

**AIRBORNE GEOPHYSICAL SURVEY**

on the

**DONJEK PROJECT AREAS**

Don 1-20 Claims

YB46996-YB47015

Wolv 1-24 Claims

YB46972-YB46995

NTS 115G/12

in the

**WHITEHORSE MINING DISTRICT**

**YUKON TERRITORY**

Prepared by

Dighem, A Division of CGG Canada Ltd.

for

**EXPATRIATE RESOURCES LTD.**

Linda E. Chung  
October 11, 1996

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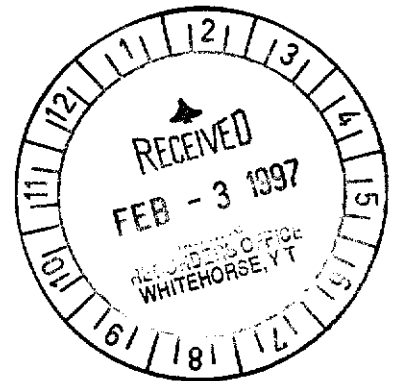
This report has been examined by  
the Geological Evaluation Unit  
under Section 53 (4) Yukon Quartz  
Mining Act and is allowed as  
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of \$ 19,800.

*MBuk*  
Regional Manager, Exploration and  
Geological Services for Commissioner  
of Yukon Territory.

Report #1253B



DIGHEM<sup>V</sup> SURVEY  
FOR  
EXPATRIATE RESOURCES LTD.  
DONJEK PROJECT AREAS  
YUKON TERRITORY



NTS 115G/5,12

Dighem, A division of CGG Canada Ltd.  
Mississauga, Ontario  
October 11, 1996

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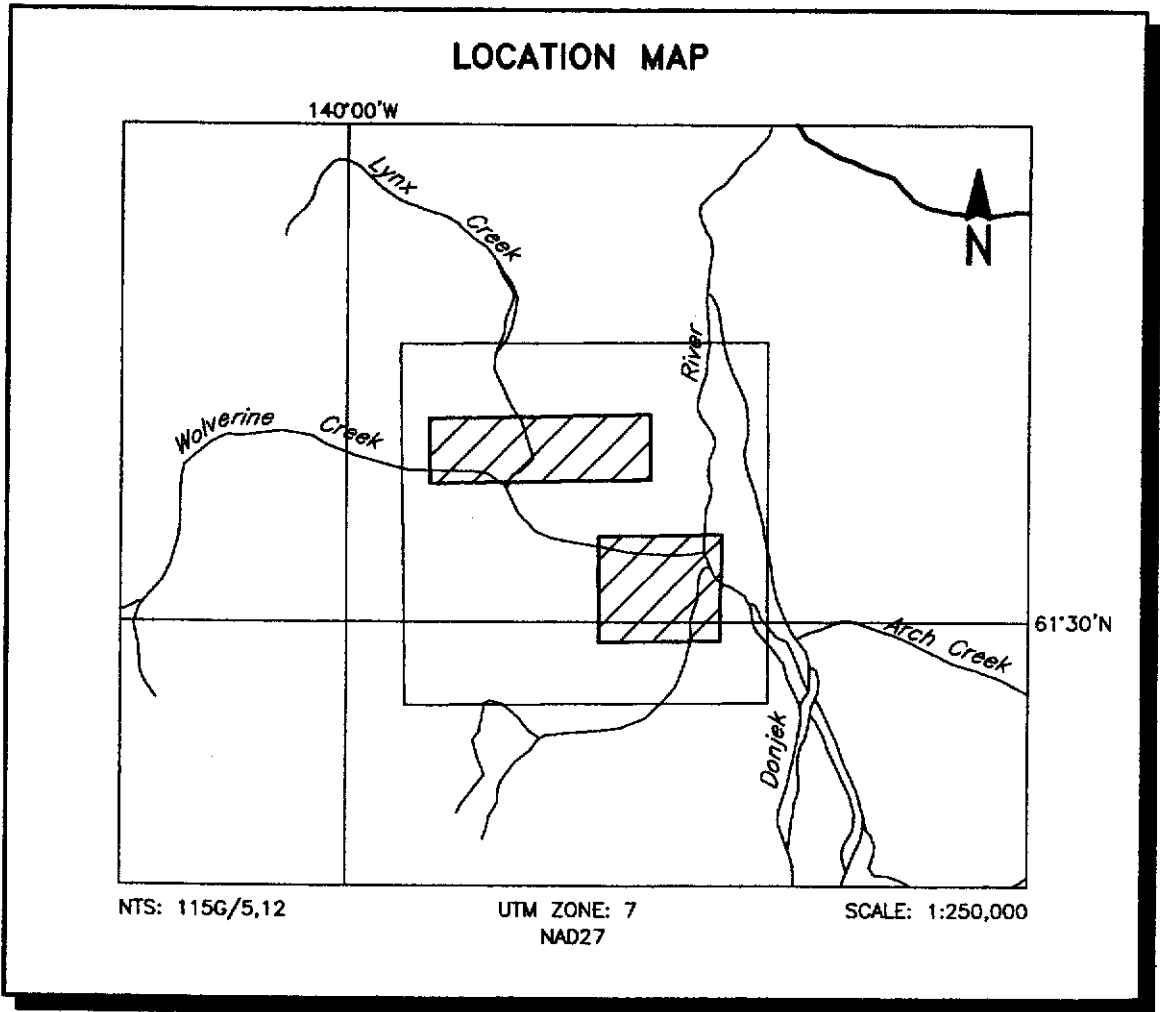
## SUMMARY

This report describes the logistics and results of a DIGHEM<sup>V</sup> airborne geophysical survey carried out for Expatriate Resources Ltd., over two properties located in the Wolverine Creek area, Yukon Territory. Total coverage of the survey blocks amounted to 167 km including tie lines. Both areas were flown on August 8, 1996.

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<sup>V</sup> multi-coil, multi-frequency electromagnetic system, supplemented by a high sensitivity Cesium magnetometer. The information from these sensors was processed to produce maps which display the magnetic and conductive properties of the survey areas. A GPS electronic navigation system, utilizing a UHF link, ensured accurate positioning of the geophysical data with respect to the base maps. Visual flight path recovery techniques were used to confirm the location of the helicopter where visible topographic features could be identified on the ground.

The survey properties contain a few anomalous features, some of which are considered to be of moderate to high priority as exploration targets. Most of the inferred bedrock conductors 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**  
**EXPATRIATE RESOURCES LTD.**  
**DONJEK AREAS, YUKON TERRITORY**  
**JOB #1253B**

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## INTRODUCTION

A DIGHEM<sup>V</sup> electromagnetic/resistivity/magnetic survey was flown for Expatriate Resources Ltd. on August 8, 1996, over two survey blocks located in the Wolverine Creek area, Yukon Territory. The Donjek Project comprises the Donjek North and Donjek South areas. The survey areas can be located on NTS map sheets 115G/5,12 (see Figure 1).

Survey coverage consisted of approximately 150 line-km, excluding tie lines, with 76 km acquired over Donjek North and 74 km in Donjek South. Flight lines were flown in an azimuthal direction of 180° with a line separation of 200 metres.

The survey employed the DIGHEM<sup>V</sup> electromagnetic system. Ancillary equipment consisted of a magnetometer, radar altimeter, video camera, analog and digital recorders and an electronic navigation system. The instrumentation was installed in an A-Star AS350B2 turbine helicopter (Registration CG-NAH) which was provided by Highland Helicopters Ltd. The helicopter flew at an average airspeed of 120 km/h with an EM bird height of approximately 30 m.

Section 2 provides details on the survey equipment, 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<sup>2</sup> of area which is presented by the bird to broadside gusts.

## SURVEY EQUIPMENT

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

### Electromagnetic System

Model: DIGHEM<sup>V</sup>

Type: Towed bird, symmetric dipole configuration operated at a nominal survey altitude of 30 metres. Coil separation is 8 metres for 900 Hz, 5500 Hz and 7200 Hz, and 6.3 metres for the 56,000 Hz coil-pair.

Coil orientations/frequencies:

coaxial	/	900 Hz
coplanar	/	900 Hz
coaxial	/	5,500 Hz
coplanar	/	7,200 Hz
coplanar	/	56,000 Hz

Channels recorded:

- 5 inphase channels
- 5 quadrature channels
- 2 monitor channels

Sensitivity:

0.06 ppm at	900 Hz
0.10 ppm at	5,500 Hz
0.10 ppm at	7,200 Hz
0.30 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 coils are vertical with their axes

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 20 m below the helicopter.

## **Magnetic Base Station**

Model: Scintrex MEP-710  
Type: Digital recording cesium vapour  
Sensitivity: 0.01 nT  
Sample rate: 1 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.

## **Radar Altimeter**

Manufacturer: Honeywell/Sperry  
Type: AA 220  
Sensitivity: 0.3 m

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 are 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

**Model:** DGR 33

**Recorder:** RMS TCR-12, 6400 bpi, tape cartridge recorder

The digital data are used to generate several computed parameters. Both measured and computed parameters are plotted as "multi-channel stacked 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)
4X7I	coaxial inphase (5500 Hz)	5 ppm	CXI (5500 Hz)
4X7Q	coaxial quad (5500 Hz)	5 ppm	CXQ (5500 Hz)
5P5I	coplanar inphase(56000 Hz)	10 ppm	CPI (56 kHz)
5P5Q	coplanar quad (56000 Hz)	10 ppm	CPQ (56 kHz)
ALTR	altimeter	3 m	ALT
MAGC	magnetics, coarse	20.0 nT	MAG100
MAGF	magnetics, fine	2.0 nT	MAG10
CXSP	coaxial sferics monitor		CXS
CPSP	coplanar sferics monitor		CPS
CXPL	coaxial powerline monitor		CXP
CPPL	coplanar powerline monitor		CPP
3PSP	coplanar sferics monitor		3PS
4XSP	coaxial sferics monitor		4XS

**Table 2-2. The Digital Profiles**

Channel Name (Freq)	Observed parameters	Scale units/mm
MAG10	magnetics (fine)	10 nT
MAG100	magnetics (coarse)	100 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
CXI (5500 Hz)	vertical coaxial coil-pair inphase	4 ppm
CXQ (5500 Hz)	vertical coaxial coil-pair quadrature	4 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
4XS	coaxial sferics monitor	
CXP	coaxial powerline monitor	
	<u>Computed Parameters</u>	
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 are recorded continuously and are displayed on the margin of each image. This procedure ensures accurate correlation of analog and digital data with respect to visible features on the ground.

## **Navigation System (RT-DGPS)**

Model: Sercel NR106, Real-time differential positioning

Type: SPS (L1 band), 10-channel, C/A code, 1575.42 MHz.

Sensitivity: -132 dBm, 0.5 second update

Accuracy: < 5 metres in differential mode,  
± 50 metres in S/A (non differential) mode

The Global Positioning System (GPS) is a line of sight, satellite navigation system which utilizes time-coded signals from at least four of the twenty-four NAVSTAR satellites. In the differential mode, two GPS receivers are used. The base station unit is used as a reference which transmits real-time corrections to the mobile unit in the aircraft, via a UHF radio datalink. The on-board system calculates the flight path of the

helicopter while providing real-time guidance. The raw XYZ data are recorded for both receivers, thereby permitting post-survey processing for accuracies of approximately 5 metres.

Although the base station receiver is able to calculate its own latitude and longitude, a higher degree of accuracy can be obtained if the reference unit is established on a known benchmark or triangulation point. For this survey, the base station was located at latitude  $61^{\circ}37.8623'N$  and  $139^{\circ}40.6502'W$  at an elevation of 830.5 m amsl. The GPS records data relative to the WGS84 ellipsoid, which is the basis of the revised North American Datum (NAD83). Conversion software is used to transform the WGS84 coordinates to the NAD27 system displayed on the base maps.

## **Field Workstation**

Manufacturer: Dighem  
Model: FWS: V2.74  
Type: 80486 based P.C.

A portable PC-based field workstation is used at the survey base to verify data quality and completeness. Flight tapes are dumped to a hard drive to permit the creation of a database. This process allows the field operators to display both the positional (flight path) and geophysical data on a screen or printer.

## **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. There is a significant offset in contour values along the sheet join between the published maps at latitude  $61^{\circ}30'N$  (Donjek South). The sheet join honours the UTM grid, rather than the elevation contours. The colour maps show the UTM grid only.

### **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 geophysicist, in conjunction with the computer-generated digital profiles, to produce

### Table 3-1 Survey Products

1. Final Transparent Maps (+3 prints) @ 1:20,000

Dighem EM anomalies  
Total field magnetic contours  
Calculated vertical magnetic gradient contours  
Resistivity (900 Hz) contours  
Resistivity (7200 Hz) contours  
Resistivity (56,000 Hz) contours

2. Colour Maps (2 sets) @ 1:20,000

Total field magnetics  
Calculated vertical magnetic gradient  
Resistivity (900 Hz)  
Resistivity (7200 Hz)  
Resistivity (56,000 Hz)  
Shadowed magnetic maps (Azimuth 360° and 45°)

3. Additional Products

Digital XYZ archive in Geosoft format (CD-ROM)  
Digital grid archives in Geosoft format  
Survey report (3 copies)  
Multi-channel stacked profiles  
Analog chart records  
Flight path video cassettes

Note: Other products can be produced from existing survey data, if requested.

the final interpreted EM anomaly map. This map includes bedrock, surficial and cultural conductors. A map containing only bedrock conductors can be generated, if desired.

## **Resistivity**

The apparent resistivity in ohm-m can be generated from the inphase and quadrature EM components for any of the frequencies, using a pseudo-layer halfspace model. A resistivity map portrays all the EM information for that frequency over the entire survey area. 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 (optional)**

The apparent percent magnetite by weight is computed wherever magnetite produces a negative inphase EM response. This calculation is more meaningful in resistive areas.

## **Total Field Magnetism**

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

## **Vertical Gradient Magnetism**

The total field magnetic data are subjected to a processing algorithm which enhances the response of magnetic bodies in the upper 500 m and attenuates the response of deeper bodies. The resulting vertical gradient (first vertical derivative) 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 are better defined on the total field magnetic map.

## **Magnetic Derivatives (optional)**

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

enhanced magnetism

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.

### **Multi-channel Stacked 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 are also presented in the final corrected form after interpretation. The profiles display electromagnetic anomalies with their respective interpretive symbols.

## **Contour, Colour and Shadow Map Displays**

The geophysical data are interpolated onto a regular grid using a modified Akima spline technique. The resulting grid is suitable for generating contour maps of excellent quality. The grid cell size is usually 25% of the line interval.

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 areas.

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. The shadow of the enhanced magnetic parameter is particularly suited for defining geological structures with crisper images and improved resolution.

Shadow maps of the total field magnetic data have been produced for both blocks, using sun azimuths of 360° and 45°.

## Conductivity-depth Sections (optional)

The apparent resistivities for all frequencies can be displayed simultaneously as coloured conductivity-depth sections. Usually, only the coplanar data are displayed as the quality tends to be higher than that of the coaxial data.

Conductivity-depth sections can be generated in two formats:

- (1) Sengpiel resistivity sections, where the apparent resistivity for each frequency is plotted at the depth of the centroid of the inphase current flow<sup>1</sup>; and,
- (2) Differential resistivity sections, where the differential resistivity is plotted at the differential depth<sup>2</sup>.

Both the Sengpiel and differential methods are derived from the pseudo-layer halfspace model. Both yield a coloured conductivity-depth section which attempts to portray a smoothed approximation of the true resistivity distribution with depth. Conductivity-depth sections are most useful in conductive layered situations, but may be unreliable in

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<sup>1</sup> Approximate Inversion of Airborne EM Data from Multilayered Ground: Sengpiel, K.P., *Geophysical Prospecting* 36, 446-459, 1988.

<sup>2</sup> The Differential Resistivity Method for Multi-frequency Airborne EM Sounding: Huang, H. and Fraser, D.C., presented at Intern. Airb. EM Workshop, Tucson, Ariz., 1993.

areas of moderate to high resistivity where signal amplitudes are weak. In areas where inphase responses have been suppressed by the effects of magnetite, the computed resistivities shown on the sections may be unreliable. The differential resistivity technique was developed by Dighem. It is more sensitive than the Sengpiel section to changes in the earth's resistivity and it reaches deeper.

## **SURVEY RESULTS**

### **GENERAL DISCUSSION**

The survey results are presented on separate map sheets for each parameter at a scale of 1:20,000. Tables 4-1 and 4-2 summarize the EM responses in the north and south blocks respectively, 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**  
**DONJEK NORTH**

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	1
2	1 - 5	11
1	<1	14
*	INDETERMINATE	19
TOTAL		45

CONDUCTOR MODEL	MOST LIKELY SOURCE	NUMBER OF RESPONSES
D	DISCRETE BEDROCK CONDUCTOR	1
B	DISCRETE BEDROCK CONDUCTOR	1
S	CONDUCTIVE COVER	43
TOTAL		45

(SEE EM MAP LEGEND FOR EXPLANATIONS)

**TABLE 4-2**  
**EM ANOMALY STATISTICS**  
**DONJEK SOUTH**

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	1
1	<1	17
*	INDETERMINATE	38
TOTAL		56

CONDUCTOR MODEL	MOST LIKELY SOURCE	NUMBER OF RESPONSES
S	CONDUCTIVE COVER	56
TOTAL		56

(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 MEP-710 cesium vapour 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 5 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 a vertical gradient 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 map.

There is some evidence on the magnetic maps which suggests that the survey areas have been subjected to deformation and/or alteration. These structural complexities are evident on the contour maps as variations in magnetic intensity, irregular patterns, and as offsets or changes in strike direction. Some of the more prominent linear features are also evident on the topographic base map.

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, have provided valuable information which can be used to effectively map the geology and structure in the survey areas.

## **Resistivity**

Resistivity maps, which display the conductive properties of the survey areas, were produced from the 900 Hz, 7200 Hz and 56,000 Hz coplanar data. The maximum resistivity values, which are calculated for each frequency, are 1,000, 8,000 and 20,000 ohm-m respectively. These cutoffs eliminate the meaningless higher resistivities which would result from very small EM amplitudes. In general, the resistivity patterns show moderately good agreement with the magnetic trends. This suggests that at least some of the resistivity lows are probably related to bedrock features, rather than conductive overburden. There are some areas, however, particularly on the western portion of Donjek North, where contour patterns appear to be strongly influenced by conductive surficial material in the creeks.

There are other resistivity lows in the area. One of these on Donjek South, is quite extensive and may reflect a "formational" conductor which may be of minor interest as a direct exploration target. However, attention may be focused on areas where such zones appear to be faulted or folded or where anomaly characteristics differ along strike.

## **Electromagnetics**

The EM anomalies resulting from this survey appear to fall within one of two general categories. The first type consists of discrete, well-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", "T" or "D" interpretive symbol, denoting a bedrock source. Only two anomalies of this type were identified.

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 in both survey blocks. 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 area 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. No conductor axes are indicated on the EM map because there were no discrete bedrock conductors which could be correlated from line to line. When studying the map sheets, consult the anomaly listings appended to this report.

### **Donjek North**

The magnetic data display a large dynamic range of approximately 2600 nT. Incursions, faults and fractures can be inferred from the breaks and changes in the directions of the magnetic units.

The most attractive EM anomaly in this block is located in the northeast corner of the survey area. Anomaly 20350A is a strong, well-defined narrow bedrock source

which appears to dip towards the north. The conductor is non-magnetic and is associated with a relative magnetic low. Anomaly 20340B may be associated with the same source as that of 20350A. This attractive conductor may be open to the east, and possibly to the north as well. Further investigations should be carried out to the north and east of this block, in order to determine the strike and extent of this interesting conductor.

Many anomalies are located within the Wolverine and Lynx Creek valleys in the western half of the survey block. They are most likely due to surficial sources. However, from the 900 Hz resistivity map there is evidence of increasing conductivity at depth coinciding with those anomalies found along Wolverine Creek. The significance of this conductive trend is further enhanced by its proximity to a probable east/west contact which can be inferred from the magnetic maps.

Other anomalies, which may be related to faults or contacts, include 20140A, 20150A & B, 20160A, 20210A, 20250A, 20260A, 20300A, 20340A and 29010C. In addition, there are several weak or poorly defined EM anomalies which may be of interest because of their magnetic correlation. These include anomalies 20070A, 20100A, 20130A, 20150C and 20270A. Anomalies 20030B, 20090A, 20150C and 20150D are all associated with well-defined resistivity lows of less than 200 ohm-m.

## Donjek South

There is a large irregularly shaped magnetic high located in the east-central portion half of the survey block. This unit yields magnetic values of more than 61,900 nT, on a background of less than 56,700 nT in the northeastern corner. Incursions, faults and fractures can be inferred from breaks and changes in the directions of the magnetic patterns.

Most of the anomalies are located within creeks or rivers and appear to be due to weakly conductive alluvial material. Anomalies of interest include those associated with contacts or faults inferred from the magnetic data or those which give rise to anomalous resistivity lows. Examples are 30040A, 30060A, 30090A, 30100A, 30120B, 30130A&B, 30140B&D, 30150B and 30160B.

The highly magnetic unit which dominates the east-central portion of the property coincides with a south-southeast trending resistivity high. This resistivity high is due primarily to the effects of magnetite, which has caused a reversal of the inphase components on several lines. The negative inphase on line 30140, for example, suggests a probable magnetite content of more than 8%.

Due to magnetite suppression, it is likely that any weakly conductive sulphides associated with this magnetite-rich host would give rise to anomalous responses on the

quadrature or high frequency parameters only. Therefore, any anomalous EM responses associated with this unit are considered to be of interest, even though they may be very weak. This includes anomalies contained within the magnetic unit, or those in the vicinity of its peripheral contact. In addition to the anomalous responses described previously, anomalies such as 30070A, 30100A, 30110A&B, 30130C, 30160C, and 30170A,C&D are all considered to be of potential interest, particularly if they occur in areas of favourable geology.

## **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 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.

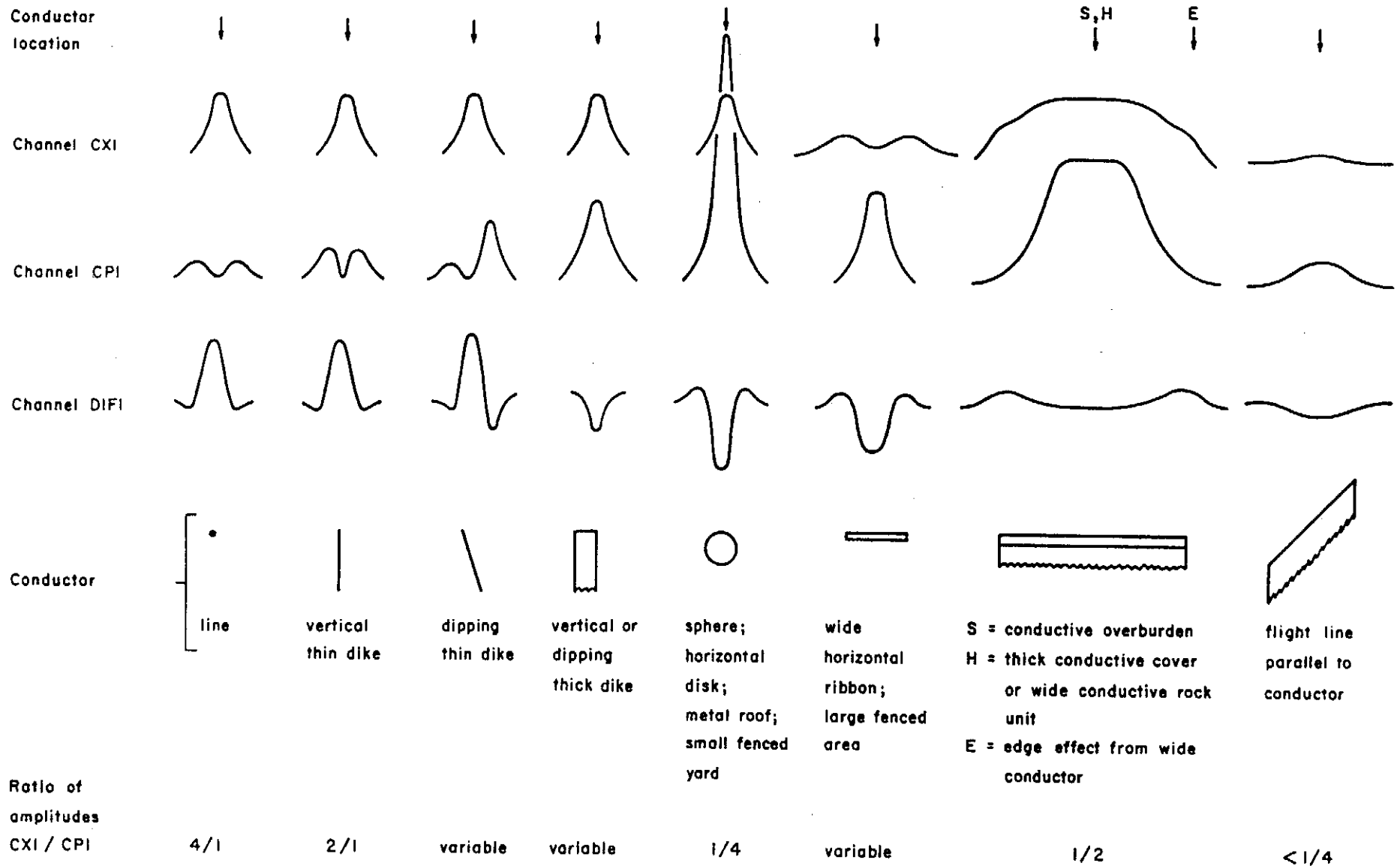


Fig. 5-1 Typical DIGHEM anomaly shapes

**Table 5-1. EM Anomaly Grades**

<u>Anomaly Grade</u>	<u>Siemens</u>
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 Inco 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)<sup>1</sup>. This model consists of a resistive layer overlying 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 quadrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the conductive half space (the source) and the sensor-source distance. The flying height is not an input variable, and the output resistivity and sensor-source distance are independent of the flying height. The apparent depth, discussed above, is

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

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 apparent value of the earth's resistivity, where resistivity =  $1/\text{conductivity}$ .
- (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<sup>2</sup>. 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 (DFI and DFQ), and the resistivity and depth channels (RES and DP) for each coplanar frequency.

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<sup>2</sup> The gradient analogy is only valid with regard to the identification of anomalous locations.

The EM difference channels (DFI and DFQ) eliminate most of the responses from conductive ground, leaving 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 (DFI and DFQ) 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 DFI for inphase and DFQ 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 DFI. 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.<sup>3</sup> 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 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.

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

## 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. Channels CXP and CPP monitor 60 Hz radiation. An anomaly on these channels 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.<sup>4</sup> 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

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<sup>4</sup> See Figure 5-1 presented earlier.

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 geometry, the most likely conductor is a metal roof or small fenced yard.<sup>5</sup> 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.<sup>5</sup> 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.

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<sup>5</sup> 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.

If, instead, a center-peaked coplanar anomaly occurred, there would be concern that a thick geologic conductor coincided with the cultural line.

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 channels 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 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 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.

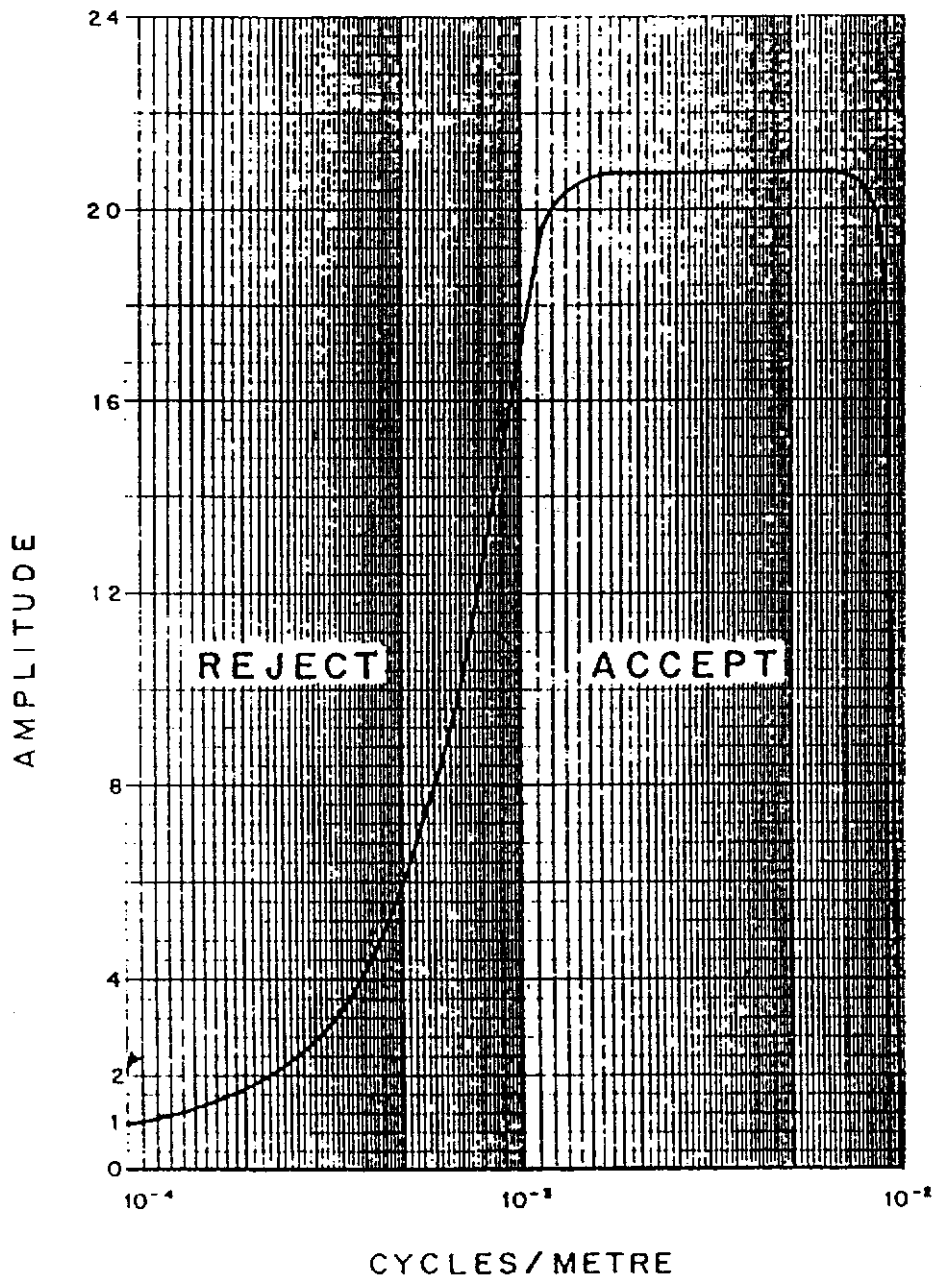


Fig. 5-2 Frequency response of magnetic enhancement operator.

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.

## CONCLUSIONS AND RECOMMENDATIONS

This report provides a very brief description of the survey results and describes the equipment, procedures and logistics of the survey over the Donjek North and Donjek South areas.

There is at least one EM anomaly in Donjek North which has been attributed to massive sulphides or possibly graphite. In addition, there is a well defined resistivity low in Donjek South which is associated with a strong magnetic high. The survey was also successful in locating a few moderately weak or broad conductors which may warrant additional work.

The various maps included with this report display the magnetic and conductive properties of the survey areas. 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 areas 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.

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**

A handwritten signature in cursive script, appearing to read "Linda Chung".

Linda E. Chung  
Geophysicist

LEC/sdp

A1253B.96R

## APPENDIX A

### LIST OF PERSONNEL

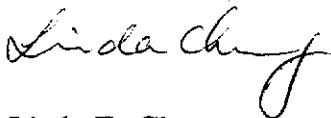
The following personnel were involved in the acquisition, processing, interpretation and presentation of data, relating to a DIGHEM<sup>V</sup> airborne geophysical survey carried out for Expatriate Resources Ltd. in the Donjek project areas, Yukon.

Greg Paleolog	Manager, Helicopter Operations
Doug McConnell	Manager, Data Processing & Interpretation
Mike White	Senior Geophysical Operator
Jeremy Weber	Field Data Processor
Pat Rooney	Pilot (Highland Helicopters Ltd.)
Gordon Smith	Data Processing Supervisor
Theron Greenaway	Computer Processor
Linda Chung	Interpretation Geophysicist
Lyn Vanderstarren	Drafting Supervisor
Mike Armstrong	Draftsperson (CAD)
Susan Pothiah	Word Processing Operator
Albina Tonello	Secretary/Expeditior

The survey consisted of 167 km of coverage, flown on August 8, 1996.

All personnel are employees of Dighem, except for the pilot who is an employee of Highland Helicopters Ltd.

#### DIGHEM



Linda E. Chung  
Geophysicist

LEC/sdp

A1253B.96R

## APPENDIX B

### STATEMENT OF COST

Date: October 4, 1996

#### IN ACCOUNT WITH DIGHEM

To: Dighem flying of Agreement dated February 28, 1996, pertaining to an Airborne Geophysical Survey in the Donjek Project area, Yukon Territory.

#### Survey Charges

150 km of flying:

Donjek North (76 km) - 50 km at a fixed cost of \$12,000 and remaining 26 km at \$95.00/km \$ 14,470.00

Donjek South (74 km) - 50 km at a fixed cost of \$12,000 and remaining 24 km at \$95.00/km \$ 14,280.00

\$ 28,750.00

#### Allocation of Costs

- Data Acquisition	(80%)
- Data Processing	(10%)
- Interpretation, Report and Maps	(10%)

**DIGHEM**



Linda E. Chung  
Geophysicist

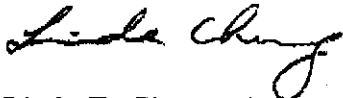
LCE/sdp

A1253B.96R

## STATEMENT OF QUALIFICATIONS

I, Linda E. Chung of the City of Scarborough, Province of Ontario, do hereby certify that:

1. I am a geophysicist, residing in Scarborough, Ontario.
2. I am a graduate of the University of Toronto, with an Honours B.Sc., Physics Specialist, Mathematics Major, Astronomy Major (1996).
3. I have been actively engaged in geophysical exploration since 1996.
4. I was personally responsible for the management of the interpretation and processing of the geophysical data described in this report.
5. I have no direct or indirect financial interest in the property described in this report.
6. I am presently employed by Dighem, a division of CGG Canada Ltd.



Linda E. Chung, Honours B.Sc.  
Geophysicist

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**APPENDIX C**

**EM ANOMALY LIST**

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## 1253 B - DONJEK NORTH, YUKON

	COAXIAL 1093 HZ	COPLANAR 893 HZ	COPLANAR 7215 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 20010	(FLIGHT	1)											
A 1826S?	5	12	5	20	52	65	2.3	1	1	35	114	0	8
B 1864S?	1	4	3	8	17	34	0.6	11	1	26	287	0	0
LINE 20020	(FLIGHT	1)											
A 1945S?	3	20	10	33	75	148	0.9	0	1	25	150	0	0
LINE 20030	(FLIGHT	1)											
A 1992S?	5	5	2	9	16	30	6.4	45	1	53	773	0	0
B 2003S?	3	10	6	18	46	58	1.5	3	1	41	120	5	0
C 2045S?	3	6	1	12	23	24	2.3	30	1	32	699	0	0
LINE 20040	(FLIGHT	1)											
A 2119S?	2	10	8	17	44	56	1.0	1	1	41	127	5	0
B 2077S?	0	9	0	16	36	82	0.4	0	1	31	663	0	0
LINE 20050	(FLIGHT	1)											
A 88S?	3	13	8	24	59	90	1.1	0	1	24	156	0	0
LINE 20060	(FLIGHT	1)											
A 213S?	1	12	6	19	40	75	0.4	0	1	32	189	0	0
LINE 20070	(FLIGHT	1)											
A 254S?	1	2	0	2	2	4	-	-	-	-	-	-	80
B 267S?	2	13	7	24	50	90	0.8	0	1	33	133	1	0
C 280S?	4	7	6	13	19	59	2.4	21	1	45	148	7	0
D 306S?	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 20080	(FLIGHT	1)											
A 399S?	3	14	4	24	54	98	0.9	0	1	29	141	0	0
LINE 20090	(FLIGHT	1)											
A 453S?	6	12	4	23	52	90	2.9	14	1	30	134	0	30
LINE 20100	(FLIGHT	1)											
A 548S?	0	2	0	2	2	4	-	-	-	-	-	-	60
LINE 20110	(FLIGHT	1)											
A 183S?	2	4	3	7	20	21	2.7	36	1	43	161	3	0
LINE 20120	(FLIGHT	1)											
A 495S?	1	6	3	10	23	31	0.6	0	1	28	249	0	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.

## 1253 B - DONJEK NORTH, YUKON

	COAXIAL 1093 HZ	COPLANAR 893 HZ	COPLANAR 7215 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 20130 (FLIGHT 1)													
A 530S?	1	2	0	2	2	4	-	-	-	-	-	-	80
LINE 20140 (FLIGHT 1)													
A 641S?	1	4	2	7	19	28	1.3	16	1	37	225	0	0
B 624S?	1	5	2	9	27	46	0.5	0	1	28	314	0	0
LINE 20150 (FLIGHT 1)													
A 705S?	1	2	1	2	2	4	-	-	-	-	-	-	0
B 708S?	1	2	1	2	2	4	-	-	-	-	-	-	0
C 728S?	2	5	2	10	19	45	1.3	23	1	36	264	0	20
D 747S?	2	22	2	40	97	196	0.5	0	1	8	282	0	0
E 750S?	3	22	1	40	97	109	0.8	0	1	7	320	0	0
LINE 20160 (FLIGHT 1)													
A 837B?	1	2	1	2	2	4	-	-	-	-	-	-	0
B 816S?	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 20170 (FLIGHT 1)													
A 1088S?	0	6	0	9	11	25	0.4	2	1	24	563	0	0
LINE 20180 (FLIGHT 1)													
A 1176S?	0	5	1	8	24	33	0.4	0	1	31	663	0	0
B 1144S?	0	2	0	2	2	4	-	-	-	-	-	-	7
LINE 20210 (FLIGHT 1)													
A 1400S?	0	2	0	2	0	4	-	-	-	-	-	-	0
LINE 20250 (FLIGHT 1)													
A 1757S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 20260 (FLIGHT 1)													
A 1814S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 20270 (FLIGHT 1)													
A 2064S?	0	4	0	8	0	52	0.4	11	1	91	875	11	40
LINE 20300 (FLIGHT 1)													
A 2341S?	0	2	0	2	0	4	-	-	-	-	-	-	0
B 2320S?	0	2	0	2	0	4	-	-	-	-	-	-	0
LINE 20320 (FLIGHT 1)													
A 2510S?	0	2	0	2	0	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.

## 1253 B - DONJEK NORTH, YUKON

	COAXIAL 1093 HZ	COPLANAR 893 HZ	COPLANAR 7215 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 DEPTH* SIEMEN	COND DEPTH M	COND DEPTH SIEMEN	RESIS M OHM-M	DEPTH M	NT
LINE 20340	(FLIGHT	1)										
A 2928S?	0	2	0	2	2	4	-	-	-	-	-	7
B 2990S?	0	7	1	7	12	33	0.4	0	1	67	733	0
LINE 20350	(FLIGHT	1)										
A 3015D	14	27	19	37	85	53	3.9	13	1	47	207	10
LINE 29010	(FLIGHT	1)										
A 1445S?	1	2	1	2	2	4	-	-	-	-	-	0
B 1380S	0	2	0	2	0	4	-	-	-	-	-	0
C 1362S?	1	2	0	2	1	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.

1253 C - DONJEK SOUTH, YUKON

	COAXIAL 1093 HZ	COPLANAR 893 HZ	COPLANAR 7215 HZ	VERTICAL DIKE	HORIZONTAL SHEET	CONDUCTIVE EARTH	MAG CORR						
ANOMALY/ FID/INTERP	REAL PEM	QUAD PEM	REAL PEM	QUAD PEM	REAL PEM	QUAD PEM	COND DEPTH* SIEMEN	M	COND DEPTH SIEMEN	M	RESIS OHM-M	DEPTH M	NT
LINE 30010 A 4691S?	(FLIGHT 0	2) 0	0	1	0	4	-	-	-	-	-	-	0
LINE 30020 A 4454S?	(FLIGHT 0	2) 2	0	2	2	4	-	-	-	-	-	-	0
LINE 30040 A 4115S?	(FLIGHT 0	2) 11	0	21	41	129	0.4	0	1	14	528	0	0
LINE 30050 A 4016S?	(FLIGHT 0	2) 2	0	2	2	4	-	-	-	-	-	-	0
B 4039S?	0	2	0	2	0	4	-	-	-	-	-	-	0
C 4054S?	0	2	0	2	2	4	-	-	-	-	-	-	170
LINE 30060 A 3896S?	(FLIGHT 0	2) 2	0	2	2	4	-	-	-	-	-	-	0
B 3880S?	0	5	0	9	32	44	0.4	0	1	40	720	0	0
C 3849S?	0	2	0	2	0	4	-	-	-	-	-	-	0
LINE 30070 A 3795S?	(FLIGHT 0	2) 2	0	2	0	4	-	-	-	-	-	-	0
LINE 30080 A 3592S?	(FLIGHT 0	2) 2	0	2	2	4	-	-	-	-	-	-	0
LINE 30090 A 3503S?	(FLIGHT 0	2) 2	0	2	2	4	-	-	-	-	-	-	0
B 3529S?	0	8	0	13	24	63	0.4	0	1	22	583	0	250
LINE 30100 A 3371S?	(FLIGHT 0	2) 6	0	10	15	69	0.4	3	1	45	722	0	0
B 3333S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 30110 A 3233S?	(FLIGHT 0	2) 2	0	2	0	4	-	-	-	-	-	-	0
B 3261S?	0	10	0	17	26	71	0.4	4	1	8	384	0	0
LINE 30120 A 3065S?	(FLIGHT 0	2) 2	0	2	0	4	-	-	-	-	-	-	0
B 3036S?	0	2	0	2	2	4	-	-	-	-	-	-	0
C 3017S?	0	2	0	2	2	4	-	-	-	-	-	-	0
D 3011S?	0	2	0	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.

1253 C - DONJEK SOUTH, YUKON

	COAXIAL 1093 HZ	COPLANAR 893 HZ	COPLANAR 7215 HZ	VERTICAL DIKE	HORIZONTAL SHEET	CONDUCTIVE EARTH	MAG CORR						
ANOMALY/ FTID/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 30130	(FLIGHT	2)											
A 2880S?	0	2	0	2	2	4	-	-	-	-	-	-	0
B 2923S?	0	2	0	2	2	4	-	-	-	-	-	-	0
C 2938S?	0	2	0	2	2	4	-	-	-	-	-	-	0
D 2944S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 30140	(FLIGHT	2)											
A 2839S?	0	8	0	14	30	90	0.4	0	1	20	689	0	0
B 2828S?	0	2	0	2	1	4	-	-	-	-	-	-	0
C 2779S?	0	2	0	2	2	4	-	-	-	-	-	-	0
D 2761S?	0	11	0	19	18	115	0.4	6	1	13	402	0	0
E 2756S?	0	2	0	2	2	4	-	-	-	-	-	-	0
F 2752S?	0	12	0	32	24	170	0.4	4	1	14	441	0	0
LINE 30150	(FLIGHT	2)											
A 2517S?	0	7	0	11	6	74	0.4	0	1	49	771	0	0
B 2508S?	0	2	0	2	2	4	-	-	-	-	-	-	0
C 2481S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 30160	(FLIGHT	2)											
A 2351S?	0	2	0	2	0	4	-	-	-	-	-	-	0
B 2367S?	0	6	0	12	12	77	0.4	0	1	28	658	0	0
C 2397S?	0	2	0	2	2	4	-	-	-	-	-	-	0
D 2412S?	0	2	0	2	2	4	-	-	-	-	-	-	0
E 2422S?	2	7	0	10	18	48	1.3	18	1	16	542	0	0
LINE 30170	(FLIGHT	2)											
A 2313S?	0	2	0	2	2	4	-	-	-	-	-	-	0
B 2280S?	0	2	0	2	2	4	-	-	-	-	-	-	0
C 2263S?	0	2	0	6	21	31	0.4	4	1	16	471	0	450
D 2257S?	0	2	0	2	2	4	-	-	-	-	-	-	0
E 2236S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 30180	(FLIGHT	2)											
A 2102S?	0	6	2	12	33	25	0.4	0	1	9	478	0	0
B 2128S?	0	2	0	2	2	4	-	-	-	-	-	-	0
LINE 30200	(FLIGHT	2)											
A 1846S	0	2	0	2	2	4	-	-	-	-	-	-	0
B 1867S	0	4	1	8	12	36	0.4	4	1	11	413	0	0
LINE 39010	(FLIGHT	2)											
A 1431S?	0	8	0	14	40	80	0.4	0	1	18	638	0	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.

## 1253 C - DONJEK SOUTH, YUKON

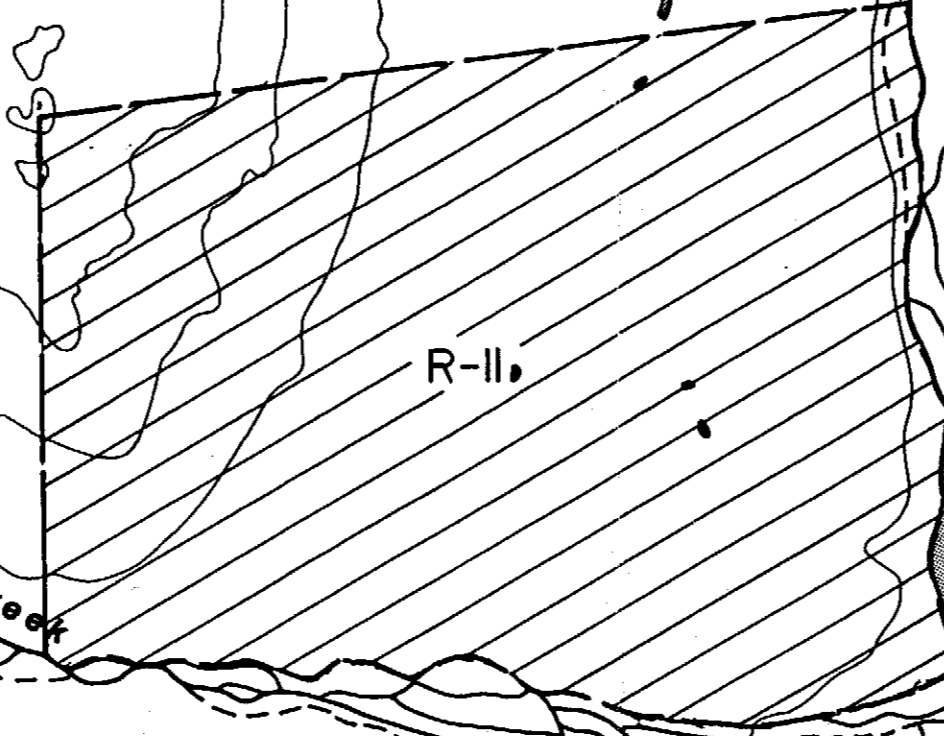
	COAXIAL 1093 HZ	COPLANAR 893 HZ		COPLANAR 7215 HZ		VERTICAL DIKE	HORIZONTAL SHEET	CONDUCTIVE EARTH	MAG CORR				
ANOMALY/ FID/INTERP	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	COND DEPTH* SIEMEN M	COND DEPTH SIEMEN M	RESIS OHM-M	DEPTH M	NT		
LINE 39010	(FLIGHT	2)											
B 1420S?	0	2	0	2	0	4	-	-	-	-	0		
C 1413S?	0	8	0	12	29	74	0.4	2	1	28	603	0	660
LINE 39020	(FLIGHT	2)											
A 1571S?	1	2	1	2	2	4	-	-	-	-	0		
B 1581S?	1	2	0	2	2	4	-	-	-	-	0		
C 1614S?	0	7	0	10	26	48	0.4	3	1	37	689	0	0
D 1637S?	0	2	0	2	0	4	-	-	-	-	0		
E 1653S?	1	14	0	28	40	112	0.4	9	1	9	328	0	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.

N ↑ 1:30,000

(ST ELIAS

1 WOLV YB46972	3 YB46974	5 YB46976	7 YB46978	9 YB46980	11 YB46982	13 WOLV YB46984	15 YB46986	17 YB46988	19 YB46990	21 YB46992	23 WOLV YB46994
2 YB46973	4 YB46975	6 YB46977	8 WOLV YB46979	10 YB46981	12 YB46983	14 YB46985	16 YB46987	18 YB46989	20 WOLV YB46991	22 YB46993	24 YB46995



1 DON YB46996	3 YB46998	5 YB47000	7 YB47002	9 DON YB47004
2 YB46997	4 YB46999	6 DON YB47001	8 YB47003	10 YB47005
11 YB47006	13 YB47008	15 YB47010	17 YB47012	19 YB47015
12 YB47007	14 DON YB47009	16 YB47011	18 YB47013	20 DON YB47014

MOUNTAIN

16 YB96999	14 YB96997	12 YB96996	10 YB96993
15 YB96998	13 YB96996	11 YB96994	9 YB96992
32 YB97015	30 YB97013	28 YB97011	26 YB97009
31 YB97014	29 YB97012	27 YB97010	25 YB97008
40 YB97023	38 YB97021	36 YB97019	34 YB97017
39 YB97022	37 YB97020	35 YB97018	33 YB97016

SP. Nos for GER  
1. Fe 10 YB9713  
YB9714  
ODI 042  
YB96964 to YA

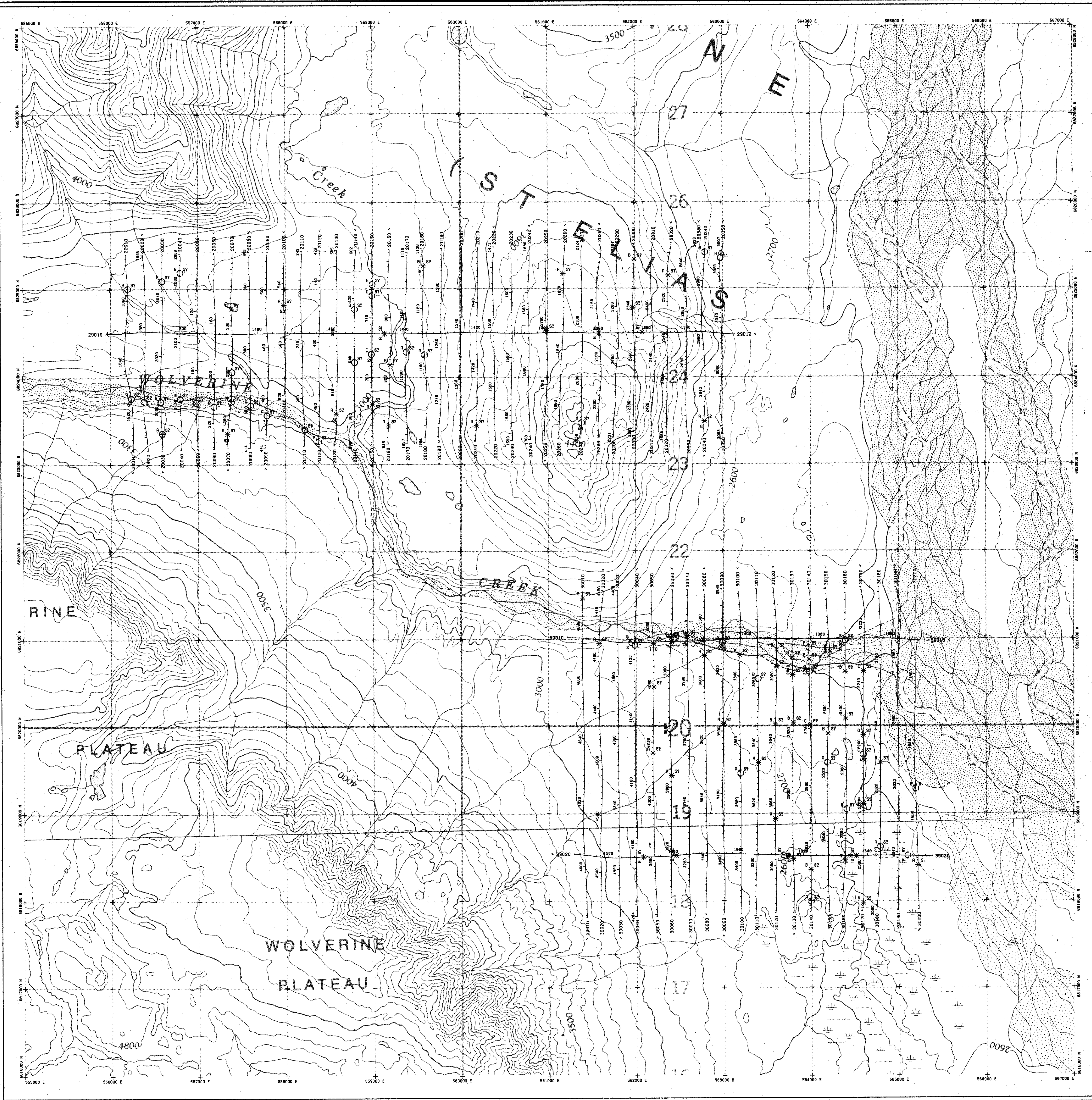
61 30

140 55'

50'

1156/12

45'



**TECHNICAL SUMMARY**

Navigation: Serial differential GPS positioning  
 Data reduction grid interval: 50 metres  
 Terrain clearance: Helicopter 50 m, Electromagnetic sensor 30 m  
 Magnetometer: 40 m  
 Data sampling interval: 0.1 second  
 Magnetometer / sensitivity: Scintrex cesium / 0.01 nT  
 Electromagnetic system: DIGHEM<sup>®</sup>

Frequency	Sensitivity	Coil Orientation
900 Hz	0.1 ppm	Vertical coaxial
5500 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	0.5 ppm	Horizontal coplanar

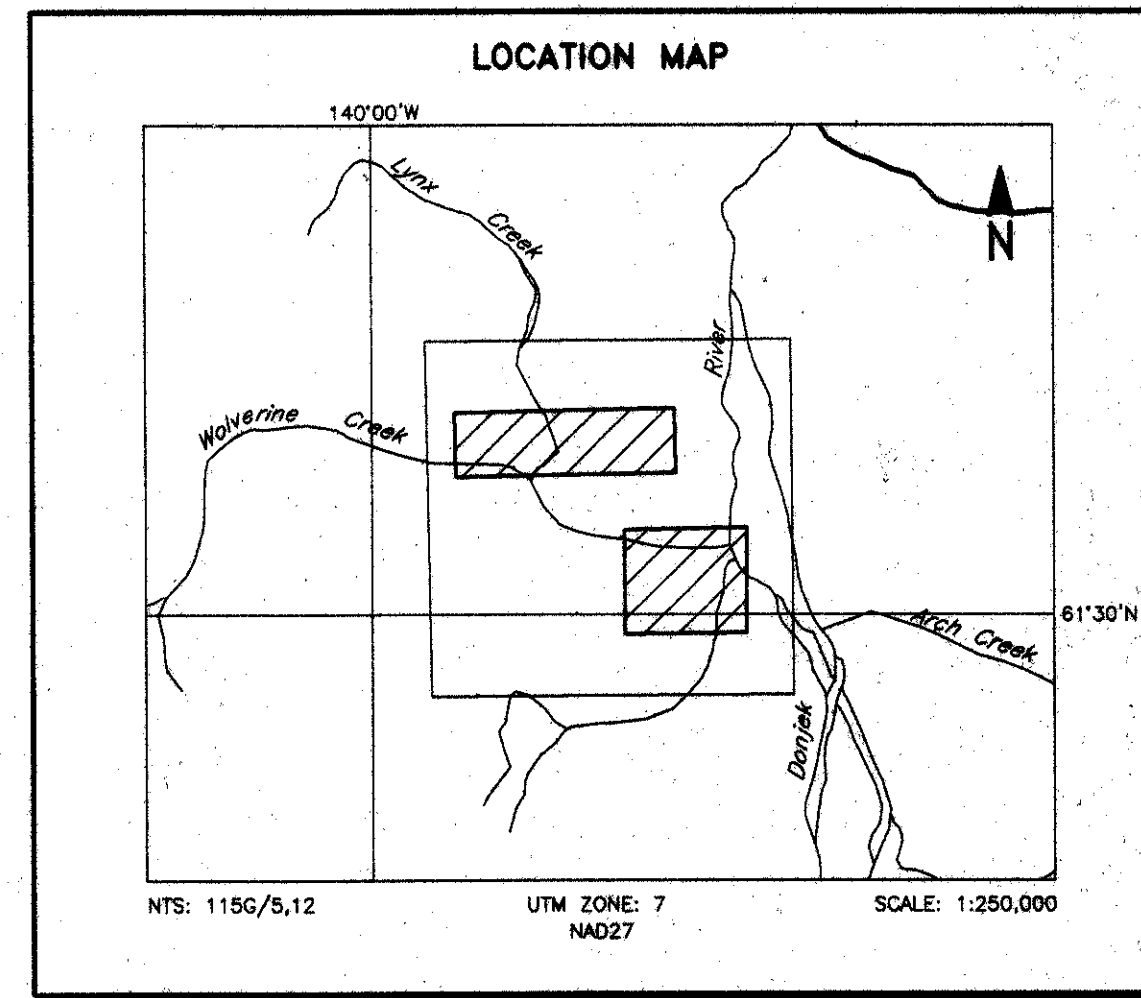
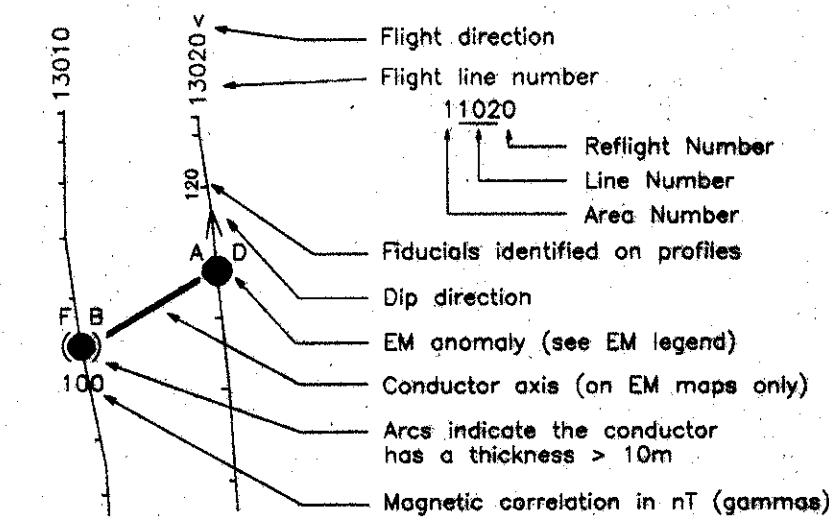


**ELECTROMAGNETIC ANOMALIES**

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	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, metal building or fence

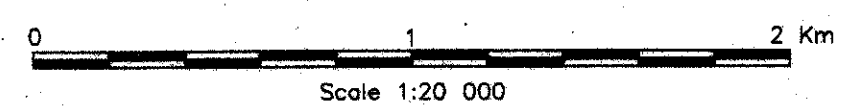
**FLIGHT LINES WITH EM ANOMALIES**



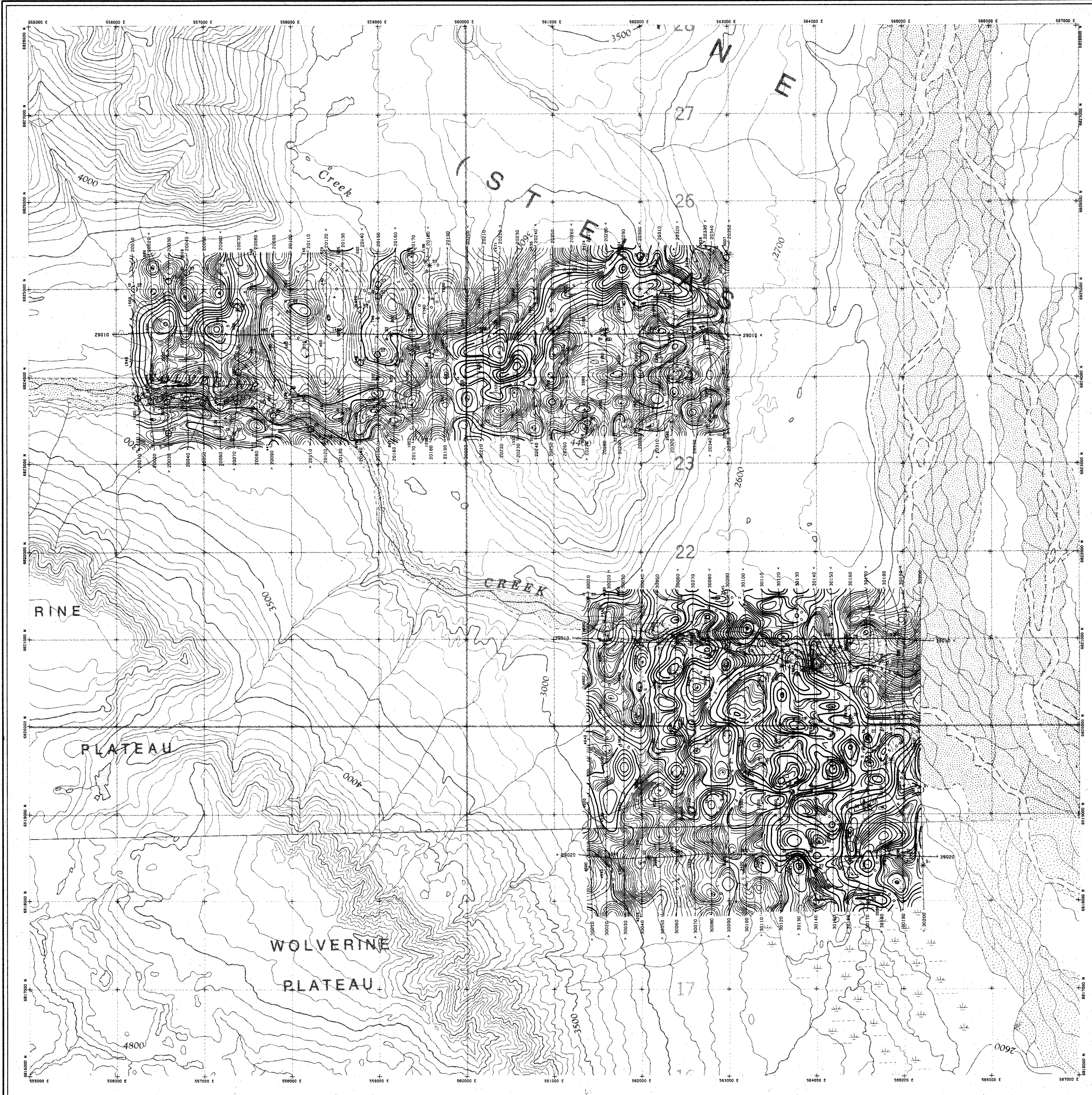
**EXPATRIATE RESOURCES LTD.**  
**DONJEK PROJECT AREAS, YUKON**

**ELECTROMAGNETIC ANOMALIES**

DIGHEM <sup>®</sup> SURVEY	NTS: 115G/5,12	GEOPHYSICIST: JC
DATE: SEPTEMBER, 1996	JOB: 1253	SHEET: 1
DIGHEM, A division of CGG Canada Ltd.		



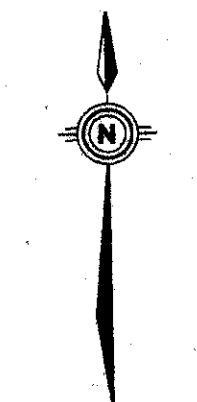
**DIGHEM**  
 Quality and Service in Airborne Geophysics



**TECHNICAL SUMMARY**

Navigation  
 Data reduction grid interval: Serial differential GPS positioning  
 50 metres  
 Terrain clearance: Helicopter 60 m  
 Electromagnetic sensor 30 m  
 Magnetometer 40 m  
 Data sampling interval: 0.1 second  
 Magnetometer / sensitivity: Scintrex cesium / 0.01 nT  
 Electromagnetic system: DIGHEM\*

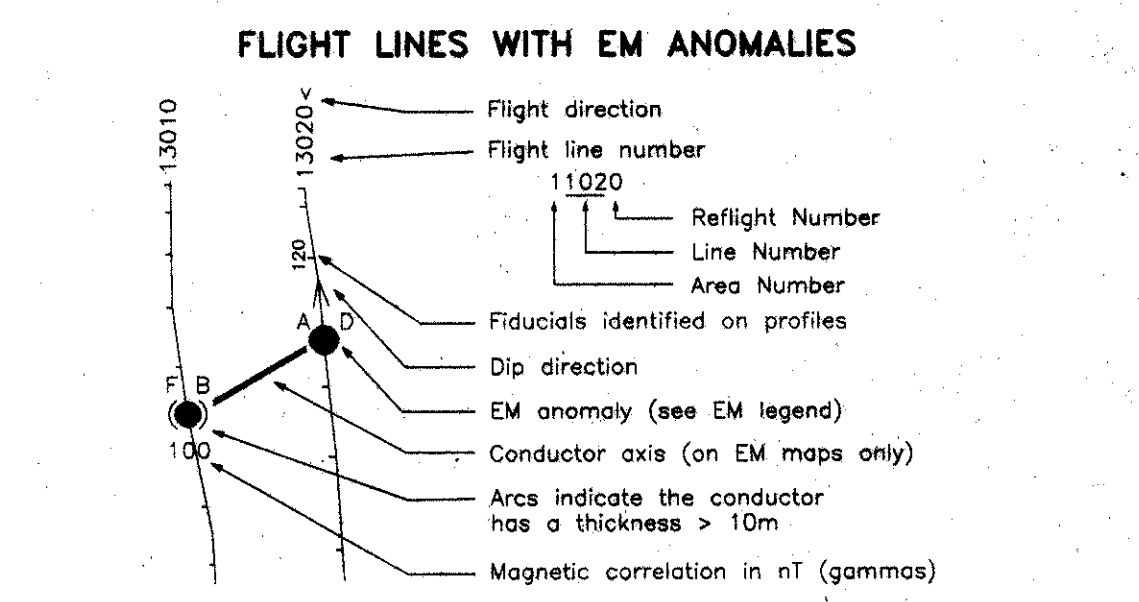
Frequency	Sensitivity	Coil Orientation
900 Hz	0.1 ppm	Vertical coaxial
5600 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	0.5 ppm	Horizontal coplanar



**ELECTROMAGNETIC ANOMALIES**

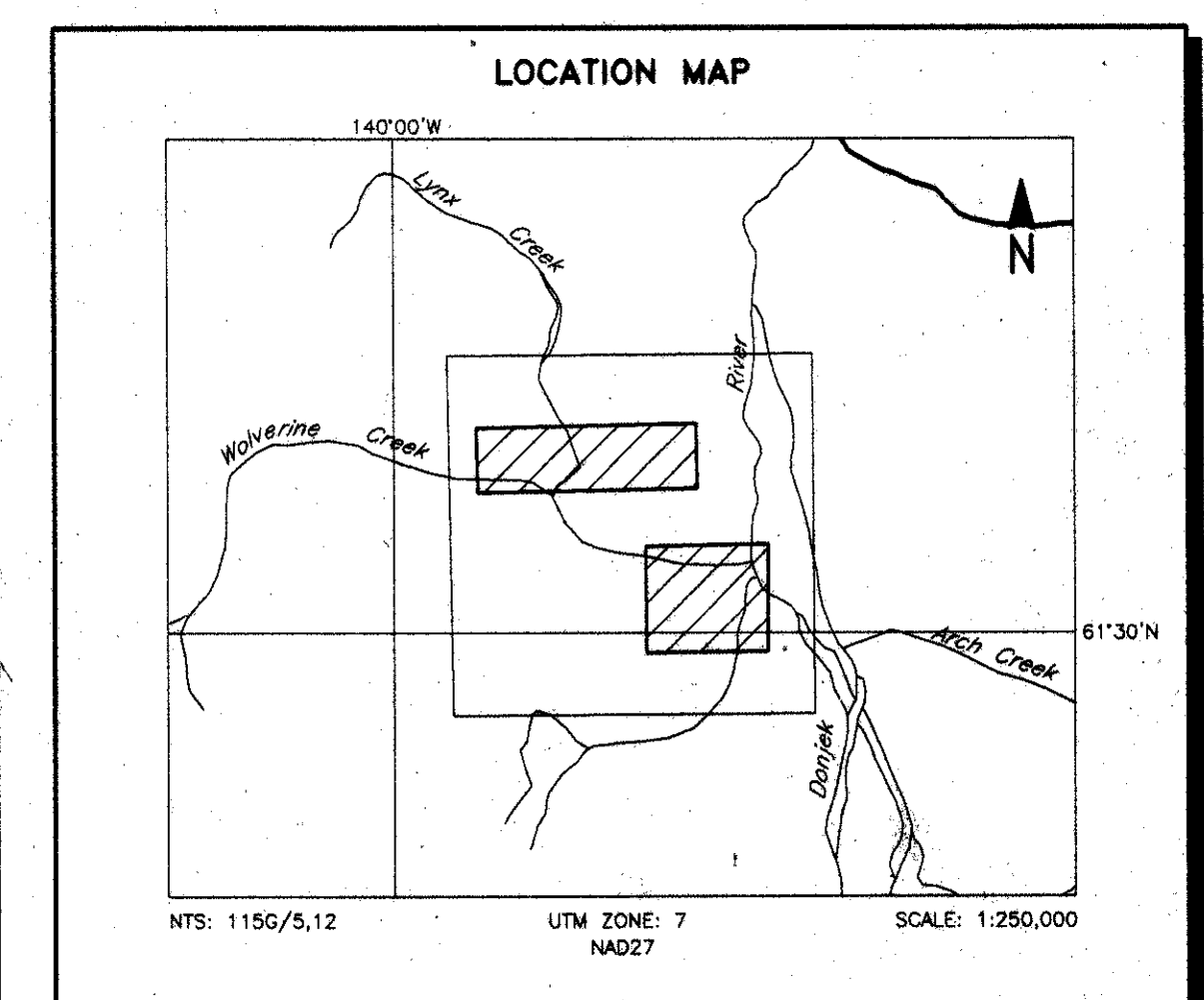
Grade	Anomaly	Conductance
7	●	>100 siemens
6	●	50-100 siemens
5	●	20-50 siemens
4	●	10-20 siemens
3	●	5-10 siemens
2	●	1-5 siemens
1	●	<1 siemens
-	*	Questionable anomaly

Anomaly identifier	Interpretive symbol	Conductor ("model")
CH	○	Bedrock conductor
	○	Narrow bedrock conductor ("thin dike")
	○	Conductive cover ("horizontal thin sheet")
	○	Broad conductive rock unit, deep conductive weathering, thick conductive cover ("half space")
	○	Edge of broad conductor ("edge of half space")
	○	Culture, e.g. power line, metal building or fence



**CALCULATED VERTICAL GRADIENT CONTOURS**

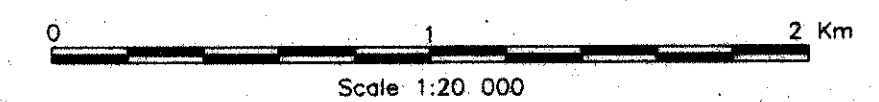
—	2.5 nT/metre
—	0.5 nT/metre
—	0.1 nT/metre
—	0.05 nT/metre



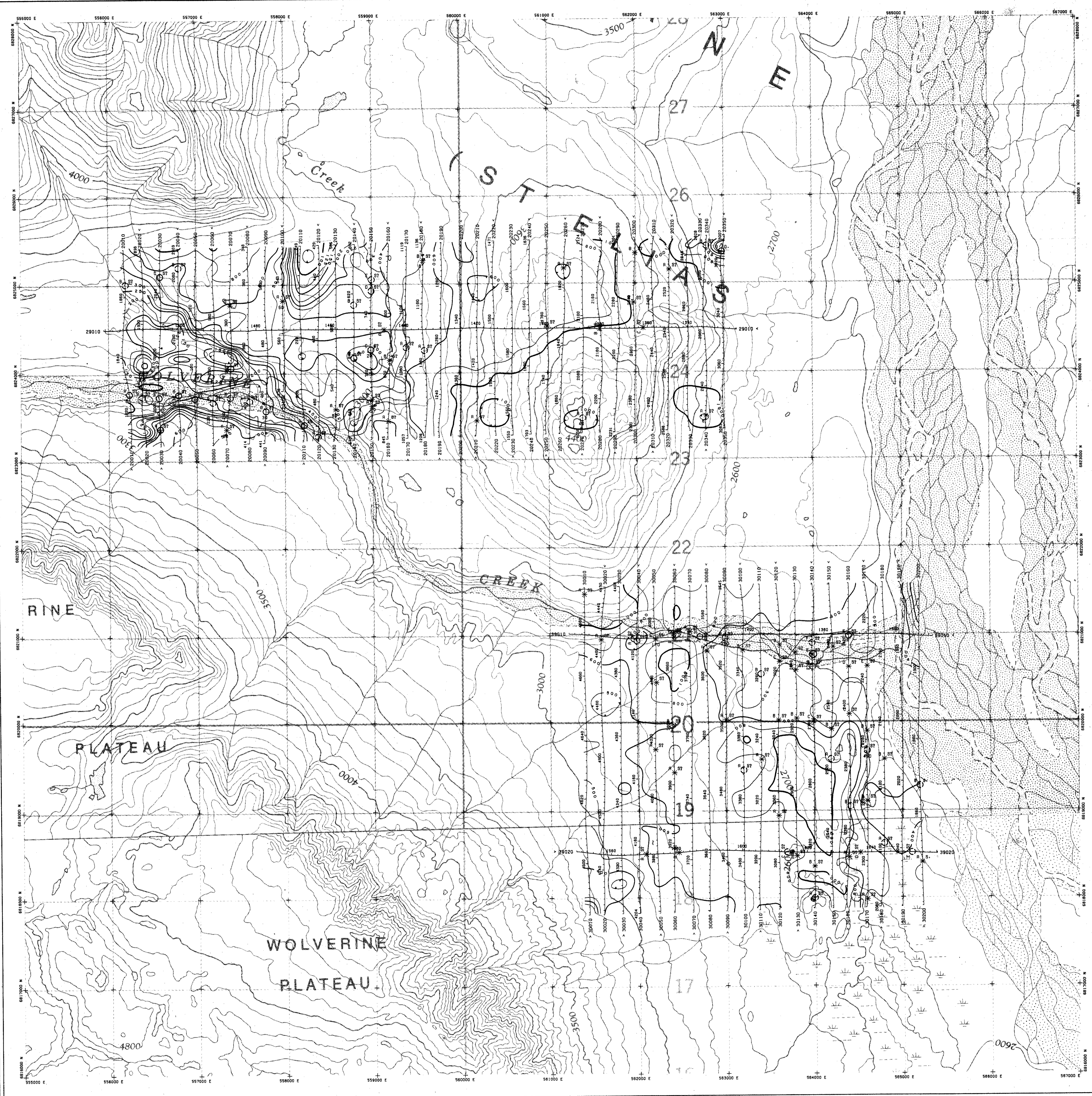
**EXPATRIATE RESOURCES LTD.**  
 DONJEK PROJECT AREAS, YUKON

**CALCULATED VERTICAL GRADIENT MAGNETICS**

DIGHEM * SURVEY	NTS: 1156/5,12	GEOPHYSICIST: KC
DATE: SEPTEMBER, 1996	JOB: 1253	SHEET: 1
DIGHEM, A division of CGG Canada Ltd.		



**DIGHEM**  
 Quality and Service in Airborne Geophysics



**TECHNICAL SUMMARY**

Navigation . . . . . Serial differential GPS positioning  
 Data reduction grid interval . . . . . 50 metres  
 Terrain clearance . . . . . Helicopter 60 m  
 . . . . . Electromagnetic sensor 30 m  
 . . . . . Magnetometer 40 m  
 Data sampling interval . . . . . 0.1 second  
 Magnetometer / sensitivity . . . . . Scintrex cesium / 0.01 nT  
 Electromagnetic system . . . . . DIGHEM

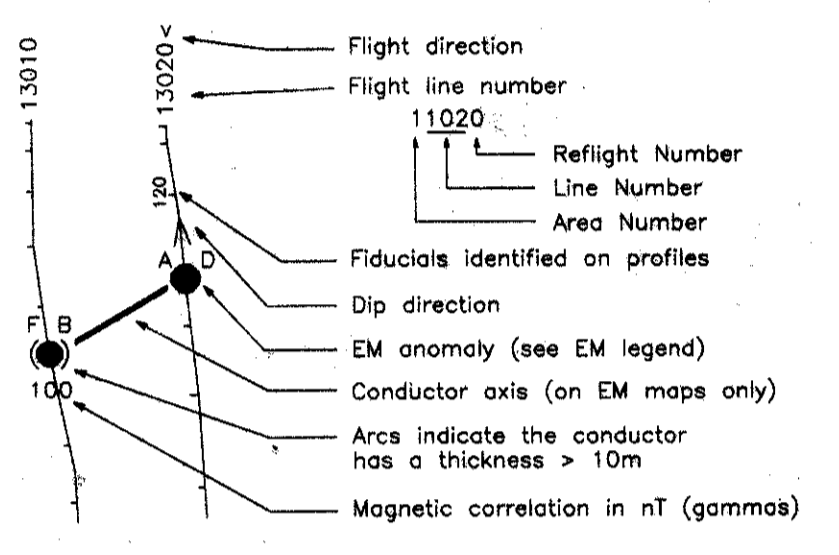
Frequency	Sensitivity	Coil Orientation
900 Hz	0.1 ppm	Vertical coaxial
5500 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	0.5 ppm	Horizontal coplanar

**ELECTROMAGNETIC ANOMALIES**

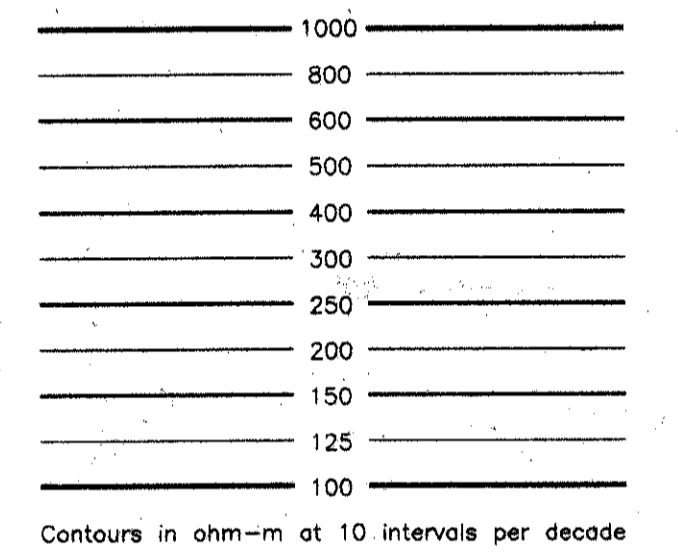
Grade	Anomaly	Conductance
7	●	>100 siemens
6	●	50-100 siemens
5	●	20-50 siemens
4	●	10-20 siemens
3	●	5-10 siemens
2	●	1-5 siemens
1	●	< 1 siemens
-	*	Questionable anomaly

Depth is greater than	Interpretive symbol	Conductor ("model")
15 m	B	Bedrock conductor
30 m	D	Narrow bedrock conductor ("thin dike")
45 m	S	Conductive cover ("horizontal thin sheet")
60 m	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, metal building or fence

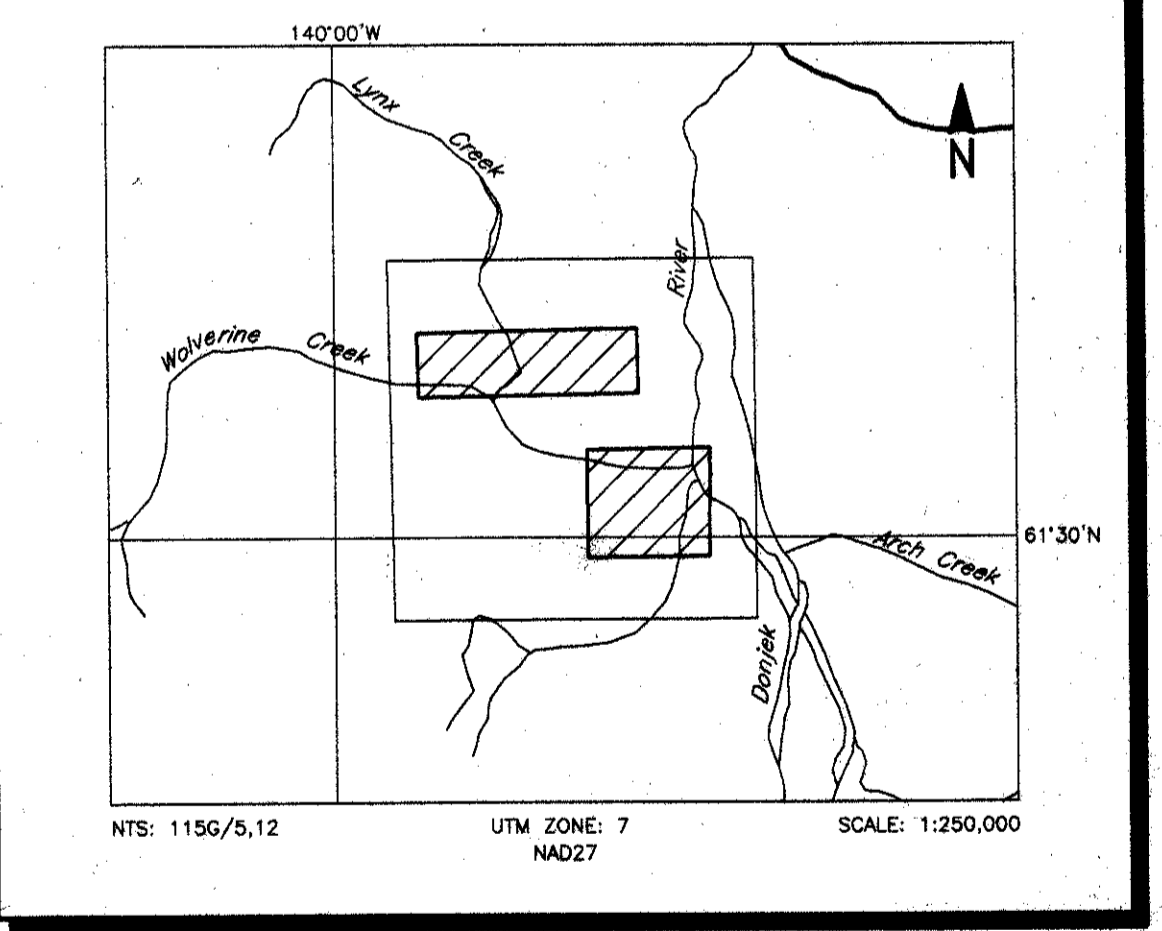
**FLIGHT LINES WITH EM ANOMALIES**



**RESISTIVITY CONTOURS**



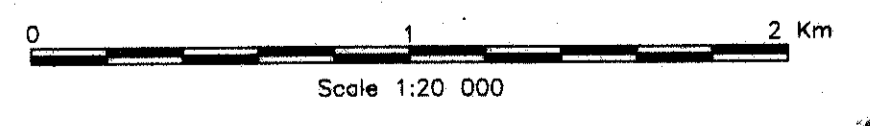
**LOCATION MAP**



**EXPATRIATE RESOURCES LTD.**  
 DONJEK PROJECT AREAS, YUKON

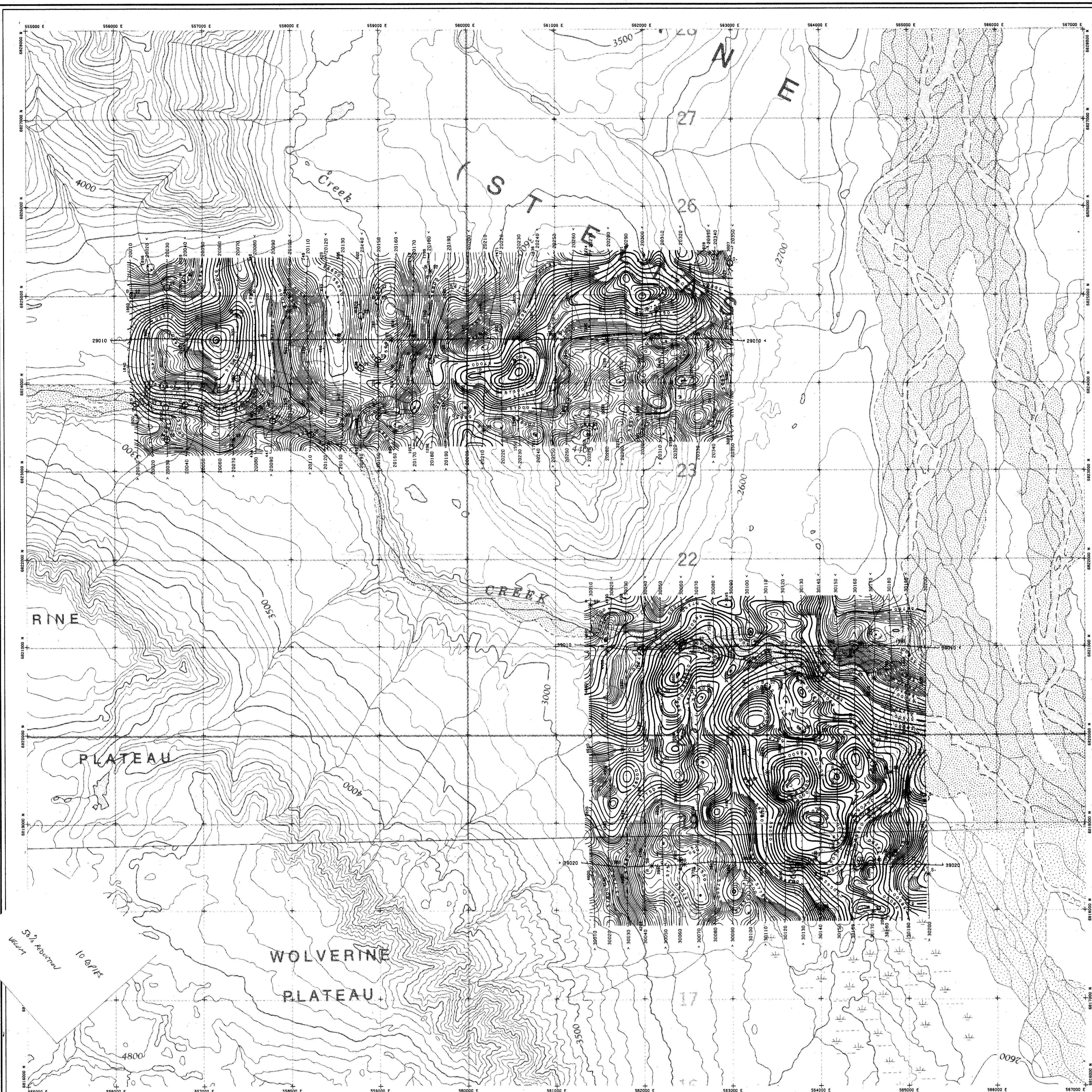
**RESISTIVITY  
 900 Hz COPLANAR**

DIGHEM SURVEY	NTS: 115G/5,12	GEOPHYSICIST: AC
DATE: SEPTEMBER, 1996	JOB: 1253	SHEET: 1
DIGHEM, A division of CGG Canada Ltd.		



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**TECHNICAL SUMMARY**

Navigation . . . . . Sercol differential GPS positioning  
 Data reduction grid interval . . . . . 50 metres  
 Terrain clearance . . . . . Helicopter 50 m  
 . . . . . Electromagnetic sensor 30 m  
 . . . . . Magnetometer 40 m  
 Data sampling interval . . . . . 0.1 second  
 Magnetometer / sensitivity . . . . . Schlögl cesium / 0.01 nT  
 Electromagnetic system . . . . . DIGEM\*

Frequency	Sensitivity	Coil Orientation
900 Hz	0.1 ppm	Vertical coaxial
5500 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	0.5 ppm	Horizontal coplanar

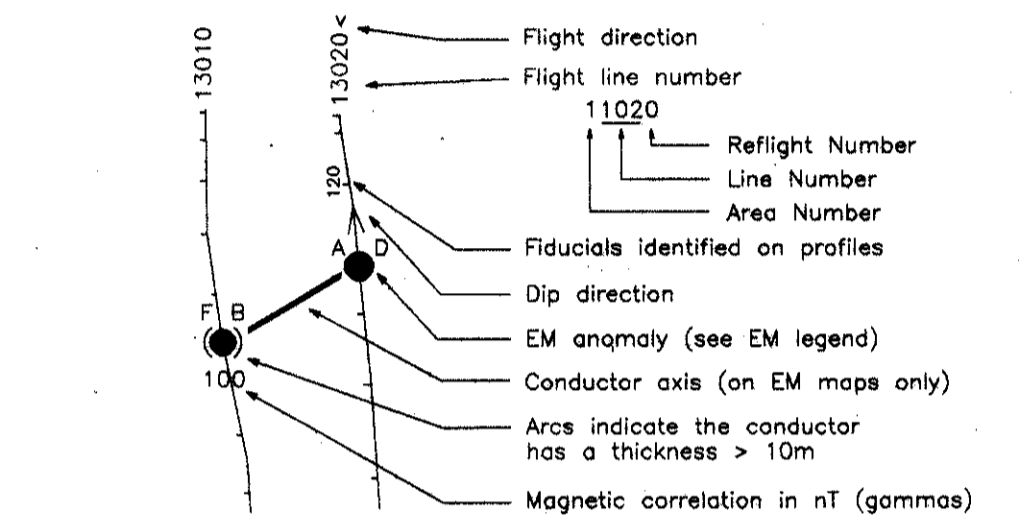


**ELECTROMAGNETIC ANOMALIES**

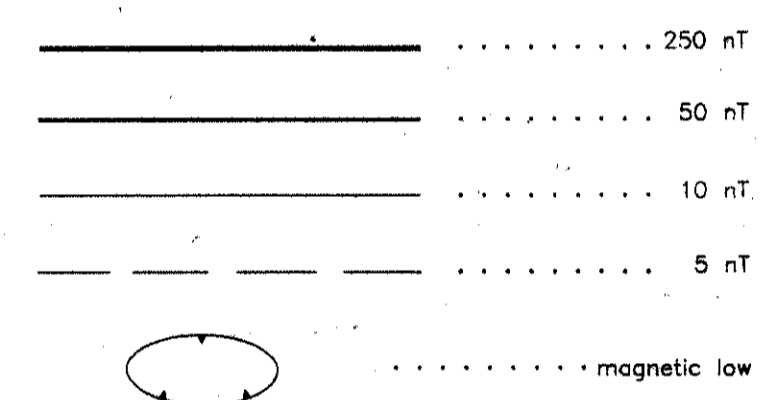
Grade	Anomaly	Conductance
7	●	>100 siemens
6	●	50-100 siemens
5	●	20-50 siemens
4	●	10-20 siemens
3	●	5-10 siemens
2	●	1-5 siemens
1	●	< 1 siemens
-	*	Questionable anomaly

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

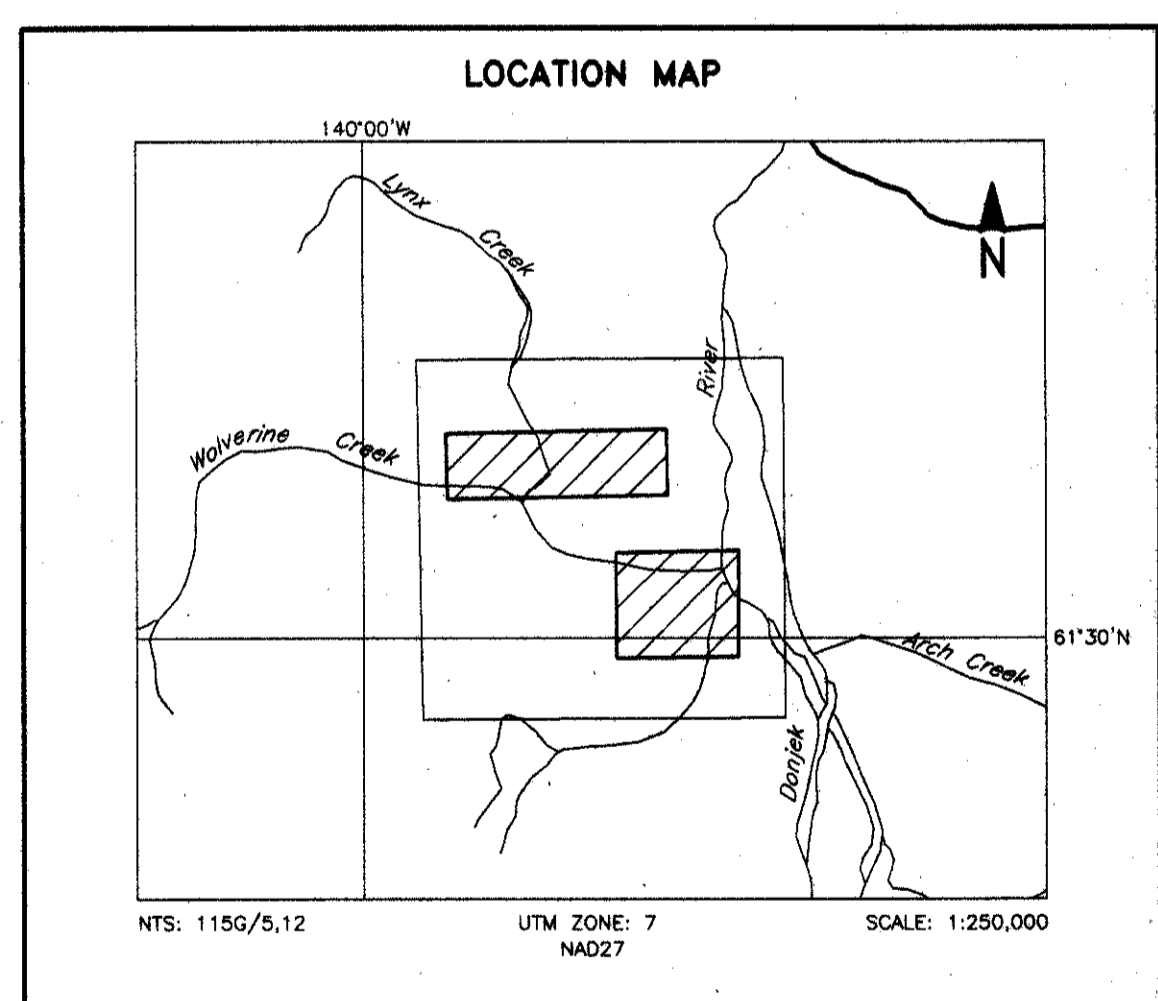
**FLIGHT LINES WITH EM ANOMALIES**



**TOTAL FIELD MAGNETIC CONTOURS**



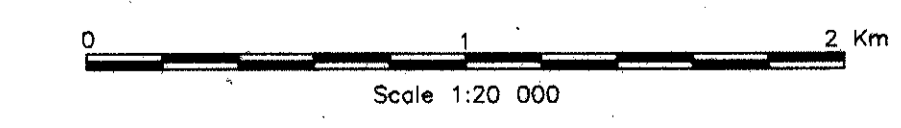
Magnetic inclination within the survey area: 76 degrees N  
 Magnetic declination within the survey area: 27 degrees E



**EXPATRIATE RESOURCES LTD.**  
 DONJEK PROJECT AREAS, YUKON

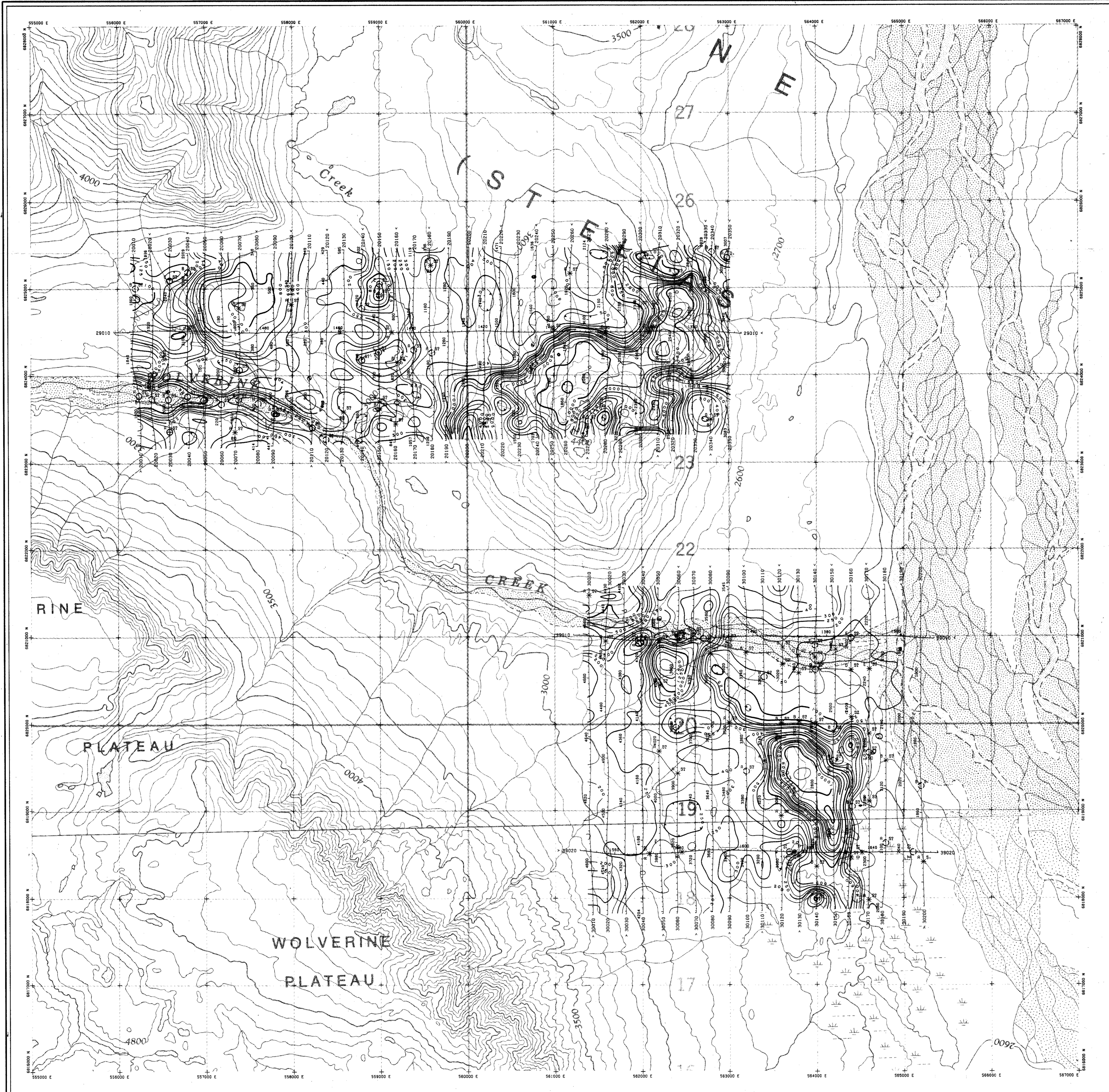
**TOTAL FIELD MAGNETICS**

DIGEM* SURVEY	NTS: 1156/5,12	GEOPHYSICIST: JC
DATE: SEPTEMBER, 1996	JOB: 1253	SHEET: 1
DIGEM, A division of CGG Canada Ltd.		



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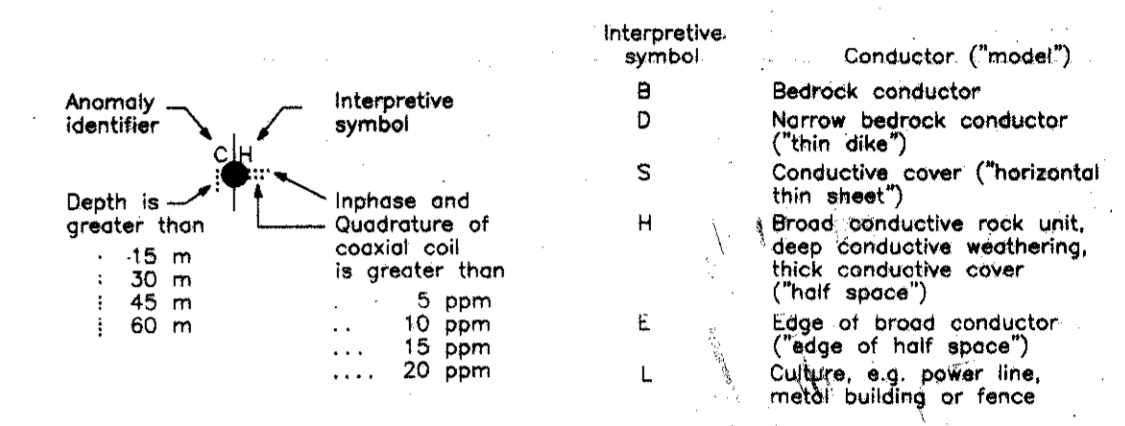
**TECHNICAL SUMMARY**

Navigation ..... Sercol differential GPS positioning  
 Data reduction grid interval ..... 50 metres  
 Helicopter 60 m  
 Terrain clearance ..... Electromagnetic sensor 30 m  
 Magnetometer 40 m  
 Data sampling interval ..... 0.1 seconds  
 Magnetometer / sensitivity ..... Scintrex cesium / 0.01 nT  
 Electromagnetic system ..... DIGHEM\*

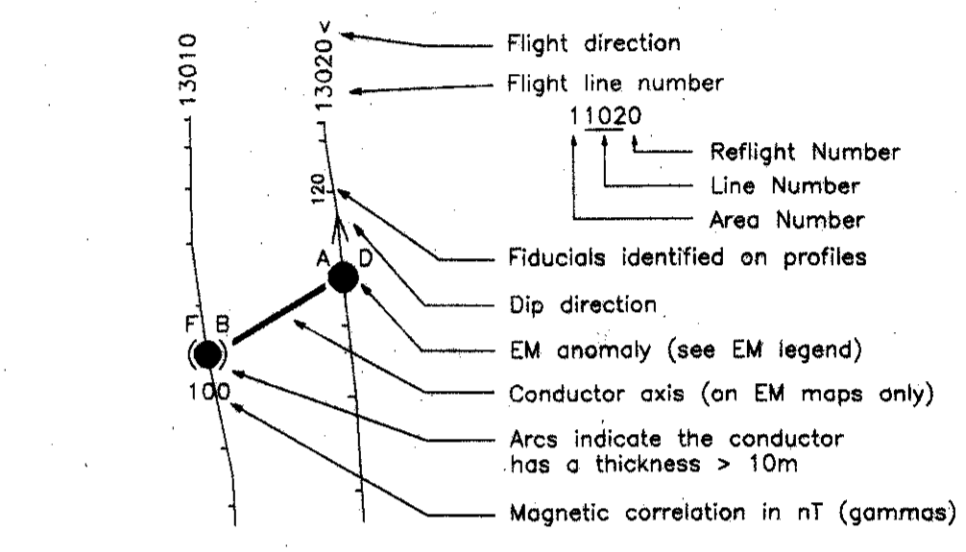
Frequency	Sensitivity	Coil Orientation
800 Hz	0.1 ppm	Vertical coaxial
5500 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	0.5 ppm	Horizontal coplanar

**ELECTROMAGNETIC ANOMALIES**

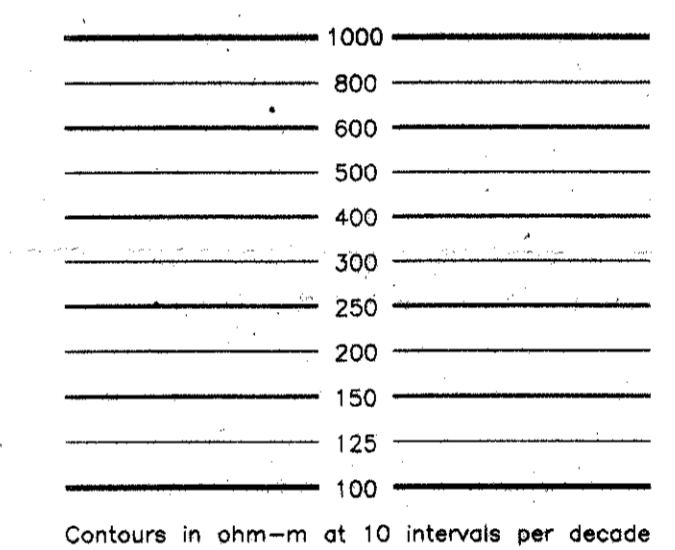
Grade	Anomaly	Conductance
7	●	>100 siemens
6	●	50-100 siemens
5	●	20-50 siemens
4	●	10-20 siemens
3	●	5-10 siemens
2	●	1-5 siemens
1	●	< 1 siemens
-	*	Questionable anomaly



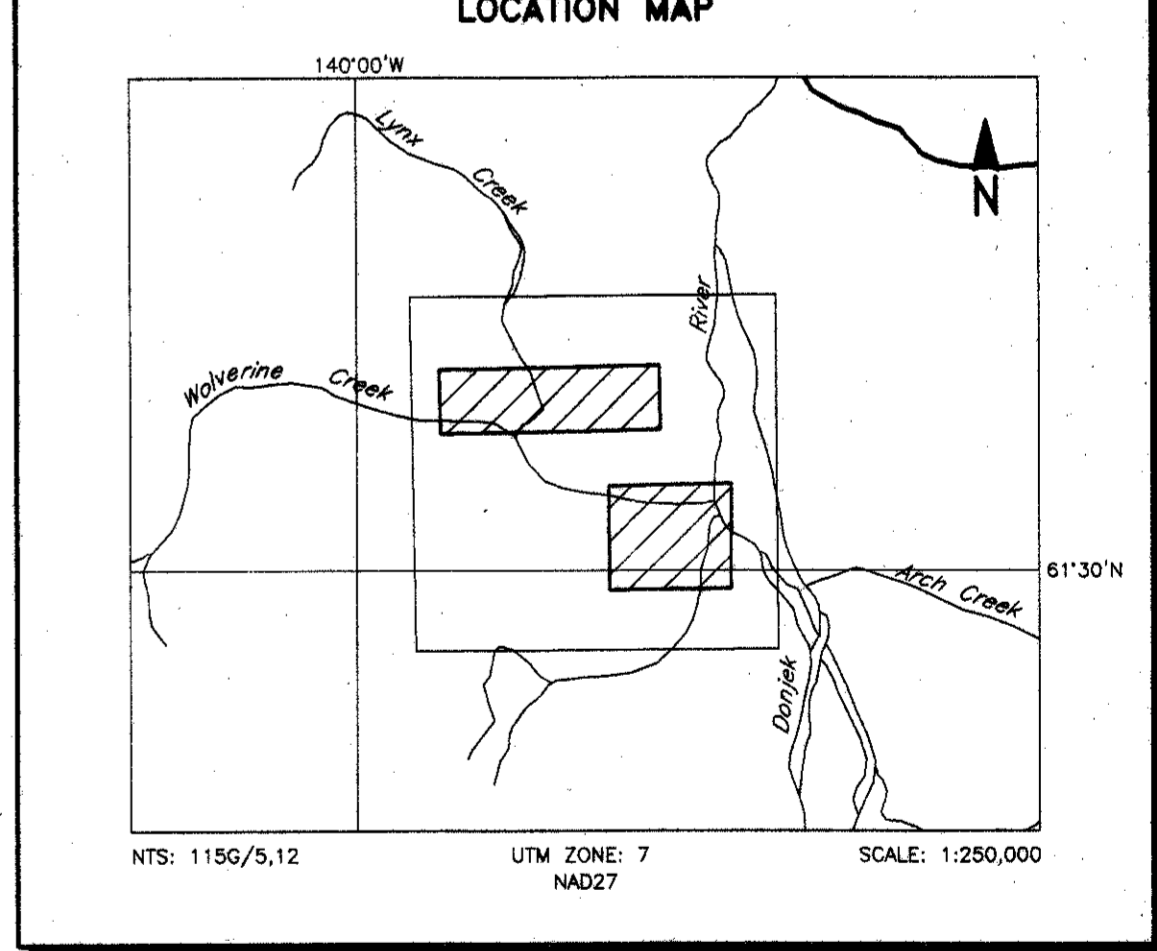
**FLIGHT LINES WITH EM ANOMALIES**



**RESISTIVITY CONTOURS**



**LOCATION MAP**

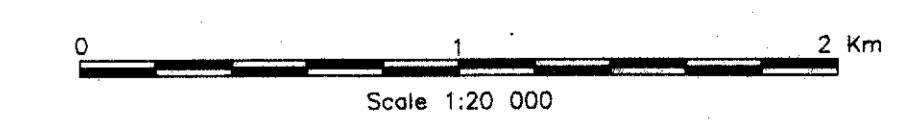


**EXPATRIATE RESOURCES LTD.**  
**DONJEK PROJECT AREAS, YUKON**

**RESISTIVITY**  
**56,000 Hz COPLANAR**

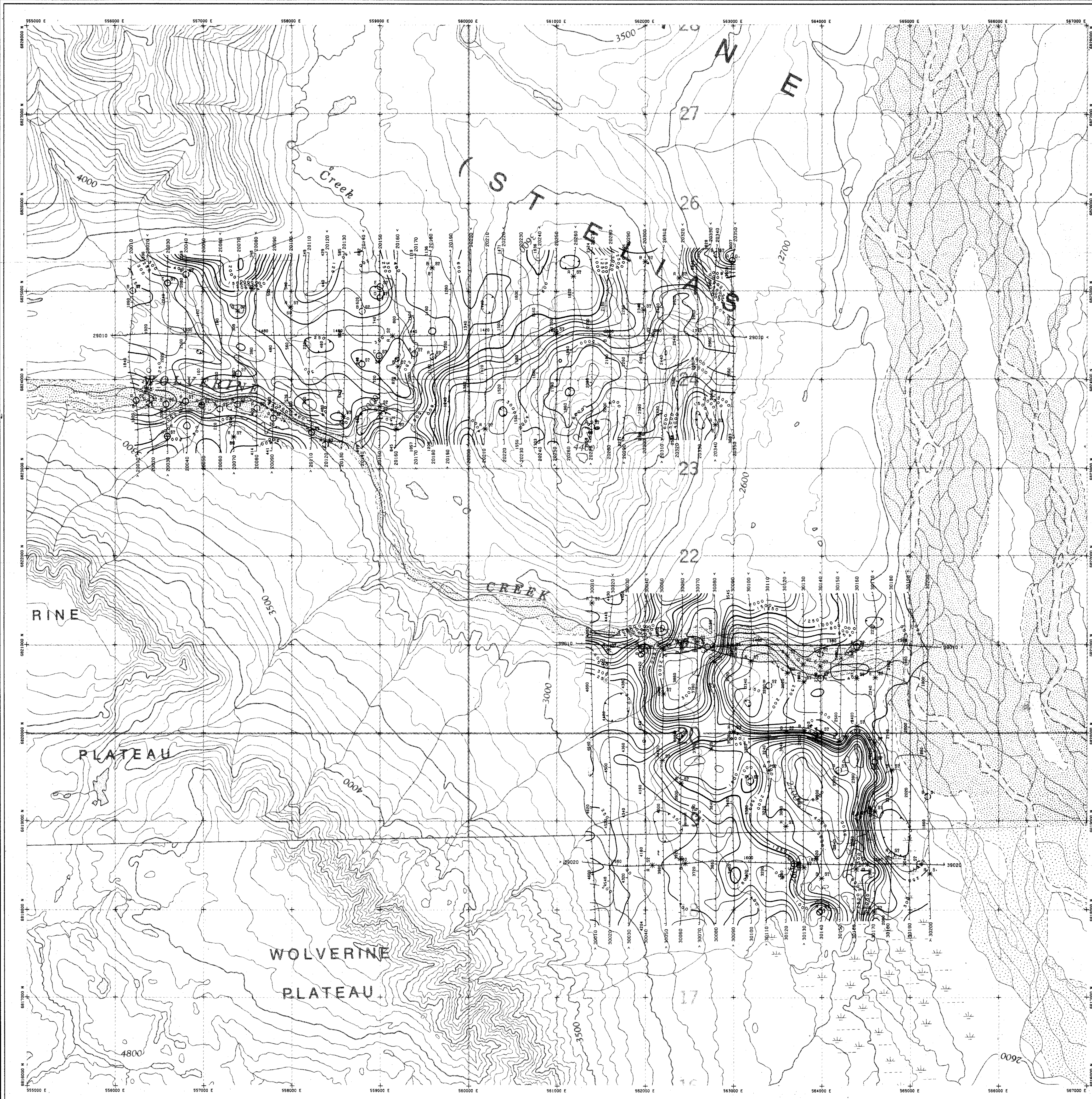
DIGHEM* SURVEY	NTS: 115G/5,12	GEOPHYSICIST: <i>AC</i>
DATE: SEPTEMBER, 1996	JOB: 1253	SHEET: 1

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**TECHNICAL SUMMARY**

Navigation : Serail differential GPS positioning  
 Data reduction grid interval : 50 metres  
 Terrain clearance : Helicopter 60 m  
 Electromagnetic sensor 30 m  
 Magnetometer 40 m  
 Data sampling interval : 0.1 second  
 Magnetometer / sensitivity : Scintrex cesium / 0.01 nT  
 Electromagnetic system : DIGHEM\*

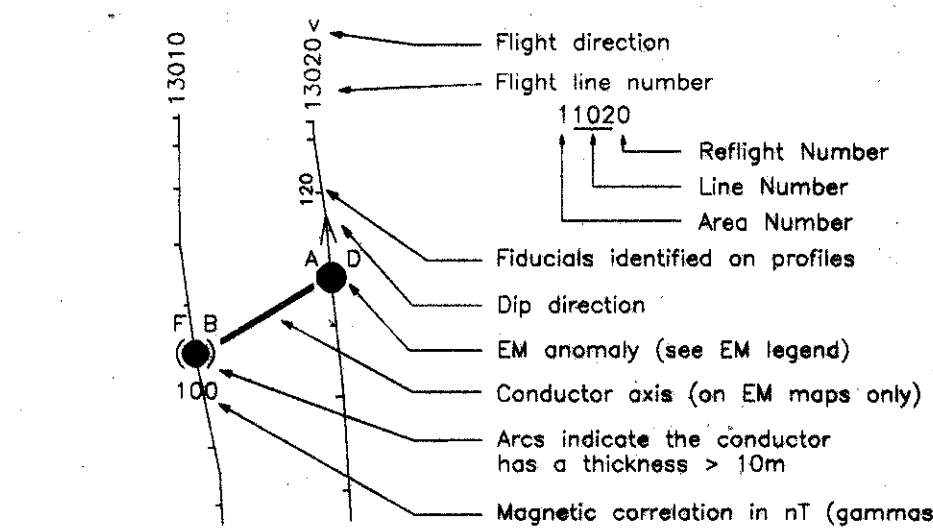
Frequency	Sensitivity	Coil Orientation
900 Hz	0.1 ppm	Vertical coaxial
5500 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	0.5 ppm	Horizontal coplanar

**ELECTROMAGNETIC ANOMALIES**

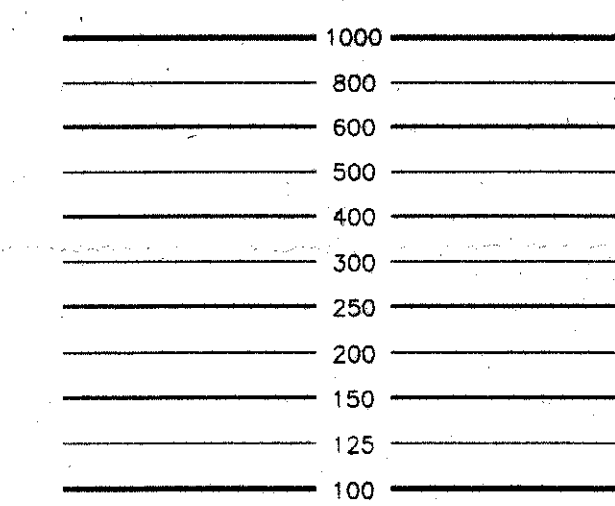
Grade	Anomaly	Conductance
7	●	>100 siemens
6	●	50-100 siemens
5	●	20-50 siemens
4	●	10-20 siemens
3	●	5-10 siemens
2	●	1-5 siemens
1	●	< 1 siemens
	*	Questionable anomaly

Anomaly identifier	Interpretive symbol	Interpretive symbol	Interpretive symbol	Interpretive symbol	Interpretive symbol
Depth is greater than	○	Inphase and Quadrature of coaxial coil is greater than	○	Conductor ("model")	B
15 m	○	5 ppm	○	Bedrock conductor	D
30 m	○	10 ppm	○	Narrow bedrock conductor ("thin dike")	S
45 m	○	15 ppm	○	Conductive cover ("horizontal thin sheet")	H
60 m	○	20 ppm	○	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, metal building or fence	

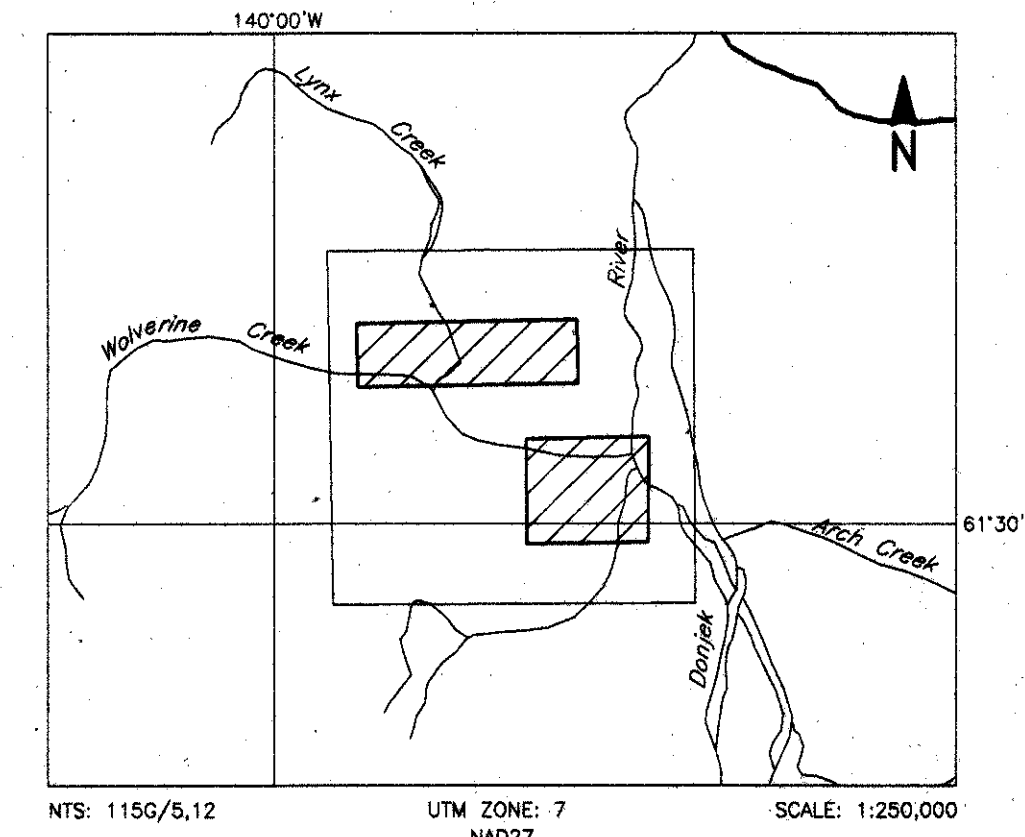
**FLIGHT LINES WITH EM ANOMALIES**



**RESISTIVITY CONTOURS**



**LOCATION MAP**



**EXPATRIATE RESOURCES LTD.**  
 DONJEK PROJECT AREAS, YUKON

**RESISTIVITY**  
**7200 Hz COPLANAR**

DIGHEM \* SURVEY : NTS: 115G/5,12 GEOPHYSICIST: α.C.  
 DATE: SEPTEMBER, 1996 JOB: 1253 SHEET: 1  
 DIGHEM, A division of CGG Canada Ltd.



**DIGHEM**  
 Quality and Service in Airborne Geophysics

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