eng.

Appendix B

Certificate

CERTIFICATE

I, John R. Poloni, of 5502-8B Avenue, in the Municipality of Delta, in the Province of British Columbia,

DO HEREBY CERTIFY THAT:

1. I am a Consulting Geologist.
2. I am a graduate of McGill University of Montreal, Quebec, where I obtained a B.Sc. Degree in Geology in 1964.
3. I am a Registered Professional Engineer in the Geological Section of the Association of Professional Engineers of the Province of British columbia.
4. I have practiced my profession since 1964.
5. I am a member of the Canadian Institute of Mining and Metallurgy.
6. I have not personally visited the Phil claims but have reviewed the survey data.

Dated this 11th day of March, 1991

John R. Poloni, B.Sc., P.Eng.

APPENDIX C

MAPS		SCALE
~~Plan No, 3~~	~~Claim Map~~	~~1: 50,000~~
~~Plan No. 4~~	~~Survey and Sample~~ Location Plan	~~1: 5000~~ (a blank) T.K.
Plan No. 5	Filtered VLF-EM	1: 5000
Plan No. 6	Magnetometer Survey	1: 5000
Plan No. 7	Total Field Magnetics	As shown
Plan No. 8	Resistivity Plan	As shown
Plan No. 9	Filtered VLF-EM	As shown

Report #1089

DIGHEM^{IV} SURVEY

FOR

JEFFCO HOLDINGS LTD.

FORT ST. JAMES, BRITISH COLUMBIA

NTS 93J/13, 93K/16, 93O/4

DIGHEM SURVEYS & PROCESSING INC.
MISSISSAUGA, ONTARIO
September 13, 1990

David E. Pritchard
Geophysicist

A1089SEP.91R

SUMMARY

This report describes the logistics and results of a DIGHEM^{IV} airborne geophysical survey carried out for Jeffco Holdings Ltd., over properties located near Fort St. James, British Columbia. Total coverage of the survey blocks amounted to 279 km. The survey was flown from June 20 to June 25, 1990.

The purpose of the survey was to detect zones of conductive mineralization and to provide information that could be used to map the geology and structure of the survey areas. This was accomplished by using a DIGHEM^{IV} multi-coil, multi-frequency electromagnetic system, supplemented by a high sensitivity Cesium magnetometer and a two-channel VLF receiver. The information from these sensors was processed to produce maps which display the magnetic and conductive properties of the survey areas. An electronic navigation system, operating in the UHF band, ensured accurate positioning of the geophysical data with respect to the base maps. Visual flight path recovery techniques were used in areas where transponder signals were blocked by topographic features.

The survey properties contain few anomalous features. Most of the anomalous responses appear to warrant further investigation using appropriate surface exploration

techniques. Areas of interest may be assigned priorities on the basis of supporting geophysical, geochemical and/or geological information. After initial investigations have been carried out, it may be necessary to re-evaluate the remaining anomalies based on information acquired from the follow-up program.

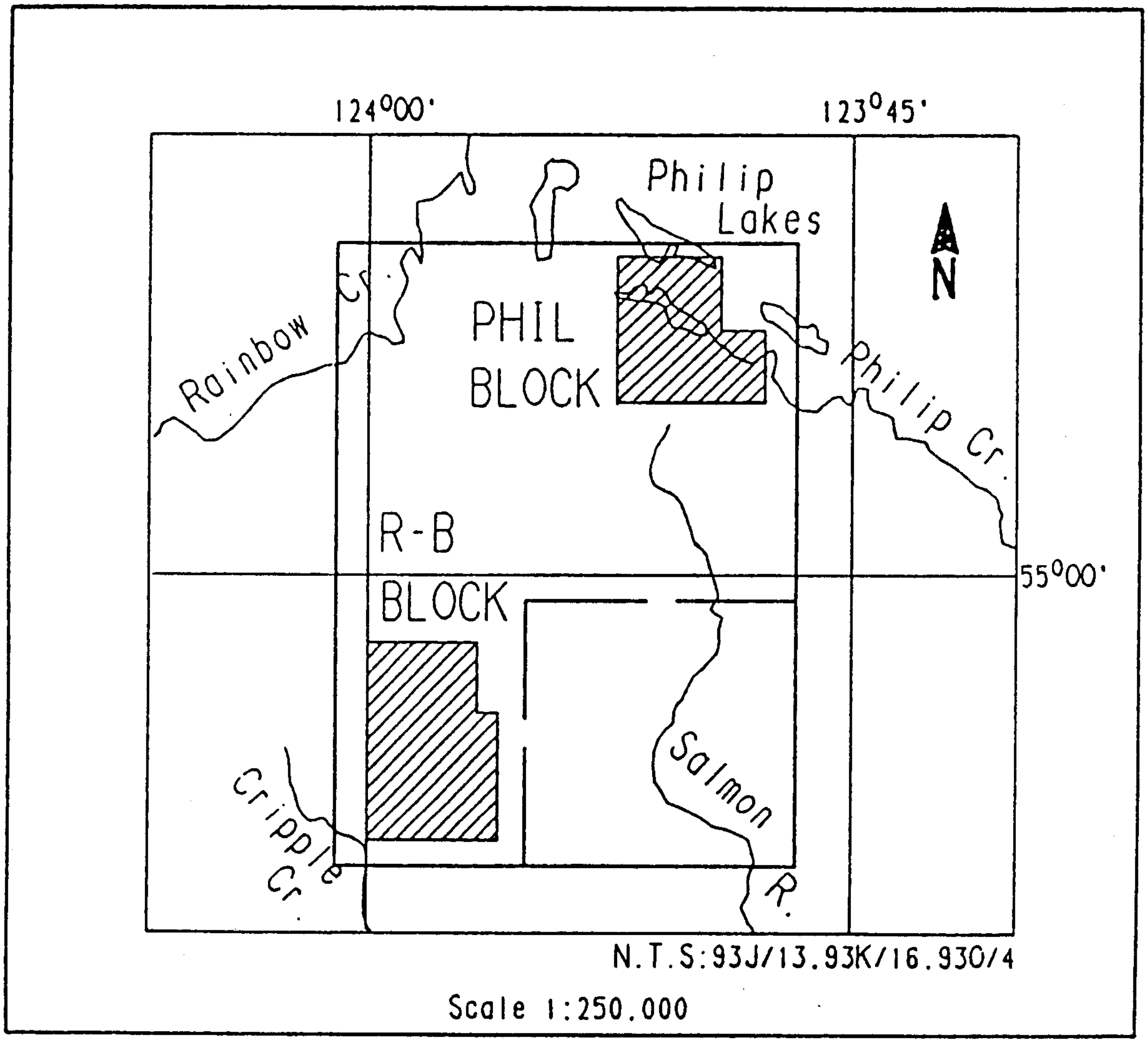


FIGURE 1

THE SURVEY AREAS

CONTENTS

INTRODUCTION

A DIGHEM^{IV} electromagnetic/resistivity/magnetic/VLF survey was flown for Jeffco Holdings Ltd. from June 20 to June 25, 1990, over two survey blocks located near Fort St. James, British Columbia. The survey areas can be located on NTS map sheets 93J/13, 93K/16 and 93O/4. (See Figure 1).

Survey coverage consisted of approximately 279 line-km, including tie lines. Flight lines were flown in an azimuthal direction of 090/270° with a line separation of 200 metres.

The survey employed the DIGHEM^{IV} electromagnetic system. Ancillary equipment consisted of a magnetometer, radar altimeter, video camera, analog and digital recorders, a VLF receiver and an electronic navigation system. Details on the survey equipment are given in Section 2.

The instrumentation was installed in an Aerospatiale AS350B turbine helicopter (Registration C-GNIX) which was provided by Questral Helicopters Ltd. The helicopter flew at an average airspeed of 125 km/h with an EM bird height of approximately 30 m.

Section 2 also provides details on the data channels, their respective sensitivities, and the navigation/flight path recovery procedure. Noise levels of less than 2 ppm are generally maintained for wind speeds up to 35 km/h. Higher winds may cause the system to be grounded because excessive bird swinging produces difficulties in flying the helicopter. The swinging results from the 5 m^2 of area which is presented by the bird to broadside gusts.

In some portions of the survey area, the steep topography forced the pilot to exceed normal terrain clearance for reasons of safety. It is possible that some weak conductors may have escaped detection in areas where the bird height exceeded 120 m. In difficult areas where near-vertical climbs were necessary, the forward speed of the helicopter was reduced to a level which permitted excessive bird swinging. This problem, combined with the severe stresses to which the bird was subjected, gave rise to aerodynamic noise levels which are slightly higher than normal. Where warranted, reflights were carried out to minimize these adverse effects.

SURVEY EQUIPMENT

This section provides a brief description of the geophysical instruments used to acquire the survey data:

Electromagnetic System

Model:	DIGHEM IV
Type:	Towed bird, symmetric dipole configuration operated at a nominal survey altitude of 30 metres. Coil separation is 8 metres for 900 Hz and 7200 Hz, and 6.3 metres for the 56,000 Hz coil-pair.
Coil orientations/frequencies:	coaxial / 900 Hz coplanar/ 900 Hz coplanar/ 7,200 Hz coplanar/56,000 Hz
Channels recorded:	4 inphase channels 4 quadrature channels 2 monitor channels
Sensitivity:	0.2 ppm at 900 Hz 0.4 ppm at 7,200 Hz 1.0 ppm at 56,000 Hz
Sample rate:	10 per second

The electromagnetic system utilizes a multi-coil coaxial/coplanar technique to energize conductors in different directions. The coaxial transmitter coil is vertical with its axis in the flight direction. The coplanar coils are horizontal. The secondary fields are sensed simultaneously by means of receiver coils which are maximum coupled to their respective transmitter coils. The system yields an inphase and a quadrature channel from each transmitter-receiver coil-pair.

Magnetometer

Model:	Picodas 3340
Type:	Optically pumped Cesium vapour
Sensitivity:	0.01 nT
Sample rate:	10 per second

The magnetometer sensor is towed in a bird 15 m below the helicopter.

Magnetic Base Station

Model:	Scintrex MP-3
Type:	Digital recording proton precession
Sensitivity:	0.10 nT
Sample rate:	0.2 per second

A digital recorder is operated in conjunction with the base station magnetometer to record the diurnal variations of the earth's magnetic field. The clock of the base station is synchronized with that of the airborne system to permit subsequent removal of diurnal drift.

VLF System

Manufacturer:	Herz Industries Ltd.	
Type:	Totem-2A	
Sensitivity:	0.1%	
Stations:	Seattle, Washington;	NLK, 24.8 kHz
	Lualualei, Hawaii;	NPM, 23.4 kHz

The VLF receiver measures the total field and vertical quadrature components of the secondary VLF field. Signals from two separate transmitters can be measured simultaneously. The VLF sensor is towed in a bird 10 m below the helicopter.

Radar Altimeter

Manufacturer:	Honeywell/Sperry
Type:	AA 220
Sensitivity:	1 ft

The radar altimeter measures the vertical distance between the helicopter and the ground. This information is used in the processing algorithm which determines conductor depth.

Analog Recorder

Manufacturer: RMS Instruments

Type: DGR33 dot-matrix graphics recorder

Resolution: 4x4 dots/mm

Speed: 1.5 mm/sec

The analog profiles were recorded on chart paper in the aircraft during the survey. Table 2-1 lists the geophysical data channels and the vertical scale of each profile.

Digital Data Acquisition System

Manufacturer: RMS Instruments

Type: DGR 33

Tape Deck: RMS TCR-12, 6400 bpi, tape cartridge recorder

The digital data were used to generate several computed parameters. Both measured and computed parameters were plotted as "digital profiles" during data processing. These parameters are shown in Table 2-2.

In Table 2-2, the log resistivity scale of 0.06 decade/mm means that the resistivity changes by an order of magnitude in 16.6 mm. The resistivities at 0, 33 and 67 mm up from the bottom of the digital profile are respectively 1, 100 and 10,000 ohm-m.

Table 2-1. The Analog Profiles

Channel Name	Parameter	Scale units/mm	Designation on digital profile
1X9I	coaxial inphase (900 Hz)	2.5 ppm	CXI (900 Hz)
1X9Q	coaxial quad (900 Hz)	2.5 ppm	CXQ (900 Hz)
3P9I	coplanar inphase (900 Hz)	2.5 ppm	CPI (900 Hz)
3P9Q	coplanar quad (900 Hz)	2.5 ppm	CPQ (900 Hz)
2P7I	coplanar inphase (7200 Hz)	5 ppm	CPI (7200 Hz)
2P7Q	coplanar quad (7200 Hz)	5 ppm	CPQ (7200 Hz)
4P5I	coplanar inphase(56000 Hz)	10 ppm	CPI (56 kHz)
4P5Q	coplanar quad (56000 Hz)	10 ppm	CPQ (56 kHz)
ALTR	altimeter	3 m	ALT
CMGC	magnetics, coarse	25 nT	MAG
CMGF	magnetics, fine	2.5 nT	
VF1T	VLF-total: primary stn.	2%	
VF1Q	VLF-quad: primary stn.	2%	
VF2T	VLF-total: secondary stn.	2%	
VF2Q	VLF-quad: secondary stn.	2%	
CXSP	coaxial sferics monitor		CXS
CPSP	coplanar sferics monitor		CPS
CXPL	coaxial powerline monitor		CXP
CPPL	coplanar powerline monitor		CPP

Table 2-2. The Digital Profiles

Channel Name (Freq)		Observed parameters	Scale units/mm
MAG		magnetics	10 nT
ALT		bird height	6 m
CXI	(900 Hz)	vertical coaxial coil-pair inphase	2 ppm
CXQ	(900 Hz)	vertical coaxial coil-pair quadrature	2 ppm
CPI	(900 Hz)	horizontal coplanar coil-pair inphase	2 ppm
CPQ	(900 Hz)	horizontal coplanar coil-pair quadrature	2 ppm
CPI	(7200 Hz)	horizontal coplanar coil-pair inphase	4 ppm
CPQ	(7200 Hz)	horizontal coplanar coil-pair quadrature	4 ppm
CPI	(56 kHz)	horizontal coplanar coil-pair inphase	10 ppm
CPQ	(56 kHz)	horizontal coplanar coil-pair quadrature	10 ppm
CXS		coaxial sferics monitor	
CXP		coaxial powerline monitor	
		Computed Parameters	
DFI	(900 Hz)	difference function inphase from CXI and CPI	2 ppm
DFQ	(900 Hz)	difference function quadrature from CXQ and CPQ	2 ppm
RES	(900 Hz)	log resistivity	.06 decade
RES	(7200 Hz)	log resistivity	.06 decade
RES	(56 kHz)	log resistivity	.06 decade
DP	(900 Hz)	apparent depth	6 m
DP	(7200 Hz)	apparent depth	6 m
DP	(56 kHz)	apparent depth	6 m
CDT		conductance	1 grade

Tracking Camera

Type: Panasonic Video

Model: AG 2400/WVCD132

Fiducial numbers and time are recorded continuously and are displayed at the lower border of the video image. This procedure ensures accurate correlation of analog and digital data with respect to visible features on the ground.

Navigation System

Model: Del Norte 547

Type: UHF electronic positioning system

Sensitivity: 1 m

Sample rate: 1 per second

The navigation system uses ground based transponder stations which transmit distance information back to the helicopter. The ground stations are set up well away from the survey area and are positioned such that the signals cross the survey block at an angle between 30° and 150°. The onboard Central Processing Unit takes any two transponder distances and determines the helicopter position relative to these two ground stations in cartesian coordinates.

The cartesian coordinates are transformed to UTM coordinates during data processing. This is accomplished by correlating a number of prominent topographical locations with the navigational data points. The use of numerous visual tie points serves two purposes: to accurately relate the navigation data to the map sheet and to minimize location errors which might result from distortions in uncontrolled photomosaic base maps.

PRODUCTS AND PROCESSING TECHNIQUES

The following products are available from the survey data. Those which are not part of the survey contract may be acquired later. Refer to Table 3-1 for a summary of the maps which accompany this report, some of which may be sent under separate cover. Most parameters can be displayed as contours, profiles, or in colour.

Base Maps

Base maps of the survey area have been produced from published topographic maps. These provide a relatively accurate, distortion-free base which facilitates correlation of the navigation data to the UTM grid. Photomosaics are useful for visual reference and for subsequent flight path recovery, but usually contain scale distortions. Orthophotos are ideal, but their cost and the time required to produce them, usually precludes their use as base maps.

Electromagnetic Anomalies

Anomalous electromagnetic responses are selected and analysed by computer to provide a preliminary electromagnetic anomaly map. This preliminary map is used, by the

Table 3-1 Plots Available from the Survey

MAP PRODUCT / NO. OF SHEETS	ANOMALY MAP	PROFILES ON MAP	CONTOURS		SHADOW MAP
			INK	COLOUR	
Electromagnetic Anomalies	20,000	N/A	N/A	N/A	N/A
Probable Bedrock Conductors	-	N/A	N/A	N/A	N/A
Resistivity (900 Hz)	N/A	-	20,000	-	-
Resistivity (7,200 Hz)	N/A	-	20,000	20,000	-
Resistivity (56,000 Hz)	N/A	-	20,000	-	-
EM Magnetite	N/A	-	-	-	-
Total Field Magnetics	N/A	-	20,000	20,000	*
Enhanced Magnetics	N/A	-	20,000	-	-
1st Vertical Derivative Magnetics	N/A	-	*	*	-
2nd Vertical Derivative Magnetics	N/A	-	-	-	-
Filtered Total Field VLF	N/A	-	20,000	20,000	-
VLF Profiles	N/A	-	-	-	-
Electromagnetic Profiles(900 Hz)	N/A	-	-	N/A	N/A
Electromagnetic Profiles(7200 Hz)	N/A	-	-	N/A	N/A
Digital Profiles	Worksheet profiles				20,000
	Interpreted profiles				-

N/A Not available
- Not required under terms of the survey contract
* Recommended
20,000 Scale of delivered map, i.e, 1:20,000

Notes:

- Inked contour maps are provided on transparent media and show flight lines, EM anomalies and suitable registration. Two paper prints of each map are supplied.

geophysicist, in conjunction with the computer-generated digital profiles, to produce the final interpreted EM anomaly map.

Resistivity

The apparent resistivity in ohm-m was generated from the inphase and quadrature EM components for the three coplanar coil-pairs, using a pseudo-layer halfspace model. The resistivity maps portray all the EM information for each frequency over both survey blocks. This contrasts with the electromagnetic anomaly map which provides information only over interpreted conductors. The large dynamic range makes the resistivity parameter an excellent mapping tool.

EM Magnetite

The apparent percent magnetite by weight is computed wherever magnetite produces a negative inphase EM response.

Total Field Magnetics

The aeromagnetic data are corrected for diurnal variation using the magnetic data collected at a base station. The regional IGRF can be removed from the data, if requested.

Enhanced Magnetics

The total field magnetic data are subjected to a processing algorithm. This algorithm enhances the response of magnetic bodies in the upper 500 m and attenuates the response of deeper bodies. The resulting enhanced magnetic map provides better definition and resolution of near-surface magnetic units. It also identifies weak magnetic features which may not be evident on the total field magnetic map. However, regional magnetic variations, and magnetic lows caused by remanence, are better defined on the total field magnetic map. The technique is described in more detail in Section 5.

Magnetic Derivatives

The total field magnetic data may be subjected to a variety of filtering techniques to yield maps of the following:

vertical gradient
second vertical derivative
magnetic susceptibility with reduction to the pole
upward/downward continuations

All of these filtering techniques improve the recognition of near-surface magnetic bodies, with the exception of upward continuation. Any of these parameters can be produced on request. Dighem's proprietary enhanced magnetic technique is designed to provide a general "all-purpose" map, combining the more useful features of the above parameters.

VLF

The VLF data are digitally filtered to remove long wavelengths such as those caused by variations in the transmitted field strength.

Digital Profiles

Distance-based profiles of the digitally recorded geophysical data are generated and plotted by computer. These profiles also contain the calculated parameters which are used in the interpretation process. These are produced as worksheets prior to interpretation, and can also be presented in the final corrected form after interpretation. The profiles display electromagnetic anomalies with their respective interpretive symbols. The differences between the worksheets and the final corrected form occur only with respect to the EM anomaly identifier.

Contour, Colour and Shadow Map Displays

The geophysical data are interpolated onto a regular grid using an akima spline technique. The resulting grid is suitable for generating contour maps of excellent quality.

Colour maps are produced by interpolating the grid down to the pixel size. The parameter is then incremented with respect to specific amplitude ranges to provide colour "contour" maps. Colour maps of the total magnetic field are particularly useful in defining the lithology of the survey area.

Monochromatic shadow maps are generated by employing an artificial sun to cast shadows on a surface defined by the geophysical grid. There are many variations in the shadowing technique. These techniques may be applied to total field or enhanced magnetic data, magnetic derivatives, VLF, resistivity, etc. Of the various magnetic products, the shadow of the enhanced magnetic parameter is particularly suited for defining geological structures with crisper images and improved resolution.

SURVEY RESULTS

GENERAL DISCUSSION

The survey results are presented on 1 map sheet for each parameter at a scale of 1:20,000. Tables 4-1 and 4-2 summarize the EM responses in the survey areas, with respect to conductance grade and interpretation.

The anomalies shown on the electromagnetic anomaly map are based on a near-vertical, half plane model. This model best reflects "discrete" bedrock conductors. Wide bedrock conductors or flat-lying conductive units, whether from surficial or bedrock sources, may give rise to very broad anomalous responses on the EM profiles. These may not appear on the electromagnetic anomaly map if they have a regional character rather than a locally anomalous character. These broad conductors, which more closely approximate a half space model, will be maximum coupled to the horizontal (coplanar) coil-pair and should be more evident on the resistivity parameter. Resistivity maps, therefore, may be more valuable than the electromagnetic anomaly maps, in areas where broad or flat-lying conductors are considered to be of importance. Contoured resistivity maps, based on the 900 Hz, 7200 Hz and 56,000 Hz coplanar data are included with this report.

TABLE 4-1

EM ANOMALY STATISTICS

R-B BLOCK

CONDUCTOR GRADE	CONDUCTANCE RANGE SIEMENS (MHOS)	NUMBER OF RESPONSES
7	> 100	0
6	50 - 100	0
5	20 - 50	0
4	10 - 20	0
3	5 - 10	0
2	1 - 5	2
1	< 1	5
*	INDETERMINATE	25
TOTAL		32

CONDUCTOR MODEL	MOST LIKELY SOURCE	NUMBER OF RESPONSES
S	CONDUCTIVE COVER	32
TOTAL		32

(SEE EM MAP LEGEND FOR EXPLANATIONS)

TABLE 4-2

EM ANOMALY STATISTICS

PHIL BLOCK

CONDUCTOR GRADE	CONDUCTANCE RANGE SIEMENS (MHOS)	NUMBER OF RESPONSES
7	> 100	0
6	50 - 100	0
5	20 - 50	0
4	10 - 20	0
3	5 - 10	3
2	1 - 5	21
1	< 1	35
*	INDETERMINATE	8
TOTAL		67

CONDUCTOR MODEL	MOST LIKELY SOURCE	NUMBER OF RESPONSES
B	DISCRETE BEDROCK CONDUCTOR	4
S	CONDUCTIVE COVER	63
TOTAL		67

(SEE EM MAP LEGEND FOR EXPLANATIONS)

Excellent resolution and discrimination of conductors was accomplished by using a fast sampling rate of 0.1 sec and by employing a common frequency (900 Hz) on two orthogonal coil-pairs (coaxial and coplanar). The resulting "difference channel" parameters often permit differentiation of bedrock and surficial conductors, even though they may exhibit similar conductance values.

Anomalies which occur near the ends of the survey lines (i.e., outside the survey area), should be viewed with caution. Some of the weaker anomalies could be due to aerodynamic noise, i.e., bird bending, which is created by abnormal stresses to which the bird is subjected during the climb and turn of the aircraft between lines. Such aerodynamic noise is usually manifested by an anomaly on the coaxial inphase channel only, although severe stresses can affect the coplanar inphase channels as well.

Magnetics

A Scintrex MP-3 proton precession magnetometer was operated at the survey base to record diurnal variations of the earth's magnetic field. The clock of the base station was synchronized with that of the airborne system to permit subsequent removal of diurnal drift.

The total field magnetic data have been presented as contours on the base map using a contour interval of 10 nT where gradients permit. The map shows the magnetic properties of the rock units underlying the survey areas.

The total field magnetic data have been subjected to a processing algorithm to produce an enhanced magnetic map. This procedure enhances near-surface magnetic units and suppresses regional gradients. It also provides better definition and resolution of magnetic units and displays weak magnetic features which may not be clearly evident on the total field maps. Maps of the vertical magnetic derivatives can also be prepared from existing survey data, if requested.

The total field magnetic map for the Phil and R-B Blocks displays background levels of approximately 58,000 nT. The R-B Block contains low gradient magnetic units. The units appear to trend northeast/southwest from line 10010 at fiducial 2470 to line 10330 at fiducial 1730. The eastern half of the block displays total field magnetic values lower than 58,000 nT, with the exception of an anomaly in the northwest corner of the block. This magnetic high peaks at 58,150 nT.

The eastern unit in the grid, marked by the 58,000 nT contour, is somewhat more active. Its dominant feature is a high trending northeast from line 10110 at fiducial 1128 to line 10190 at fiducial 3538. This high coincides with a resistive unit evident on the resistivity maps.

The Phil Block is somewhat more magnetically active. The magnetic map and its colour image display structural breaks which criss-cross the grid. A magnetic high trending northeast extends from line 20190 at fiducial 1000 to line 20250 at fiducial 4960. Paralleling this high to the south is a magnetic low lineation. It bisects the southwestern magnetically active area. The lineation extends from fiducial 2680 on line 20140 to fiducial 2260 on line 20290.

The main axis of the central magnetic unit extends northwest from line 20190 at fiducial 1056 to the northwest corner of the block. A second lineation intersects this axis at line 20320 at fiducial 1996. These breaks may represent a series of separate rock units. A magnetic low loosely paralleling the central zone to the northeast reflects a conductive zone seen on the 900 Hz and 7200 Hz resistivity maps which represent a subsurface geologic unit.

If a specific magnetic intensity can be assigned to the rock type which is believed to host the target mineralization, it may be possible to select areas of higher priority on the basis of the total field magnetic data. This is based on the assumption that the magnetite content of the host rocks will give rise to a limited range of contour values which will permit differentiation of various lithological units.

The magnetic results, in conjunction with the other geophysical parameters, should provide valuable information which can be used to effectively map the geology and structure in the survey areas.

VLF

VLF results were obtained from the transmitting stations at Seattle, Washington (NLK - 24.8 kHz) and Lualualei, Hawaii (NPM - 23.4 kHz). The VLF maps show the contoured results of the filtered total field from Lualualei, Hawaii (NPM) for the R-B Block. In the Phil Block, signals from Seattle, Washington (NLK) were used. There was no valid VLF signal available for survey lines 20190 through 20210.

The VLF method is quite sensitive to the angle of coupling between the conductor and the propogated EM field. Consequently, conductors which strike towards the VLF station will usually yield a stronger response than conductors which are nearly orthogonal to it. The general northeast strike in the survey area provides good coupling with the VLF field from NPM, and adequate coupling with NLK.

The VLF parameter does not normally provide the same degree of resolution available from the EM data. Closely-spaced conductors, conductors of short strike length or conductors which are poorly coupled to the VLF field, may escape detection with this method. Erratic signals from the VLF transmitters can also give rise to strong, isolated anomalies which should be viewed with caution. Regardless of these limitations, however, the VLF results have provided valuable additional information, particularly within the more resistive portions of the survey area. The VLF method could probably be used as a follow-up tool in most areas, although its effectiveness will be somewhat limited in areas of moderate to high conductivity. The filtered total field VLF contours are presented on the base map with a contour interval of one percent.

<u>Resistivity</u>

Resistivity maps, which display the conductive properties of the survey area, were produced from the 900 Hz, 7200 Hz and 56,000 Hz coplanar data. In general, the resistivity patterns show limited correlation with the magnetic trends. This suggests that many of the resistivity lows are probably not related to bedrock features, but may be influenced by conductive overburden.

The resistivity lows in the areas reflect "formational" conductors which may be of minor interest as direct exploration targets. However, attention may be focused on areas where these zones appear to be faulted or folded.

The R-B Block displays a conductive zone roughly outlined by a 1000 ohm-m contour. This zone extends from the southwest corner to the northeast along a river valley. The zone is defined with greater detail at the higher frequencies suggesting that it is surficial. No other conductive zones are evident.

The resistivity maps for all three frequencies over the Phil Block display the surficial swamp material and lake sediments in the northwest and east-central portions of the grid.

Electromagnetics

The EM anomalies resulting from this survey appear to fall within two general categories. The first type consists of weakly defined anomalies which yield marked inflections on the difference channels. These anomalies are usually attributed to conductive sulphides or graphite and are generally given a "B" interpretive symbol, denoting a bedrock source.

The second class of anomalies comprises moderately broad responses which exhibit the characteristics of a half space and do not yield well-defined inflections on the difference channels. Anomalies in this category are usually given an "S" or "H" interpretive symbol. The lack of a difference channel response usually implies a broad or flat-lying conductive source such as overburden. Some of these anomalies may reflect conductive rock units or zones of deep weathering.

The effects of conductive overburden are evident over portions of the survey areas. Although the difference channels (DFI and DFQ) are extremely valuable in detecting bedrock conductors which are partially masked by conductive overburden, sharp undulations in the bedrock/overburden interface can yield anomalies in the difference channels which may be interpreted as possible bedrock conductors. Such anomalies usually fall into the "S?" or "B?" classification but may also be given an "E" interpretive symbol, denoting a resistivity contrast at the edge of a conductive unit.

In areas where EM responses are evident primarily on the quadrature components, zones of poor conductivity are indicated. Where these responses are coincident with magnetic anomalies, it is possible that the inphase component amplitudes have been suppressed by the effects of magnetite. Most of these poorly-conductive magnetic features give rise to resistivity anomalies which are only slightly below background. If it is expected that poorly-conductive economic mineralization may be associated with magnetite-rich units, most of these weakly anomalous features will be of interest. In areas where magnetite causes the inphase components to become negative, the apparent conductance and depth of EM anomalies may be unreliable.

As economic mineralization within the areas may be associated with massive to weakly disseminated sulphides, which may or may not be hosted by magnetite-rich rocks, it is difficult to assess the relative merits of EM anomalies on the basis of conductance. It is recommended that an attempt be made to compile a suite of geophysical "signatures" over areas of interest. Anomaly characteristics are clearly defined on the computer-processed geophysical data profiles which are supplied as one of the survey products.

A complete assessment and evaluation of the survey data should be carried out by one or more qualified professionals who have access to, and can provide a meaningful compilation of, all available geophysical, geological and geochemical data.

CONDUCTORS IN THE SURVEY AREA

The electromagnetic anomaly map shows the anomaly locations with the interpreted conductor type, dip, conductance and depth being indicated by symbols. Direct magnetic correlation is also shown if it exists. The strike direction and length of the conductors are indicated when anomalies can be correlated from line to line. When studying the map sheet, consult the anomaly listings appended to this report.

The R-B Block contains no bedrock conductors. There are several anomalies indicated by "S?" which may be related to subsurface strata, but these are not discrete.

The Phil Block also has several anomalies indicated as "S?" which should be looked at in greater detail. There are four anomalies which exhibit characteristics of bedrock conductors. They are indicated by "B" and "B?" and are located on line 20270 at fiducial 2868, line 20370 at fiducial 1065 and line 20390 at fiducials 1480 and 1494. These are relatively weak conductors but do have some inphase response. Anomaly 20390B shows typically how the bedrock anomalies are indicated by the DFI and DFQ channels on the Interpreted Digital Profiles. This anomaly is attributed to a thin bedrock source, with the peak from the coaxial coil-pair coinciding with a trough indicated on the trace from the coplanar coil-pair.

BACKGROUND INFORMATION

This section provides background information on parameters which are available from the survey data. Those which have not been supplied as survey products may be generated later from raw data on the digital archive tape.

ELECTROMAGNETICS

DIGHEM electromagnetic responses fall into two general classes, discrete and broad. The discrete class consists of sharp, well-defined anomalies from discrete conductors such as sulfide lenses and steeply dipping sheets of graphite and sulfides. The broad class consists of wide anomalies from conductors having a large horizontal surface such as flatly dipping graphite or sulfide sheets, saline water-saturated sedimentary formations, conductive overburden and rock, and geothermal zones. A vertical conductive slab with a width of 200 m would straddle these two classes.

The vertical sheet (half plane) is the most common model used for the analysis of discrete conductors. All anomalies plotted on the electromagnetic map are analyzed according to this model. The following section entitled **Discrete Conductor Analysis** describes this model in detail, including the effect of using it on anomalies caused by broad conductors such as conductive overburden.

The conductive earth (half space) model is suitable for broad conductors. Resistivity contour maps result from the use of this model. A later section entitled **Resistivity Mapping** describes the method further, including the effect of using it on anomalies caused by discrete conductors such as sulfide bodies.

Geometric interpretation

The geophysical interpreter attempts to determine the geometric shape and dip of the conductor. Figure 5-1 shows typical DIGHEM anomaly shapes which are used to guide the geometric interpretation.

Discrete conductor analysis

The EM anomalies appearing on the electromagnetic map are analyzed by computer to give the conductance (i.e., conductivity-thickness product) in siemens (mhos) of a vertical sheet model. This is done regardless of the interpreted geometric shape of the conductor. This is not an unreasonable procedure, because the computed conductance increases as the electrical quality of the conductor increases, regardless of its true shape. DIGHEM anomalies

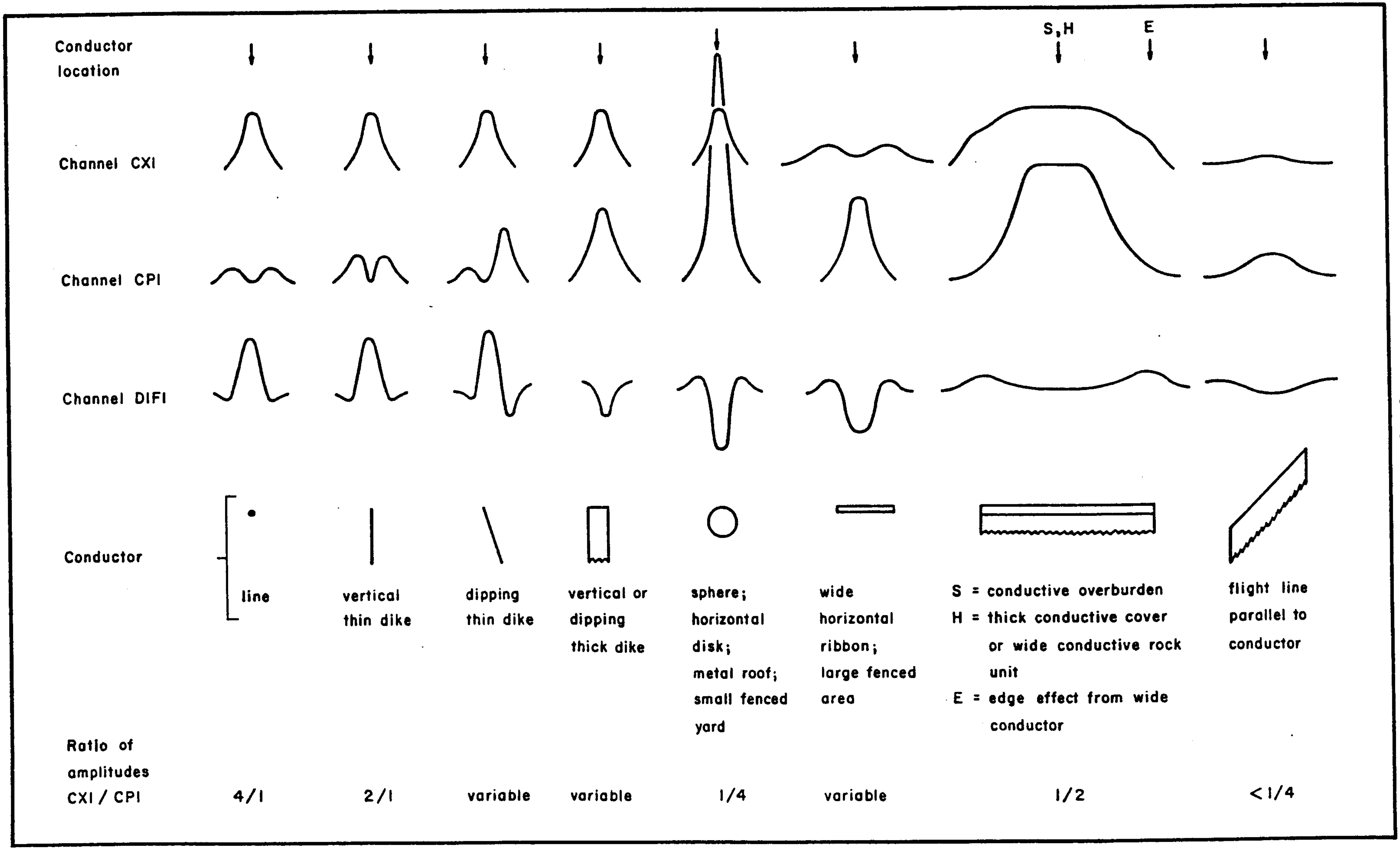


Fig. 5-1 Typical DIGHEM anomaly shapes

are divided into seven grades of conductance, as shown in Table 5-1 below. The conductance in siemens (mhos) is the reciprocal of resistance in ohms.

Table 5-1. EM Anomaly Grades

Anomaly Grade	siemens
7	> 100
6	50 - 100
5	20 - 50
4	10 - 20
3	5 - 10
2	1 - 5
1	< 1

The conductance value is a geological parameter because it is a characteristic of the conductor alone. It generally is independent of frequency, flying height or depth of burial, apart from the averaging over a greater portion of the conductor as height increases. Small anomalies from deeply buried strong conductors are not confused with small anomalies from shallow weak conductors because the former will have larger conductance values.

Conductive overburden generally produces broad EM responses which may not be shown as anomalies on the EM maps. However, patchy conductive overburden in otherwise resistive areas can yield discrete anomalies with a conductance grade (cf. Table 5-1) of 1, 2 or even 3 for conducting clays which have resistivities as low as 50 ohm-m. In areas where ground resistivities are below 10 ohm-m, anomalies caused by weathering variations and similar causes can have any conductance grade. The anomaly shapes from the multiple coils often allow such conductors to be recognized, and these are indicated by the letters S, H, and sometimes E on the electromagnetic anomaly map (see EM map legend).

For bedrock conductors, the higher anomaly grades indicate increasingly higher conductances. Examples: DIGHEM's New Insco copper discovery (Noranda, Canada) yielded a grade 5 anomaly, as did the neighbouring copper-zinc Magusi River ore body; Mattabi (copper-zinc, Sturgeon Lake, Canada) and Whistle (nickel, Sudbury, Canada) gave grade 6; and DIGHEM's Montcalm nickel-copper discovery (Timmins, Canada) yielded a grade 7 anomaly. Graphite and sulfides can span all grades but, in any particular survey area, field work may show that the different grades indicate different types of conductors.

Strong conductors (i.e., grades 6 and 7) are characteristic of massive sulfides or graphite. Moderate conductors (grades 4 and 5) typically reflect graphite or sulfides of a less massive character, while weak bedrock conductors (grades 1 to 3) can signify poorly connected graphite or heavily disseminated sulfides. Grades 1 and 2 conductors may not respond to ground EM equipment using frequencies less than 2000 Hz.

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductances. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near Bathurst, Canada, yielded a well-defined grade 2 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine grained massive pyrite, thereby inhibiting electrical conduction.

Faults, fractures and shear zones may produce anomalies which typically have low conductances (e.g., grades 1 to 3). Conductive rock formations can yield anomalies of any conductance grade. The conductive materials in such rock formations can be salt water, weathered products such as clays, original depositional clays, and carbonaceous material.

On the interpreted electromagnetic map, a letter identifier and an interpretive symbol are plotted beside the EM grade symbol. The horizontal rows of dots, under the interpretive symbol, indicate the anomaly amplitude on the flight record. The vertical column of dots, under the anomaly letter, gives the estimated depth. In areas where anomalies are crowded, the letter identifiers, interpretive symbols and dots may be obliterated. The EM grade symbols, however, will always be discernible, and the obliterated information can be obtained from the anomaly listing appended to this report.

The purpose of indicating the anomaly amplitude by dots is to provide an estimate of the reliability of the conductance calculation. Thus, a conductance value obtained from a large ppm anomaly (3 or 4 dots) will tend to be accurate whereas one obtained from a small ppm anomaly (no dots) could be quite inaccurate. The absence of amplitude dots indicates that the anomaly from the coaxial coil-pair is 5 ppm or less on both the inphase and quadrature channels. Such small anomalies could reflect a weak conductor at the surface or a stronger conductor at depth. The conductance grade and depth estimate illustrates which of these possibilities fits the recorded data best.

Flight line deviations occasionally yield cases where two anomalies, having similar conductance values but dramatically different depth estimates, occur close together on the same conductor. Such examples illustrate the reliability of the conductance measurement while showing that the depth estimate can be unreliable. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, overlying conductive overburden, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be deeper or to one side of the flight line, or because it has a shallow dip. A heavy tree cover can also produce errors in depth estimates. This is because the depth estimate is computed as the distance of bird from conductor, minus the altimeter reading. The altimeter can lock onto the top of a dense forest canopy. This situation yields an erroneously large depth estimate but does not affect the conductance estimate.

Dip symbols are used to indicate the direction of dip of conductors. These symbols are used only when the anomaly shapes are unambiguous, which usually requires a fairly resistive environment.

A further interpretation is presented on the EM map by means of the line-to-line correlation of anomalies, which is based on a comparison of anomaly shapes on adjacent lines. This provides conductor axes which may define the geological structure over portions of the survey area. The absence of conductor axes in an area implies that anomalies could not be correlated from line to line with reasonable confidence.

DIGHEM electromagnetic maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a follow-up program. The actual conductance values are printed in the attached anomaly list for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of conductors in terms of length, strike and dip, geometric shape, conductance, depth, and thickness. The accuracy is comparable to an interpretation from a high quality ground EM survey having the same line spacing.

The attached EM anomaly list provides a tabulation of anomalies in ppm, conductance, and depth for the vertical sheet model. The EM anomaly list also shows the conductance and depth for a thin horizontal sheet (whole plane) model, but only the vertical sheet parameters appear on the EM map. The horizontal sheet model is suitable for a flatly dipping thin bedrock conductor such as a sulfide sheet having a thickness less than 10 m. The list also shows the resistivity and depth for a conductive earth (half space) model, which is suitable for thicker slabs such as thick conductive overburden. In the EM anomaly list, a depth value of zero for the conductive earth model, in an area of thick cover, warns that the anomaly may be caused by conductive overburden.

Since discrete bodies normally are the targets of EM surveys, local base (or zero) levels are used to compute local anomaly amplitudes. This contrasts with the use of true zero levels which are used to compute true EM amplitudes. Local anomaly amplitudes are shown in the EM anomaly list and these are used to compute the vertical sheet parameters of conductance and depth. Not shown in the EM anomaly list are the true amplitudes which are used to compute the horizontal sheet and conductive earth parameters.

Questionable Anomalies

DIGHEM maps may contain EM responses which are displayed as asterisks (*). These responses denote weak anomalies of indeterminate conductance, which may reflect one of the following: a weak conductor near the surface, a strong conductor at depth (e.g., 100 to 120 m below surface) or to one side of the flight line, or aerodynamic noise. Those responses that have the appearance of valid bedrock anomalies on the flight profiles are indicated by appropriate interpretive symbols (see EM map legend). The others probably do not warrant further investigation unless their locations are of considerable geological interest.

The thickness parameter

DIGHEM can provide an indication of the thickness of a steeply dipping conductor. The amplitude of the coplanar anomaly (e.g., CPI channel on the digital profile) increases relative to the coaxial anomaly (e.g., CXI) as the apparent thickness increases, i.e., the thickness in the horizontal plane. (The thickness is equal to the conductor width if the conductor dips at 90 degrees and strikes at right angles to the flight line.) This report refers to a conductor as thin when the thickness is likely to be less than 3 m, and thick when in excess of 10 m. Thick conductors are indicated on the EM map by parentheses "( )". For base metal exploration in steeply dipping geology, thick conductors can be high priority targets because many massive sulfide ore bodies are thick, whereas non-economic bedrock conductors are often thin. The system cannot sense the thickness when the strike of the conductor is subparallel to the flight line, when the conductor has a shallow dip, when the anomaly amplitudes are small, or when the resistivity of the environment is below 100 ohm-m.

Resistivity mapping

Areas of widespread conductivity are commonly encountered during surveys. In such areas, anomalies can be generated by decreases of only 5 m in survey altitude as well as by increases in conductivity. The typical flight record in conductive areas is characterized by inphase and quadrature channels which are continuously active. Local EM peaks reflect either increases in conductivity of the earth or decreases in survey altitude. For such conductive areas, apparent resistivity profiles and contour maps are necessary for the correct interpretation of the airborne data. The advantage of the resistivity parameter is that anomalies caused by altitude changes are virtually eliminated, so the resistivity data reflect only those anomalies caused by conductivity changes. The resistivity analysis also helps the interpreter to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden. For example, discrete conductors will generally appear as narrow lows on the contour map and broad conductors (e.g., overburden) will appear as wide lows.

The resistivity profiles and the resistivity contour maps present the apparent resistivity using the so-called pseudo-layer (or buried) half space model defined by Fraser (1978)[1]. This model consists of a resistive layer overlying

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1 Resistivity mapping with an airborne multicoil electromagnetic system: Geophysics, v. 43, p.144-172

a conductive half space. The depth channels give the apparent depth below surface of the conductive material. The apparent depth is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material, in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. The apparent depth parameter must be interpreted cautiously because it will contain any errors which may exist in the measured altitude of the EM bird (e.g., as caused by a dense tree cover). The inputs to the resistivity algorithm are the inphase and qaudrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the conductive half space (the source) and the sensor-source distance are independent of the flying height. The apparent depth, discussed above, is simply the sensor-source distance minus the measured altitude or flying height. Consequently, errors in the measured altitude will affect the apparent depth parameter but not the apparent resistivity parameter.

The apparent depth parameter is a useful indicator of simple layering in areas lacking a heavy tree cover. The

DIGHEM system has been flown for purposes of permafrost mapping, where positive apparent depths were used as a measure of permafrost thickness. However, little quantitative use has been made of negative apparent depths because the absolute value of the negative depth is not a measure of the thickness of the conductive upper layer and, therefore, is not meaningful physically. Qualitatively, a negative apparent depth estimate usually shows that the EM anomaly is caused by conductive overburden. Consequently, the apparent depth channel can be of significant help in distinguishing between overburden and bedrock conductors.

The resistivity map often yields more useful information on conductivity distributions than the EM map. In comparing the EM and resistivity maps, keep in mind the following:

(a) The resistivity map portrays the absolute value of the earth's resistivity, where resistivity = 1/conductivity.

(b) The EM map portrays anomalies in the earth's resistivity. An anomaly by definition is a change from the norm and so the EM map displays anomalies, (i) over narrow, conductive bodies and (ii) over the boundary zone between two wide formations of differing conductivity.

The resistivity map might be likened to a total field map and the EM map to a horizontal gradient in the direction of flight[2]. Because gradient maps are usually more sensitive than total field maps, the EM map therefore is to be preferred in resistive areas. However, in conductive areas, the absolute character of the resistivity map usually causes it to be more useful than the EM map.

Interpretation in conductive environments

Environments having background resistivities below 30 ohm-m cause all airborne EM systems to yield very large responses from the conductive ground. This usually prohibits the recognition of discrete bedrock conductors. However, DIGHEM data processing techniques produce three parameters which contribute significantly to the recognition of bedrock conductors. These are the inphase and quadrature difference channels (DIFI and DIFQ), and the resistivity and depth channels (RES and DP) for each coplanar frequency.

The EM difference channels (DIFI and DIFQ) eliminate most of the responses from conductive ground, leaving

[2] The gradient analogy is only valid with regard to the identification of anomalous locations.

responses from bedrock conductors, cultural features (e.g., telephone lines, fences, etc.) and edge effects. Edge effects often occur near the perimeter of broad conductive zones. This can be a source of geologic noise. While edge effects yield anomalies on the EM difference channels, they do not produce resistivity anomalies. Consequently, the resistivity channel aids in eliminating anomalies due to edge effects. On the other hand, resistivity anomalies will coincide with the most highly conductive sections of conductive ground, and this is another source of geologic noise. The recognition of a bedrock conductor in a conductive environment therefore is based on the anomalous responses of the two difference channels (DIFI and DIFQ) and the resistivity channels (RES). The most favourable situation is where anomalies coincide on all channels.

The DP channels, which give the apparent depth to the conductive material, also help to determine whether a conductive response arises from surficial material or from a conductive zone in the bedrock. When these channels ride above the zero level on the digital profiles (i.e., depth is negative), it implies that the EM and resistivity profiles are responding primarily to a conductive upper layer, i.e., conductive overburden. If the DP channels are below the zero level, it indicates that a resistive upper layer exists, and this usually implies the existence of a bedrock conductor. If the low frequency DP channel is below the zero level and the high frequency DP is above, this suggests that a bedrock conductor occurs beneath conductive cover.

The conductance channel CDT identifies discrete conductors which have been selected by computer for appraisal by the geophysicist. Some of these automatically selected anomalies on channel CDT are discarded by the geophysicist. The automatic selection algorithm is intentionally oversensitive to assure that no meaningful responses are missed. The interpreter then classifies the anomalies according to their source and eliminates those that are not substantiated by the data, such as those arising from geologic or aerodynamic noise.

Reduction of geologic noise

Geologic noise refers to unwanted geophysical responses. For purposes of airborne EM surveying, geologic noise refers to EM responses caused by conductive overburden and magnetic permeability. It was mentioned previously that the EM difference channels (i.e., channel DIFI for inphase and DIFQ for quadrature) tend to eliminate the response of conductive overburden. This marked a unique development in airborne EM technology, as DIGHEM is the only EM system which yields channels having an exceptionally high degree of immunity to conductive overburden.

Magnetite produces a form of geological noise on the inphase channels of all EM systems. Rocks containing less than 1% magnetite can yield negative inphase anomalies caused by magnetic permeability. When magnetite is widely distributed throughout a survey area, the inphase EM channels may continuously rise and fall, reflecting variations in the magnetite percentage, flying height, and overburden thickness. This can lead to difficulties in recognizing deeply buried bedrock conductors, particularly if conductive overburden also exists. However, the response of broadly distributed magnetite generally vanishes on the inphase difference channel DIFI. This feature can be a significant aid in the recognition of conductors which occur in rocks containing accessory magnetite.

EM magnetite mapping

The information content of DIGHEM data consists of a combination of conductive eddy current responses and magnetic permeability responses. The secondary field resulting from conductive eddy current flow is frequency-dependent and consists of both inphase and quadrature components, which are positive in sign. On the other hand, the secondary field resulting from magnetic permeability is independent of frequency and consists of only an inphase component which is negative in sign. When magnetic permeability manifests itself by decreasing the measured amount of positive inphase, its presence may be difficult to recognize. However, when it manifests itself by yielding a negative inphase anomaly (e.g., in the absence of eddy current flow), its presence is assured. In this latter case, the negative component can be used to estimate the percent magnetite content.

A magnetite mapping technique was developed for the coplanar coil-pair of DIGHEM. The technique yields a channel (designated FEO) which displays apparent weight percent magnetite according to a homogeneous half space model.[3] The method can be complementary to magnetometer mapping in certain cases. Compared to magnetometry, it is far less sensitive but is more able to resolve closely spaced magnetite zones, as well as providing an estimate of the amount of magnetite in the rock. The method is sensitive to 1/4% magnetite by weight when the EM sensor is at a height of 30 m above a magnetitic half space. It can individually resolve steep dipping narrow magnetite-rich bands which are separated by 60 m. Unlike magnetometry, the EM magnetite method is unaffected by remanent magnetism or magnetic

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[3] Refer to Fraser, 1981, Magnetite mapping with a multi-coil airborne electromagnetic system: Geophysics, v. 46, p. 1579-1594.

latitude.

The EM magnetite mapping technique provides estimates of magnetite content which are usually correct within a factor of 2 when the magnetite is fairly uniformly distributed. EM magnetite maps can be generated when magnetic permeability is evident as negative inphase responses on the data profiles.

Like magnetometry, the EM magnetite method maps only bedrock features, provided that the overburden is characterized by a general lack of magnetite. This contrasts with resistivity mapping which portrays the combined effect of bedrock and overburden.

Recognition of culture

Cultural responses include all EM anomalies caused by man-made metallic objects. Such anomalies may be caused by inductive coupling or current gathering. The concern of the interpreter is to recognize when an EM response is due to culture. Points of consideration used by the interpreter, when coaxial and coplanar coil-pairs are operated at a common frequency, are as follows:

1. Channel CPS monitors 60 Hz radiation. An anomaly on

this channel shows that the conductor is radiating power. Such an indication is normally a guarantee that the conductor is cultural. However, care must be taken to ensure that the conductor is not a geologic body which strikes across a power line, carrying leakage currents.

2. A flight which crosses a "line" (e.g., fence, telephone line, etc.) yields a center-peaked coaxial anomaly and an m-shaped coplanar anomaly.[4] When the flight crosses the cultural line at a high angle of intersection, the amplitude ratio of coaxial/coplanar response is 4. Such an EM anomaly can only be caused by a line. The geologic body which yields anomalies most closely resembling a line is the vertically dipping thin dike. Such a body, however, yields an amplitude ratio of 2 rather than 4. Consequently, an m-shaped coplanar anomaly with a CXI/CPI amplitude ratio of 4 is virtually a guarantee that the source is a cultural line.

3. A flight which crosses a sphere or horizontal disk yields center-peaked coaxial and coplanar anomalies with a CXI/CPI amplitude ratio (i.e., coaxial/coplanar) of 1/4. In the absence of geologic bodies of this

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[4] See Figure 5-1 presented earlier.

geometry, the most likely conductor is a metal roof or small fenced yard.[5] Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

4. A flight which crosses a horizontal rectangular body or wide ribbon yields an m-shaped coaxial anomaly and a center-peaked coplanar anomaly. In the absence of geologic bodies of this geometry, the most likely conductor is a large fenced area.[5] Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

5. EM anomalies which coincide with culture, as seen on the camera film or video display, are usually caused by culture. However, care is taken with such coincidences because a geologic conductor could occur beneath a fence, for example. In this example, the fence would be expected to yield an m-shaped coplanar anomaly as in case #2 above. If, instead, a center-peaked coplanar anomaly occurred, there would be concern that a thick geologic conductor coincided with the cultural line.

---

5 It is a characteristic of EM that geometrically similar anomalies are obtained from: (1) a planar conductor, and (2) a wire which forms a loop having dimensions identical to the perimeter of the equivalent planar conductor.

6. The above description of anomaly shapes is valid when the culture is not conductively coupled to the environment. In this case, the anomalies arise from inductive coupling to the EM transmitter. However, when the environment is quite conductive (e.g., less than 100 ohm-m at 900 Hz), the cultural conductor may be conductively coupled to the environment. In this latter case, the anomaly shapes tend to be governed by current gathering. Current gathering can completely distort the anomaly shapes, thereby complicating the identification of cultural anomalies. In such circumstances, the interpreter can only rely on the radiation channel CPS and on the camera film or video records.

MAGNETICS

The existence of a magnetic correlation with an EM anomaly is indicated directly on the EM map. In some geological environments, an EM anomaly with magnetic correlation has a greater likelihood of being produced by sulfides than one that is non-magnetic. However, sulfide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Canada).

The magnetometer data are digitally recorded in the aircraft to an accuracy of one nT (i.e., one gamma) for proton magnetometers, and 0.01 nT for cesium magnetometers. The digital tape is processed by computer to yield a total field magnetic contour map. When warranted, the magnetic data may also be treated mathematically to enhance the magnetic response of the near-surface geology, and an enhanced magnetic contour map is then produced. The response of the enhancement operator in the frequency domain is illustrated in Figure 5-2. This figure shows that the passband components of the airborne data are amplified 20 times by the enhancement operator. This means, for example, that a 100 nT anomaly on the enhanced map reflects a 5 nT anomaly for the passband components of the airborne data.

The enhanced map, which bears a resemblance to a downward continuation map, is produced by the digital bandpass filtering of the total field data. The enhancement is equivalent to continuing the field downward to a level (above the source) which is 1/20th of the actual sensor-source distance.

Because the enhanced magnetic map bears a resemblance to a ground magnetic map, it simplifies the recognition of trends in the rock strata and the interpretation of geological structure. It defines the near-surface local

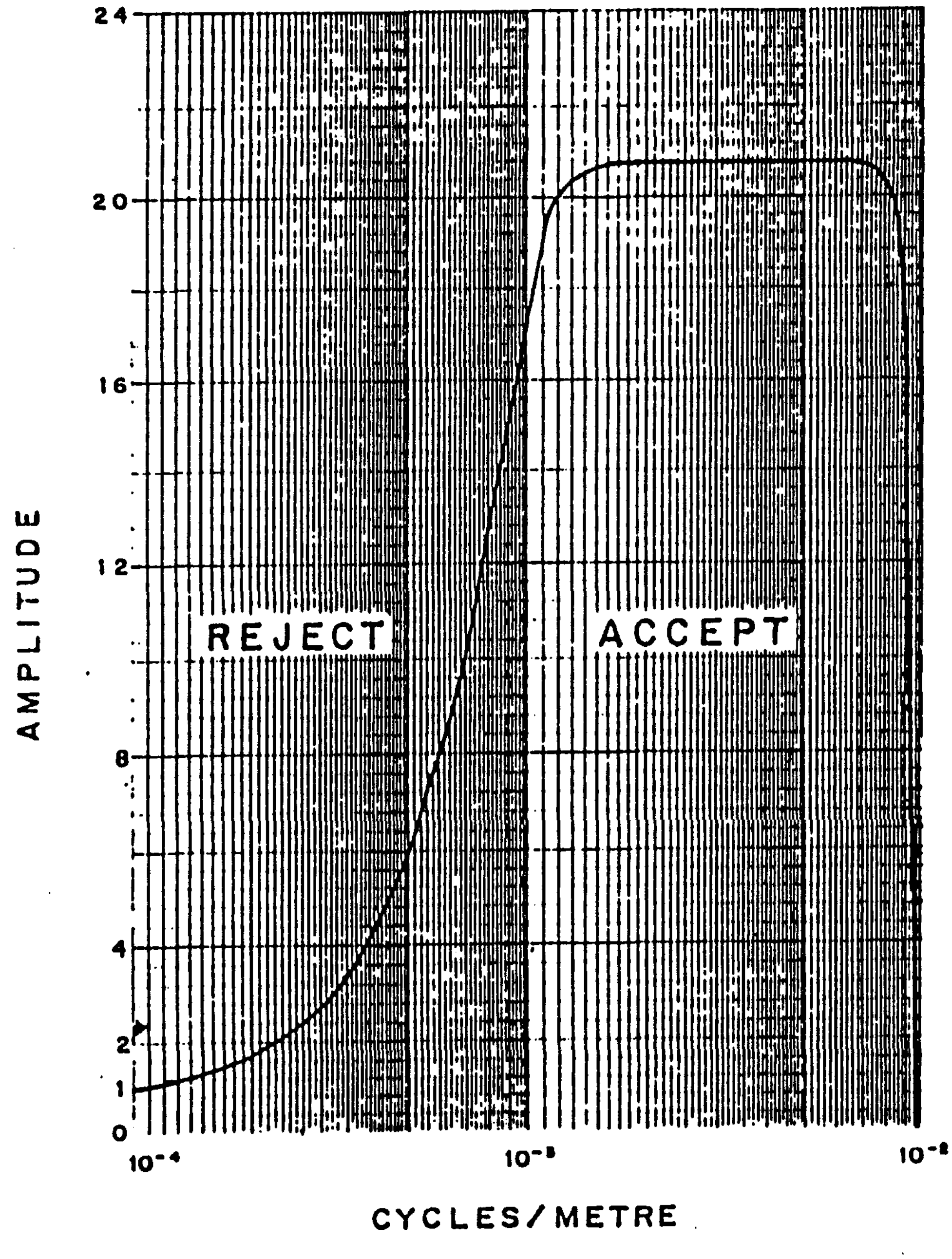

Fig. 5-2 Frequency response of magnetic enhancement operator for a sample interval of 50 m.

geology while de-emphasizing deep-seated regional features. It primarily has application when the magnetic rock units are steeply dipping and the earth's field dips in excess of 60 degrees.

Any of a number of filter operators may be applied to the magnetic data, to yield vertical derivatives, continuations, magnetic susceptibility, etc. These may be displayed in contour, colour or shadow.

VLF

VLF transmitters produce high frequency uniform electromagnetic fields. However, VLF anomalies are not EM anomalies in the conventional sense. EM anomalies primarily reflect eddy currents flowing in conductors which have been energized inductively by the primary field. In contrast, VLF anomalies primarily reflect current gathering, which is a non-inductive phenomenon. The primary field sets up currents which flow weakly in rock and overburden, and these tend to collect in low resistivity zones. Such zones may be due to massive sulfides, shears, river valleys and even unconformities.

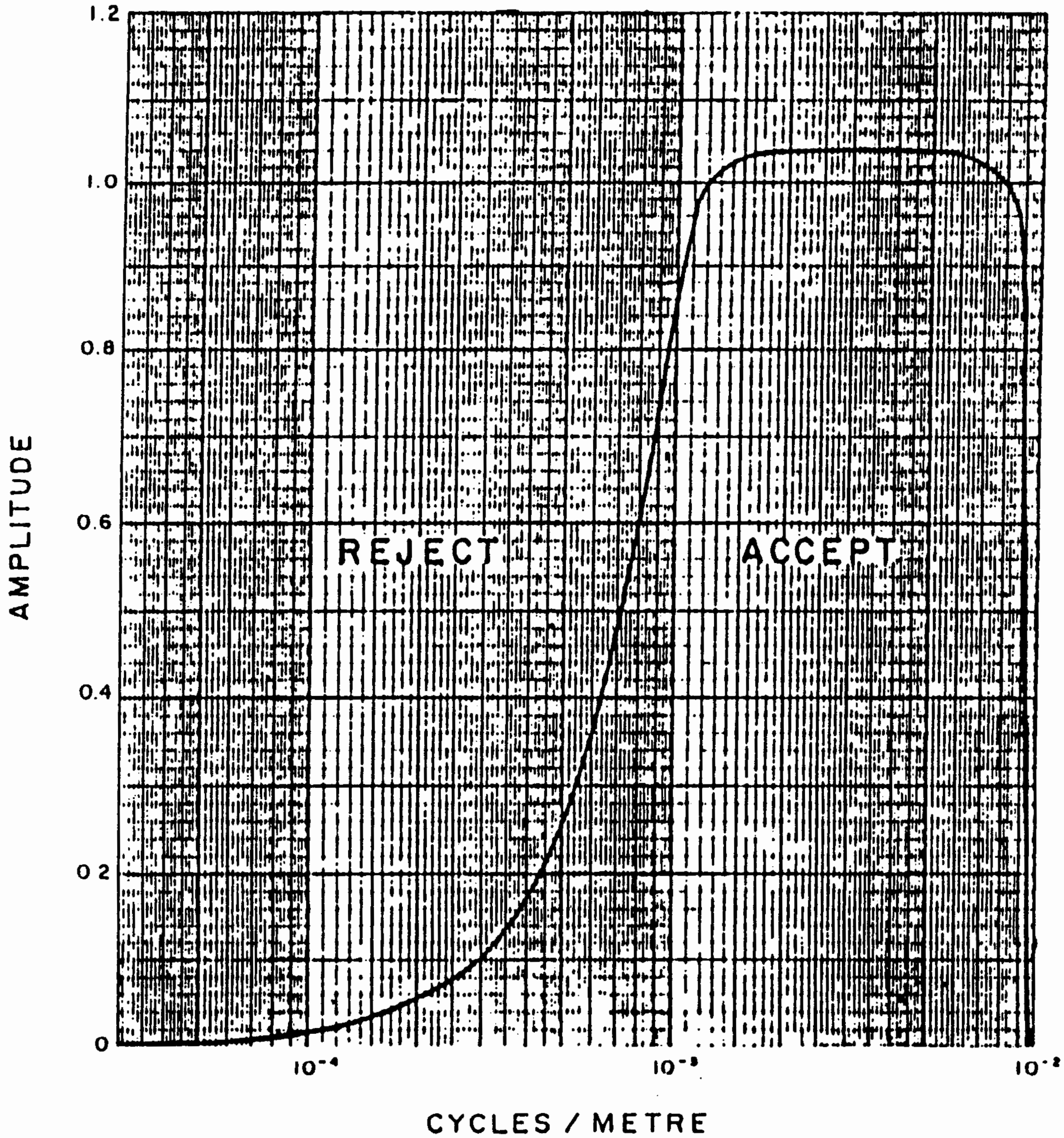

Fig. 5-3 Frequency response of VLF operator.

The VLF field is horizontal. Because of this, the method is quite sensitive to the angle of coupling between the conductor and the transmitted VLF field. Conductors which strike towards the VLF station will usually yield a stronger response than conductors which are nearly orthogonal to it.

The Herz Industries Ltd. Totem VLF-electromagnetometer measures the total field and vertical quadrature components. Both of these components are digitally recorded in the aircraft with a sensitivity of 0.1 percent. The total field yields peaks over VLF current concentrations whereas the quadrature component tends to yield crossovers. Both appear as traces on the profile records. The total field data are filtered digitally and displayed as contours to facilitate the recognition of trends in the rock strata and the interpretation of geologic structure.

The response of the VLF total field filter operator in the frequency domain (Figure 5-3) is basically similar to that used to produce the enhanced magnetic map (Figure 5-2). The two filters are identical along the abscissa but different along the ordinant. The VLF filter removes long wavelengths such as those which reflect regional and wave transmission variations. The filter sharpens short wavelength responses such as those which reflect local geological variations.

CONCLUSIONS AND RECOMMENDATIONS

This report provides a very brief description of the survey results and describes the equipment, procedures and logistics of the survey.

There are four bedrock anomalies in the Phil survey block which are typical of massive sulphide responses. The survey was also successful in locating several moderately weak and broad conductors which may warrant additional work. The various maps included with this report display the magnetic and conductive properties of the survey area. It is recommended that the survey results be reviewed in detail, in conjunction with all available geophysical, geological and geochemical information. Particular reference should be made to the computer generated data profiles which clearly define the characteristics of the individual anomalies.

Most anomalies in the area are moderately weak and poorly-defined. Many have been attributed to conductive overburden or deep weathering, although a few appear to be associated with magnetite-rich rock units. Others coincide with VLF anomalies which may reflect faults or shears. Such structural breaks are considered to be of particular interest as they may have influenced mineral deposition within the survey areas.

The interpreted bedrock conductors defined by the survey should be subjected to further investigation, using appropriate surface exploration techniques. Anomalies which are currently considered to be of moderately low priority may require upgrading if follow-up results are favourable.

It is also recommended that image processing of existing geophysical data be considered, in order to extract the maximum amount of information from the survey results. Current software and imaging techniques often provide valuable information on structure and lithology, which may not be clearly evident on the contour and colour maps. These techniques can yield images which define subtle, but significant, structural details.

Respectfully submitted,

DIGHEM SURVEYS & PROCESSING INC.

David E. Pritchard
Geophysicist

DEP/sdp

A1089SEP.91R

APPENDIX A

LIST OF PERSONNEL

The following personnel were involved in the acquisition, processing, interpretation and presentation of data, relating to a DIGHEM^{IV} airborne geophysical survey carried out for Jeffco Holdings Ltd., near Fort St. James, British Columbia.

Steve Kilty	Vice President, Operations
Dave Pritchard	Survey Operations Supervisor
David Miles	Senior Geophysical Operator
Robert Gordon	Second Geophysical Operator
Dave Wilton	Pilot (Questral Helicopters Ltd.)
Gordon Smith	Data Processing Supervisor
David Pritchard	Computer Processor
David Pritchard	Interpretation Geophysicist
Reinhard Zimmerman	Drafting Supervisor
Lyn Vanderstarren	Draftsperson (CAD)
Susan Pothiah	Word Processing Operator
Albina Tonello	Secretary/Expeditor

The survey consisted of 279 km of coverage, flown from June 20 to June 25, 1990.

All personnel are employees of Dighem Surveys & Processing Inc., except for the pilot who is an employee of Questral Helicopters Ltd.

DIGHEM SURVEYS & PROCESSING INC.

Dave Pritchard

David E. Pritchard
Geophysicist

DEP/sdp

Ref: Report #1089

A1089SEP.91R

A P P E N D I X   C

EM ANOMALY LIST

ANOMALY/ FID/INTERP	COAXIAL 900 HZ REAL PPM	COAXIAL 900 HZ QUAD PPM	COPLANAR 900 HZ REAL PPM	COPLANAR 900 HZ QUAD PPM	COPLANAR 7200 HZ REAL PPM	COPLANAR 7200 HZ QUAD PPM	VERTICAL DIKE COND SIEMEN	VERTICAL DIKE DEPTH* M	HORIZONTAL SHEET COND SIEMEN	HORIZONTAL SHEET DEPTH M	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH M	MAG CORR NT
LINE 10010	(FLIGHT		6)										
A 2564 S	0	4	0	7	19	32	0.5	0	1	84	972	0	0
LINE 10030	(FLIGHT		6)										
A 1950 S	1	2	0	2	2	4	-	-	-	-	-	-	0
B 1983 S	1	2	0	5	10	19	0.5	0	1	26	467	0	0
LINE 10040	(FLIGHT		6)										
A 1747 S	1	2	1	2	2	4	-	-	-	-	-	-	0
B 1630 S	1	2	0	2	2	4	-	-	-	-	-	-	0
LINE 10050	(FLIGHT		6)										
A 3062 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10070	(FLIGHT		6)										
A 3956 S	1	2	0	6	18	15	0.8	0	1	27	732	0	0
LINE 10080	(FLIGHT		6)										
A 4103 S	1	3	0	7	7	8	0.6	0	1	33	771	0	40
LINE 10090	(FLIGHT		6)										
A 4453 S	1	1	0	2	2	3	-	-	-	-	-	-	18
B 4431 S	1	2	0	2	2	4	-	-	-	-	-	-	0
LINE 10100	(FLIGHT		7)										
A 1282 S	1	2	0	2	2	4	-	-	-	-	-	-	0
LINE 10110	(FLIGHT		7)										
A 1160 S	1	2	0	2	2	4	-	-	-	-	-	-	0
LINE 10120	(FLIGHT		7)										
A 833 S	1	2	0	2	2	4	-	-	-	-	-	-	0
LINE 10130	(FLIGHT		7)										
A 2163 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10140	(FLIGHT		7)										
A 2313 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10150	(FLIGHT		7)										
A 2600 S	1	2	1	2	1	4	-	-	-	-	-	-	0
LINE 10160	(FLIGHT		7)										
A 2770 S	1	2	1	2	2	4	-	-	-	-	-	-	0

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

1089 A R-B

ANOMALY/ FID/INTERP	COAXIAL 900 HZ REAL PPM	COAXIAL 900 HZ QUAD PPM	COPLANAR 900 HZ REAL PPM	COPLANAR 900 HZ QUAD PPM	COPLANAR 7200 HZ REAL PPM	COPLANAR 7200 HZ QUAD PPM	VERTICAL DIKE COND SIEMEN	VERTICAL DIKE DEPTH* M	HORIZONTAL SHEET COND SIEMEN	HORIZONTAL SHEET DEPTH M	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH M	MAG CORR NT
LINE 10170	(FLIGHT		7)										
A 3165 S?	2	2	1	4	13	4	1.0	0	1	24	209	0	0
B 3125 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10180	(FLIGHT		7)										
A 3303 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10190	(FLIGHT		7)										
A 3633 S	0	1	1	2	2	4	-	-	-	-	-	-	0
LINE 10210	(FLIGHT		7)										
A 4079 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10230	(FLIGHT		7)										
A 4555 S	1	2	1	2	2	4	-	-	-	-	-	-	0
B 4509 S	0	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10251	(FLIGHT		7)										
A 5015 S	1	2	2	5	5	16	1.8	11	1	60	333	8	0
LINE 10260	(FLIGHT		8)										
A 237 S	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10290	(FLIGHT		8)										
A 1038 S	1	2	1	2	2	4	-	-	-	-	-	-	0
B 981 S?	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10320	(FLIGHT		8)										
A 1530 S	1	2	0	3	9	14	0.6	0	1	17	335	0	0
B 1544 S	1	1	0	2	2	4	-	-	-	-	-	-	0
LINE 10330	(FLIGHT		8)										
A 1781 S	1	2	0	2	2	4	-	-	-	-	-	-	0
B 1710 S	1	2	0	2	2	4	-	-	-	-	-	-	40

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

ANOMALY/ FID/INTERP	COAXIAL 900 HZ REAL PPM	COAXIAL 900 HZ QUAD PPM	COPLANAR 900 HZ REAL PPM	COPLANAR 900 HZ QUAD PPM	COPLANAR 7200 HZ REAL PPM	COPLANAR 7200 HZ QUAD PPM	VERTICAL DIKE COND SIEMEN	VERTICAL DIKE DEPTH* M	HORIZONTAL SHEET COND SIEMEN	HORIZONTAL SHEET DEPTH M	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH M	MAG CORR NT
LINE 20190	(FLIGHT		4)										
A 1090 S	0	13	7	25	79	61	1.0	0	1	18	148	0	0
B 1110 S	0	8	4	16	47	36	0.5	0	1	32	193	0	0
LINE 20200	(FLIGHT		3)										
A 2261 S	0	2	1	2	2	4	-	-	-	-	-	-	50
B 2244 S	0	2	1	2	2	4	-	-	-	-	-	-	40
C 2227 S	2	7	3	19	2	44	1.3	0	1	31	173	0	0
LINE 20210	(FLIGHT		3)										
A 1967 S	0	4	2	9	2	12	0.5	0	1	33	498	0	0
B 2060 S	0	4	2	9	20	36	0.5	0	1	29	279	0	50
C 2096 S	0	10	1	19	48	69	0.5	0	1	22	319	0	11
LINE 20220	(FLIGHT		3)										
A 1829 S	0	2	0	2	2	4	-	-	-	-	-	-	0
B 1795 S	0	4	0	11	11	34	0.5	0	1	25	704	0	0
C 1759 S	0	6	2	10	25	44	0.5	0	1	28	290	0	0
D 1727 S	0	7	3	16	41	24	0.5	0	1	10	481	0	0
LINE 20230	(FLIGHT		3)										
A 1563 S?	0	8	5	18	17	25	0.7	0	1	28	227	0	20
B 1570 S?	0	7	3	12	34	29	0.7	0	1	36	202	1	0
C 1613 S?	0	6	2	10	21	48	0.5	0	1	13	330	0	30
D 1625 S	0	5	3	9	9	30	0.5	0	1	17	269	0	0
LINE 20240	(FLIGHT		2)										
A 5460 S	1	3	1	6	19	16	0.8	0	1	25	267	0	0
B 5367 S?	1	5	3	1	27	24	1.0	0	1	39	150	18	0
C 5353 S	1	2	1	2	2	4	-	-	-	-	-	-	0
D 5303 S	0	2	1	6	19	26	0.5	0	1	32	230	0	0
LINE 20250	(FLIGHT		2)										
A 4899 S	0	4	1	7	21	30	0.6	0	1	39	625	0	0
B 4964 S?	2	6	6	11	12	7	2.6	0	1	25	229	0	0
C 4996 S	1	5	1	10	24	38	0.8	0	1	25	213	0	40
LINE 20260	(FLIGHT		2)										
A 4690 S?	0	5	0	9	30	22	0.5	0	1	39	779	0	0
B 4643 S	0	5	1	8	19	21	0.5	0	1	21	198	0	50
C 4633 S	0	4	1	8	17	23	0.5	0	1	19	256	0	0
D 4589 S?	0	2	1	11	24	21	0.5	0	1	19	333	0	30

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

	COAXIAL 900 HZ		COPLANAR 900 HZ		COPLANAR 7200 HZ		VERTICAL DIKE		HORIZONTAL SHEET		CONDUCTIVE EARTH		MAG CORR
ANOMALY/ FID/INTERP	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	COND SIEMEN	DEPTH* M	COND SIEMEN	DEPTH M	RESIS OHM-M	DEPTH M	NT
LINE 20270	(FLIGHT		2)										
A 2972 S	0	3	1	7	21	28	0.5	0	1	28	659	0	0
B 2919 S	0	2	0	2	2	4	-	-	-	-	-	-	0
C 2896 S?	0	9	7	16	58	25	1.5	0	1	21	232	0	0
D 2880 S?	1	6	3	14	28	46	0.8	0	1	23	111	0	0
E 2867 B?	2	4	3	7	2	11	2.7	25	1	45	153	9	20
F 2853 S?	1	5	3	10	24	22	1.5	0	1	19	198	0	0
G 2844 S	0	8	4	13	7	47	0.7	0	1	6	438	0	0
H 2795 S	0	7	2	12	35	37	0.5	0	1	18	339	0	8
LINE 20280	(FLIGHT		2)										
A 2593 S?	2	7	7	13	21	16	2.6	0	1	25	108	0	0
LINE 20290	(FLIGHT		2)										
A 2340 S?	1	9	8	14	41	31	2.3	0	1	24	72	0	0
B 2329 S	0	7	5	11	33	20	0.9	0	1	24	101	0	0
C 2259 S	0	8	2	17	51	57	0.5	0	1	16	297	0	0
LINE 20300	(FLIGHT		2)										
A 1984 S	0	7	2	15	36	40	0.5	0	1	24	200	0	40
B 2045 S	0	5	5	9	9	11	1.6	0	1	27	79	0	7
LINE 20310	(FLIGHT		1)										
A 1549 S	0	8	6	14	45	12	1.3	0	1	33	152	0	0
B 1496 S?	1	4	6	10	10	8	2.7	0	1	29	75	0	0
LINE 20320	(FLIGHT		1)										
A 2011 S?	2	7	7	14	5	13	2.7	0	1	33	75	0	0
LINE 20330	(FLIGHT		1)										
A 2343 S	1	4	3	9	19	15	1.5	9	1	44	60	15	0
B 2319 S?	5	22	11	45	132	122	2.1	0	1	22	65	0	0
C 2295 S?	4	13	15	28	44	45	3.8	9	2	24	42	3	0
D 2287 S	9	32	25	5	2	9	6.3	6	2	26	38	4	0
LINE 20340	(FLIGHT		1)										
A 2466 S	1	2	1	2	2	4	-	-	-	-	-	-	40
B 2491 S?	7	11	18	39	6	15	5.0	0	2	27	40	2	0
C 2554 S	0	11	5	23	24	80	0.8	0	1	15	334	0	0
LINE 20350	(FLIGHT		1)										
A 2815 S	1	14	4	34	96	125	0.7	0	1	9	218	0	80

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1089 B PHIL

ANOMALY/ FID/INTERP	COAXIAL 900 HZ REAL PPM	COAXIAL 900 HZ QUAD PPM	COPLANAR 900 HZ REAL PPM	COPLANAR 900 HZ QUAD PPM	COPLANAR 7200 HZ REAL PPM	COPLANAR 7200 HZ QUAD PPM	VERTICAL DIKE COND SIEMEN	VERTICAL DIKE DEPTH* M	HORIZONTAL SHEET COND SIEMEN	HORIZONTAL SHEET DEPTH M	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH M	MAG CORR NT
LINE 20350	(FLIGHT		1)										
B 2798 S?	1	6	1	10	26	73	0.9	0	1	11	392	0	0
C 2782 S?	2	6	5	11	3	9	2.6	0	1	50	64	17	0
LINE 20360	(FLIGHT		2)										
A 759 S	0	6	2	11	32	40	0.5	0	1	49	159	12	7
B 783 S	0	10	4	19	27	60	0.5	0	1	16	193	0	0
LINE 20370	(FLIGHT		2)										
A 1065 B?	0	7	4	13	29	40	0.5	0	1	34	127	0	6
B 1024 S	0	8	3	14	31	31	0.5	0	1	20	159	0	7
C 998 S?	0	36	6	74	187	284	0.5	5	1	7	193	0	0
LINE 20390	(FLIGHT		2)										
A 1522 S	0	12	0	26	6	36	0.5	0	1	0	406	0	0
B 1494 B	1	2	1	2	2	4	-	-	-	-	-	-	0
C 1480 B?	7	8	9	16	36	28	6.0	0	2	32	42	4	0
D 1429 S?	3	11	13	19	19	10	3.6	0	1	26	86	0	0
LINE 29010	(FLIGHT		5)										
A 2409 S	4	7	3	14	7	34	2.7	0	1	17	570	0	0
B 2418 S	1	2	1	2	2	4	-	-	-	-	-	-	0
C 2426 S	3	9	1	17	55	41	1.3	0	1	0	449	0	0
LINE 29020	(FLIGHT		5)										
A 2607 S?	2	6	5	13	42	26	2.0	0	1	15	252	0	0

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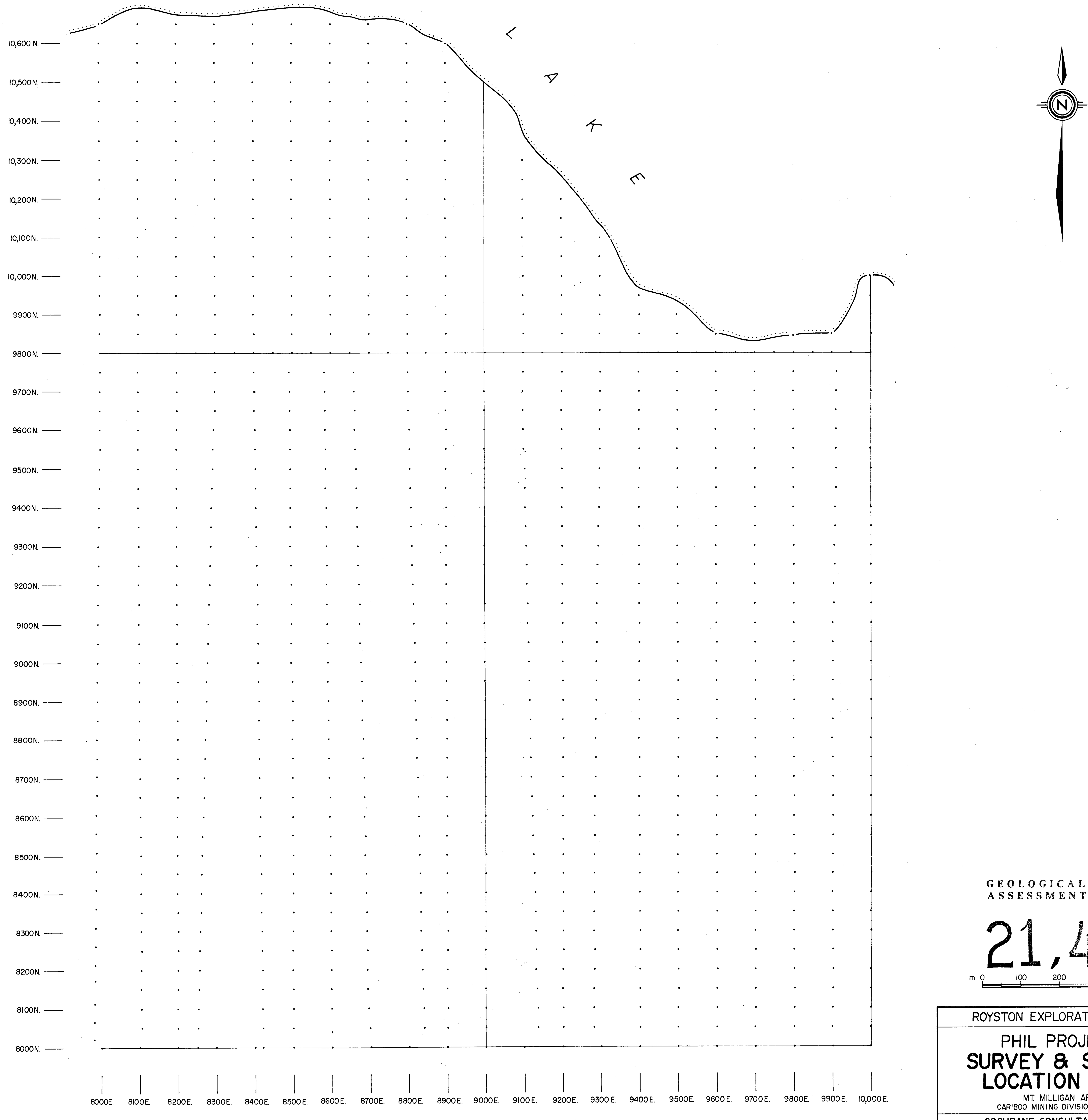


GEOLOGICAL BRANCH
ASSESSMENT REPORT

21,440

m 0 100 200 300 400 m

ROYSTON EXPLORATIONS INC.

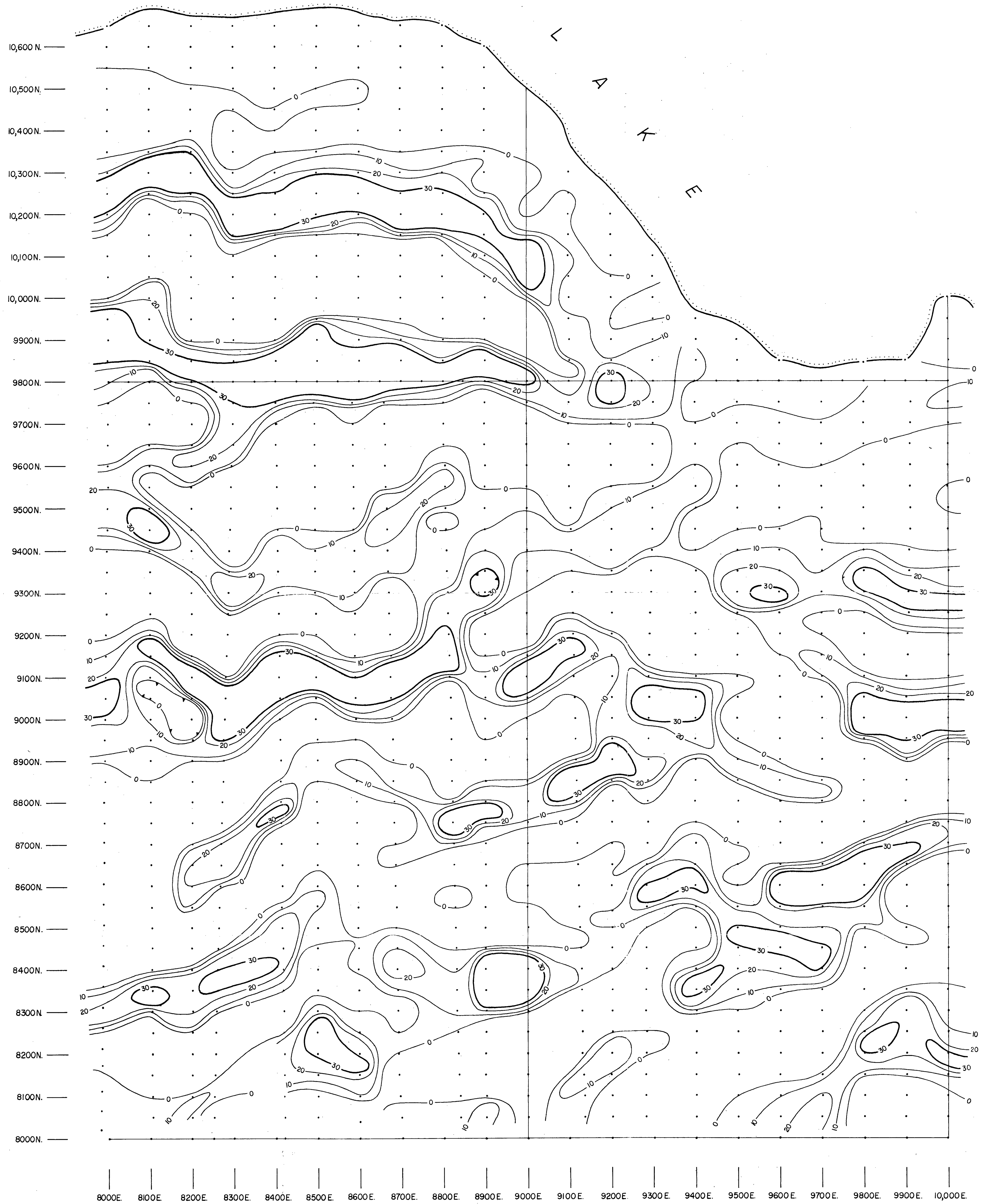
PHIL PROJECT

SURVEY & SAMPLE LOCATION PLAN

MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.

COCHRANE CONSULTANTS LTD.

DRAWN.	J.J.P.	CHECKED.	J.J.P.	PLAN No. 4
DATE.	MAY, 1991	SCALE.	1:5000	



GEOLOGICAL BRANCH
ASSESSMENT REPORT

21,440

m 0 100 200 300 400 m

ROYSTON EXPLORATIONS INC.

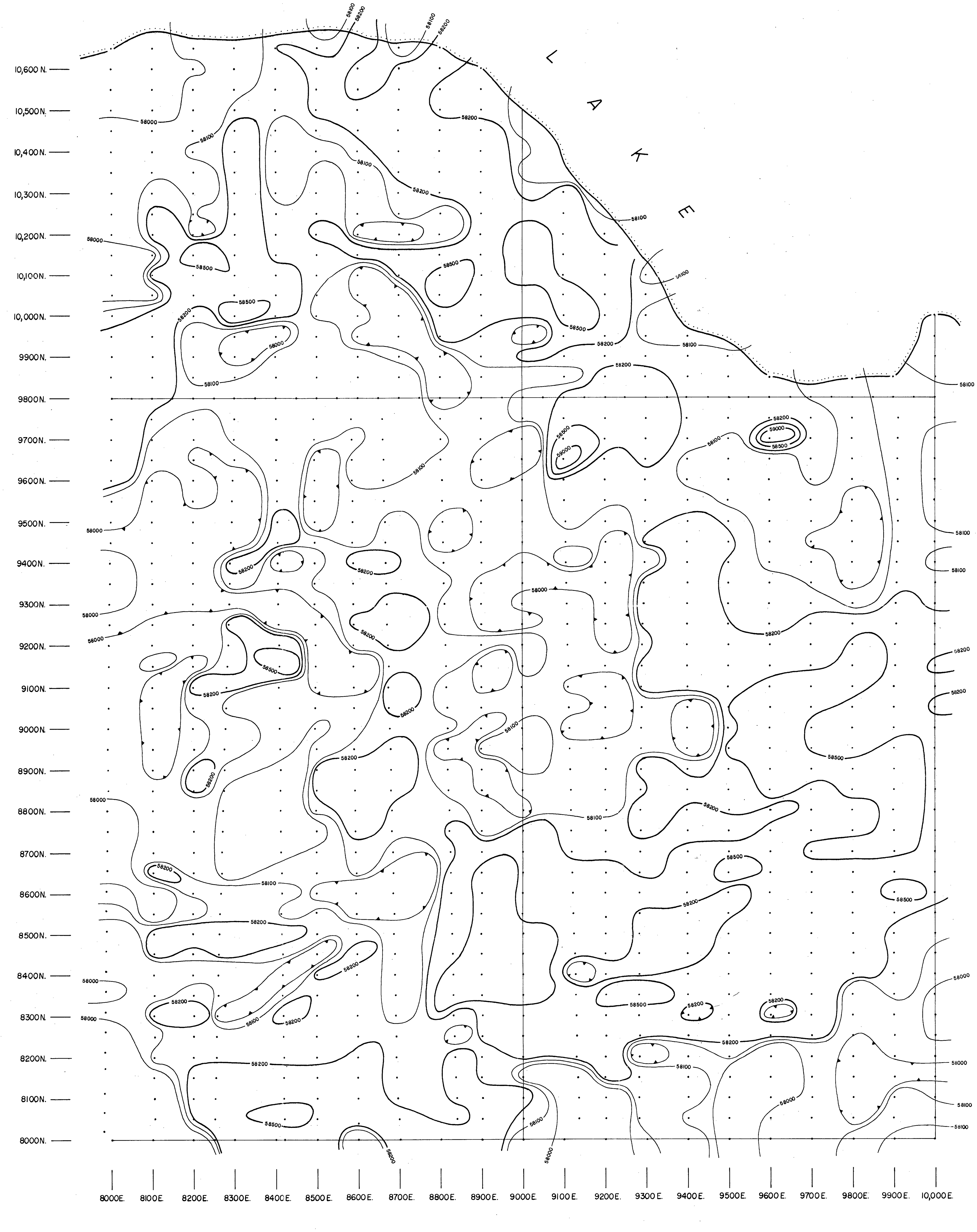
PHIL PROJECT

FILTERED VLF-EM SURVEY PLAN

MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.

COCHRANE CONSULTANTS LTD.

DRAWN.	J.J.P.	CHECKED.	J.J.P.	PLAN No.
DATE.	MAY, 1991	SCALE.	1:5000	5

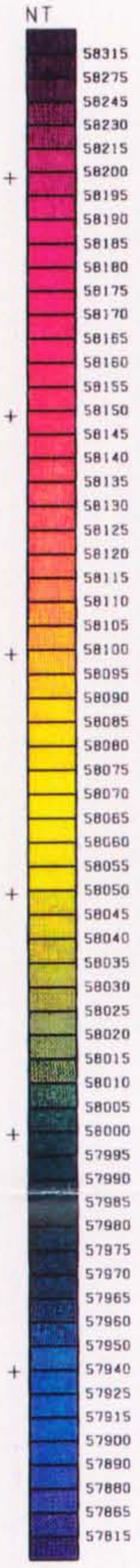


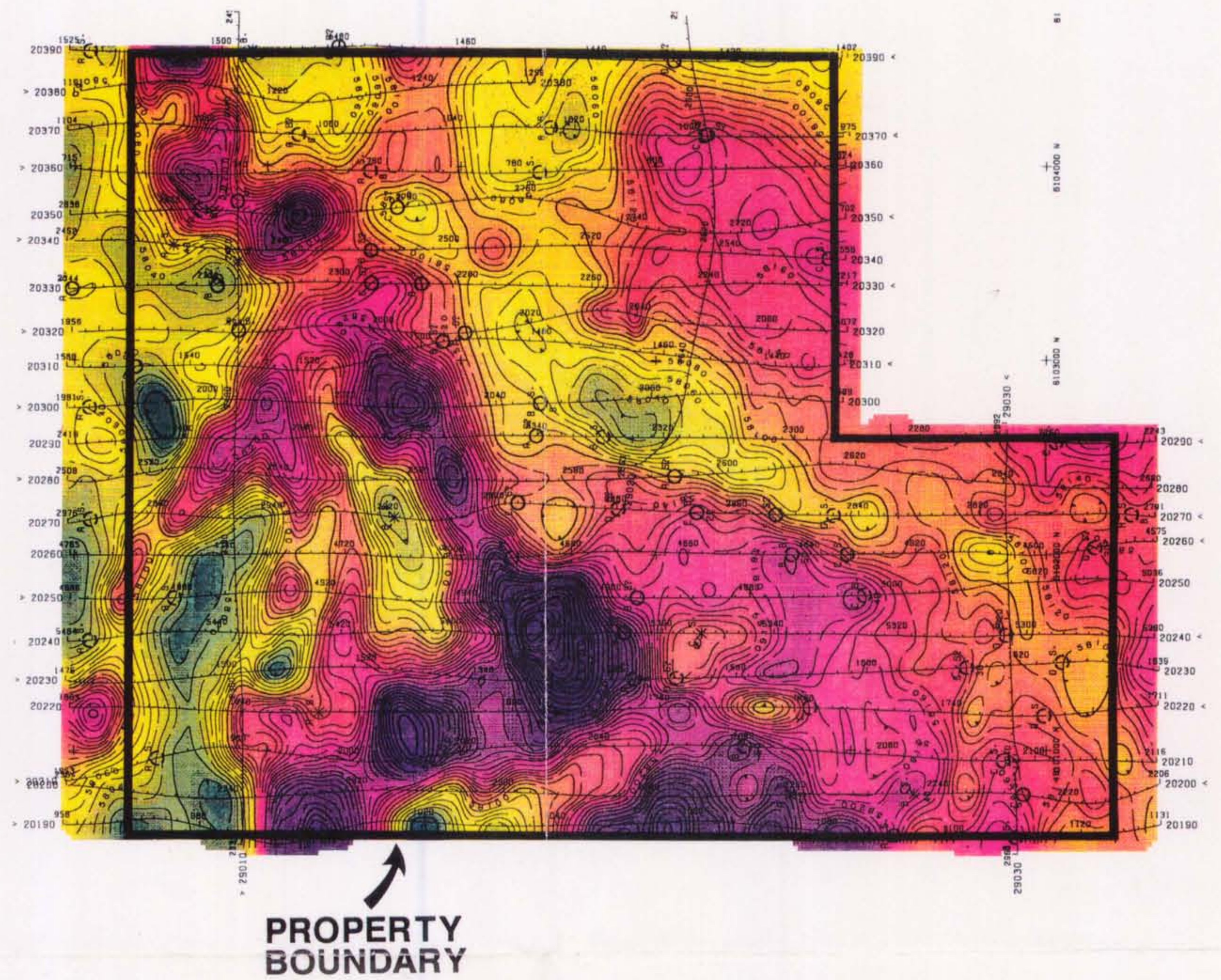
GEOLOGICAL BRANCH
ASSESSMENT REPORT

21,440

m 0 100 200 300 400 m

ROYSTON EXPLORATIONS INC.			
PHIL PROJECT **MAGNETOMETER SURVEY PLAN** MT. MILLIGAN AREA CARIBOO MINING DIVISION, B.C.			
COCHRANE CONSULTANTS LTD.			
DRAWN. J.J.P.	CHECKED. J.J.P.	PLAN No. 6	
DATE. MAY, 1991	SCALE. 1:5000		





FLIGHT LINES WITH EM ANOMALIES

- Flight direction
- Flight line number
- 11020 — Reflight Number; Line Number; Area Number
- Fiducials identified on profiles
- Dip direction
- EM anomaly (see EM legend)
- Conductor axis (on EM maps only)
- Arcs indicate the conductor has a thickness > 10m
- Magnetic correlation in nT (gammas)

EM LEGEND

Grade	Anomaly	Conductance
7	●	≥100 siemens
6	◕	50-100 siemens
5	◒	20-50 siemens
4	⊕	10-20 siemens
3	⊕	5-10 siemens
2	○	1-5 siemens
1	◌	<1 siemens
-	✳	Questionable anomaly

Anomaly identifier — Interpretive symbol

Depth is greater than: 15 m, 30 m, 45 m, 60 m

Inphase and Quadrature of coaxial coil is greater than: 5 ppm, 10 ppm, 15 ppm, 20 ppm

Interpretive symbol	Conductor ("model")
B.	Bedrock conductor
D.	Narrow bedrock conductor ("thin dike")
S.	Conductive cover ("horizontal thin sheet")
H.	Broad conductive rock unit, deep conductive weathering, thick conductive cover ("half space")
E.	Edge of broad conductor ("edge of half space")
L.	Culture, e.g. power line, building, fence

CONTOUR INTERVALS

- 500nT
- 100nT
- 20nT
- 10nT
- magnetic low

Magnetic inclination within the survey area: 75 degrees

0 1 2 Km

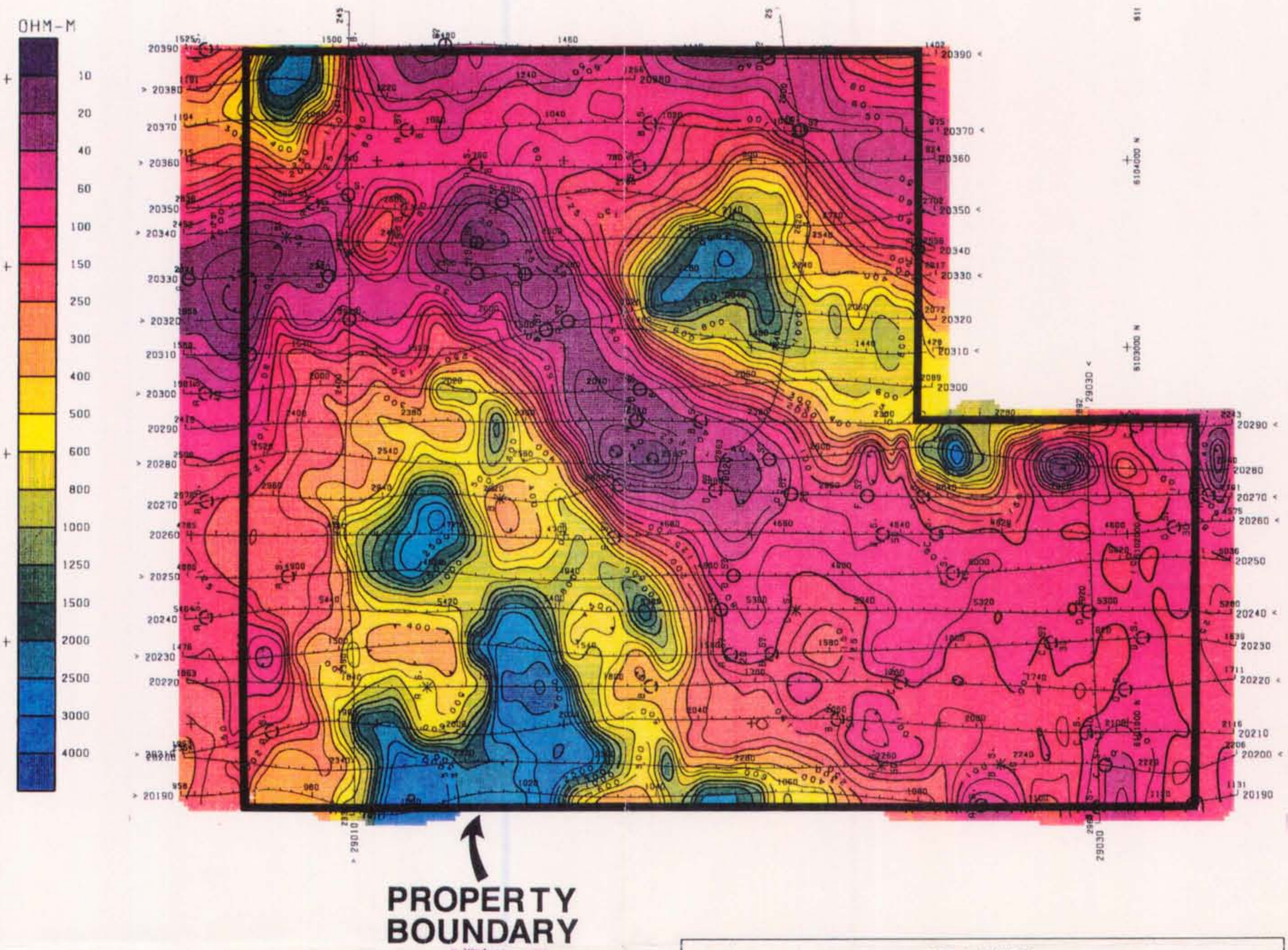
ROYSTON EXPLORATIONS INC

PHIL PROJECT
TOTAL FIELD MAGNETICS

MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.

COCHRANE CONSULTANTS LTD.

Drawn: J.J.P.	Checked: D.C.	PLAN No.
Scale:	Date: May, 1991	7



EM LEGEND

Grade	Anomaly	Conductance
7	●	≥100 siemens
6	◕	50-100 siemens
5	◒	20-50 siemens
4	⊕	10-20 siemens
3	⊕	5-10 siemens
2	○	1-5 siemens
1	◌	<1 siemens
-	✳	Questionable anomaly

Anomaly identifier — Interpretive symbol — C|H.

Depth is greater than: 15 m, 30 m, 45 m, 60 m

Inphase and Quadrature of coaxial coil is greater than: 5 ppm, 10 ppm, 15 ppm, 20 ppm

Interpretive symbol	Conductor ('model')
B.	Bedrock conductor
D.	Narrow bedrock conductor ('thin dike')
S.	Conductive cover ('horizontal thin sheet')
H.	Broad conductive rock unit, deep conductive weathering, thick conductive cover ('half space')
E.	Edge of broad conductor ('edge of half space')
L.	Culture, e.g. power line, building, fence

FLIGHT LINES WITH EM ANOMALIES

- 13010 / 13020 <
- Flight direction
- Flight line number
- 11020: Reflight Number, Line Number, Area Number
- Fiducials identified on profiles
- Dip direction
- EM anomaly (see EM legend)
- Conductor axis (on EM maps only)
- Arcs indicate the conductor has a thickness > 10m
- Magnetic correlation in nT (gammas)

CONTOUR LEVELS

1000, 800, 600, 500, 400, 300, 250, 200, 150, 125, 100

Contours in ohm-m at 10 intervals per decade

GEOLOGICAL BRANCH
ASSESSMENT REPORT

21,440

0 1 2 Km

ROYSTON EXPLORATIONS INC

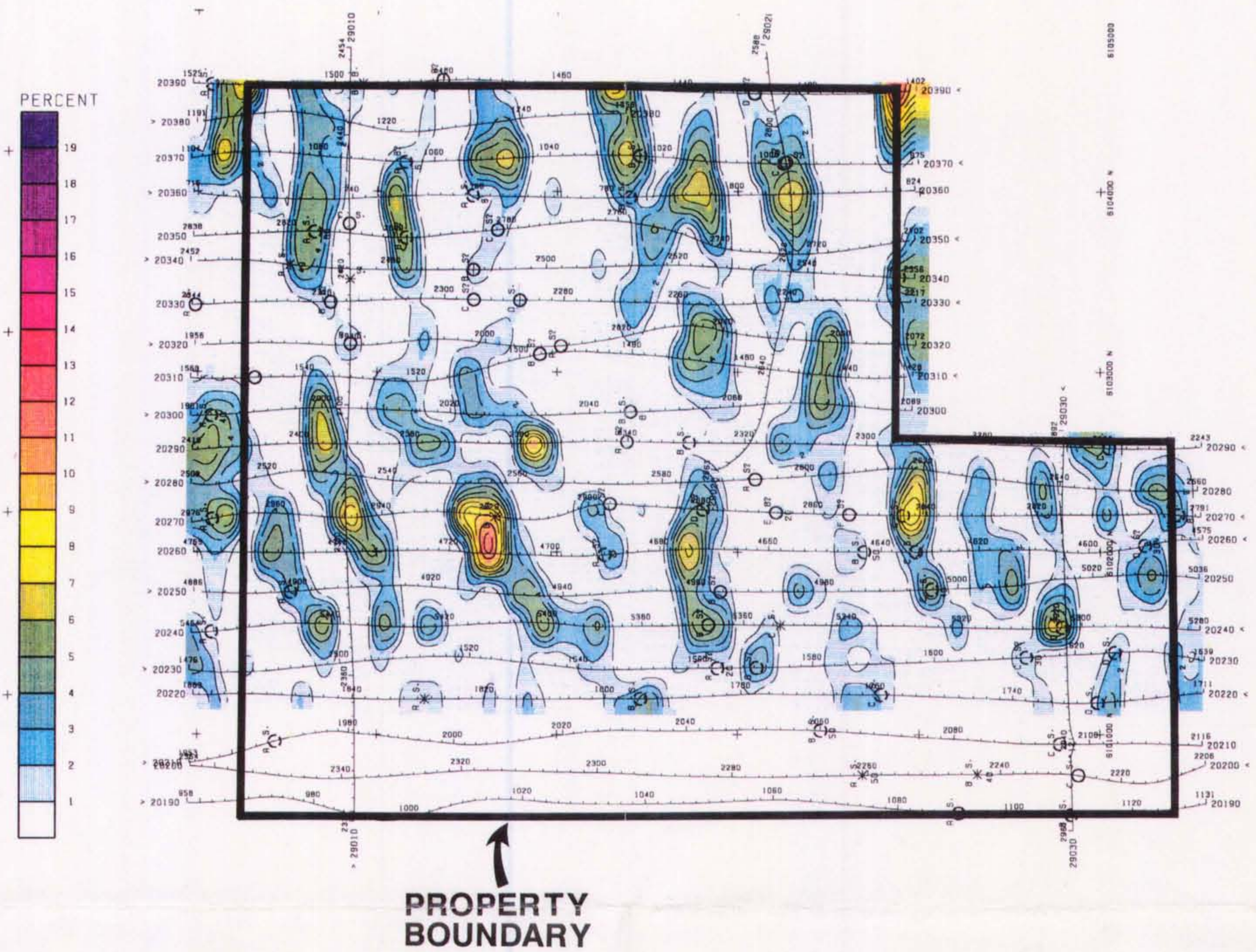
PHIL PROJECT

RESISTIVITY PLAN

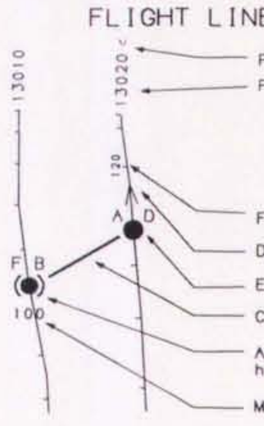
MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.

COCHRANE CONSULTANTS LTD.

Drawn: J.J.P.	Checked: D.C.	PLAN No.
Scale:	Date: May, 1991	8



FLIGHT LINES WITH EM ANOMALIES



EM LEGEND

Grade	Anomaly	Conductance
7	●	≥100 siemens
6	◕	50-100 siemens
5	◒	20-50 siemens
4	⊕	10-20 siemens
3	⊕	5-10 siemens
2	○	1-5 siemens
1	◌	<1 siemens
-	✳	Questionable anomaly

Anomaly identifier — Interpretive symbol — C|H

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E.	Edge of broad conductor ("edge of half space")
L.	Culture, e.g. power line, building, fence

CONTOURS

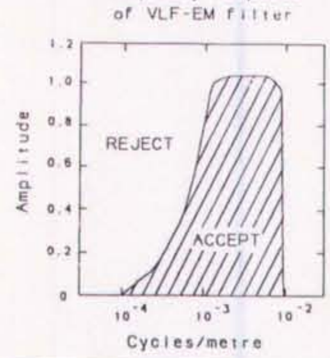
Contours in percent

——— 10 ———

——— 2 ———

— — — 1 — — —

Frequency response of VLF-EM filter



VLF STATION

	TRANSMITTER	LINE
R-B Block	NPM(Lualualei, Hawaii)23.4 kHz	all
PHIL Block	NLK(Seattle, Wash.) 24.8kHz	all

0 1 2 Km

GEOLOGICAL BRANCH
ASSESSMENT REPORT

21,440

ROYSTON EXPLORATIONS INC

PHIL PROJECT
FILTERED VLF

MT. MILLIGAN AREA
CARIBOO MINING DIVISION, B.C.

COCHRANE CONSULTANTS LTD.

Drawn: J.J.P.	Checked: D.C.	PLAN No.
Scale:	Date: May, 1991	9