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NOTES TO PROSPECTORS - JAKES CORNER

DIGHEM SURVEY INTERPRETATION

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1.0 INTRODUCTION

In March 1994, Dighem Surveys flew a large helicopter multicoil electromagnetic and magnetic field survey north and east of Jakes Corner in the southern Yukon Territory. A comprehensive technical report prepared by P. Smith (1994) was released later in the year describing the survey and its results. The Dighem survey sparked a lot of interest in this promising area of the Yukon. In response to requests from local prospectors, the Geoscience Office of the Canada/Yukon Mineral Development Agreement prepared a new geological map of the survey area and commissioned a review of the survey results together with the new geological data. This report contains a geological map based on the most recent geological mapping in the survey area and upon the results of the HEM survey (Hunt *et al.* 1994). It also contains a description of possible types of deposits which could be found here together with predicted Dighem^V system responses. Finally, the report includes six 1:20,000 EM anomaly maps together with a description of 34 conductors which merit further investigation.

This report is intended as a practical guide to understanding and using the results of the Dighem survey in prospecting although it contains some modelling results which may be of interest to other readers. It was written primarily for the prospector and/or geologist who realizes that the survey contains a lot of useful data but is not prepared to take a short course in geophysics in order to make use of it. Fortunately, it is possible to use this survey very effectively without having detailed technical knowledge about how the system works and without knowing much about electromagnetic theory. Once a prospector has a general idea of how the airborne system responds to different targets and learns how to read the data profiles, it is possible to get a lot of information from the data. HEM surveys were perhaps the most important tool used in the diamond exploration rush in the Northwest Territories over the past few years. Kimberlite pipes were frequently found by interpreters who had no prior experience with the airborne systems and little (or no) understanding of how they worked. They were successful because they studied the responses over known kimberlite pipes and recognize these responses in other areas. This same approach to other targets will work very well in prospecting the Jakes Corner survey area.

2.0 OVERVIEW OF THE DIGHEM^V SYSTEM

In order to make use of the HEM data, it is necessary to have a basic idea of how the system works. Readers requiring a more comprehensive understanding of the Dighem^V system should consult Smith (1994).

The Dighem^V system consists of five pairs of coils mounted in a rigid plastic (Kevlar) tube or "bird" which is towed beneath a helicopter (Figure 1.1). The coils are mounted in two different orientations inside the bird. This is to allow the system to determine the shape of an object by focussing electromagnetic waves on it from different directions. Three of the coil pairs are held horizontal and referred to as being coplanar. These coils produce a vertical magnetic field which preferentially energizes flat-lying conductors such as flat rock units and overburden layers. Two of the coil pairs are vertical and mounted so that a line down the centre of the bird will pass through the centres of the coils; these are referred to as being coaxial. These coils produce a horizontal magnetic field which is the best orientation for energizing vertical or steeply dipping conductors such as faults or steeply dipping rock units. By comparing the strength of the response from the horizontal coils with that from the vertical coils, it is possible to determine whether the target is flat-lying or steeply dipping.

Each pair of coils consists of a transmitting coil and a receiver coil. The signal from the transmitting coil, in addition to producing a strong direct signal in the receiver coil (primary field), also energizes conductive horizons in the earth which produce their own magnetic fields (secondary fields). The HEM system is designed to remove the very strong signal from the nearby transmitting coil in order that only the secondary signal from conductors in the earth be recorded by the receiver.

The secondary signal naturally has the same frequency as the primary signal but it is much weaker and no longer "in step" with the primary signal. It also points in the opposite direction, in effect opposing the primary field. The airborne system measures the amplitude of the secondary field in parts per million of the primary field and the extent to which it has been delayed or "phase shifted" in the earth. This is done by breaking the signal down into "in-phase" and out-of-phase or "quadrature" components. Consequently the readings from each set of coils will consist of an in-phase and quadrature channel. Poor conductors such as faults, disseminated sulphides or overburden show mostly quadrature responses while good conductors such as massive sulphides or graphite show strong in-phase as well as quadrature responses.

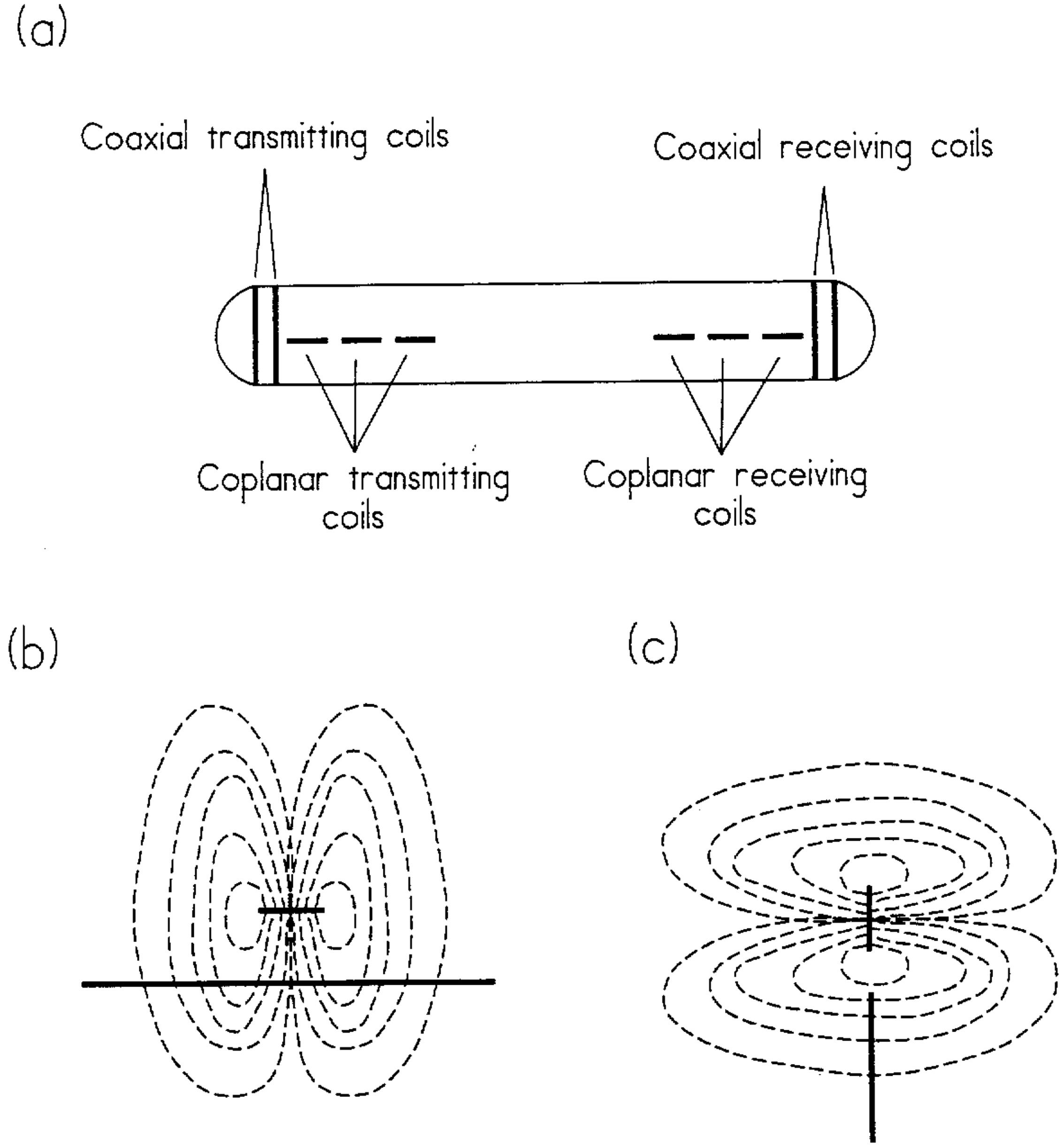

Figure 1.1 (a) Schematic diagram of Dighem bird.
(b) Horizontal coplanar coils energize flat-lying conductors.
(c) Vertical coaxial coils energize vertical and steeply dipping conductors.

In addition to determining the shape of a conductor it is necessary to determine how well the body will conduct electricity. Different earth materials conduct electricity to different degrees and it is necessary to measure the electrical properties of a target in order to get some idea of what it might be composed of. In most cases, all that an airborne system can determine is the electrical conductance or the overall ability of the conductor to pass electricity. This quantity is measured in Siemens (S). Massive sulphide conductances generally range from 10 to 40 S. Disseminated sulphides, clay, fault gouge and conductive shales generally show conductances ranging from 0.5 to 10 S. Unfortunately, graphite is a good conductor and produces conductances which are about the same as those of massive sulphides.

In order to measure the conductance of body, it is necessary to take measurements at different frequencies. Targets with low conductances will produce strong responses only at high frequencies while a target with a high conductance will show strong responses at both low and high frequencies. The Dighem^V system transmits at 900, 5500, 7200 and 56,000 Hz in order to provide a wide spectrum of frequencies; this allows the interpreter to make accurate estimates of the electrical conductance.

The inverse of electrical conductance or conductivity is electrical resistance or resistivity. The resistance, like the conductance, is a measure of the *overall* resistance to an electrical current in a target. The resistivity on the other hand, is the resistance per metre of the material in the target. Because resistivity and conductivity are independent of the size of a target, these are useful properties which are specific to different earth materials.

As noted above, the horizontal coplanar coils are best oriented to measuring the properties of flat-lying conductors. If you take the measurements from these coils at a given frequency and make a simplifying assumption, you can calculate an "apparent resistivity" (or conductivity) of the earth at that frequency. Because you only have one measurement to work with, you cannot get a very detailed idea of what the actual resistivity is; in effect you are measuring an overall average. This is referred to as a "half-space apparent resistivity" and this is the quantity which is colour-contoured on the resistivity maps. Apparent resistivity is measured and contoured in ohm-metres (ohm-m). In the Yukon, bedrock commonly has resistivities ranging from 500 to 5000 ohm-m, till ranges from 50 to 500 ohm-m, clay ranges from 1 to 200 ohm-m and sulphides and graphite have resistivities ranging from 0.01 to 50 ohm-m.

If the apparent resistivity maps are compared with each other, it is immediately obvious that the apparent resistivities calculated at one frequency have different values and distributions that those calculated at another frequency. There is a sound physical reason for this. Anyone who has ever left their radio on while driving in a tunnel knows that the radio waves will not penetrate very far into the earth. In fact, the higher the frequency, the shallower the depth of penetration. This explains why low frequency AM radio waves carry further than higher frequency FM waves. The same effect prevents the high frequency Dighem coil frequency (56,000 Hz) from penetrating to any depth in the earth while the lower frequencies will be allowed to pass to greater depths. Since the apparent resistivity is, in effect, an average resistivity, the apparent resistivity maps show average resistivities to different depths. This explains the close correlation between 56,000 Hz (56 KHz) apparent resistivity lows and drainages, swamps and lakes. Some of this effect will carry into the lower frequency apparent resistivity maps as well.

The Dighem^{V} system also contains a magnetometer and VLF receiver. The magnetic field readings are corrected to remove the effect of diurnal variation using a base station magnetometer. This instrument takes readings at a fixed location every few seconds so that changes in the geomagnetic field during each flight can be removed from the data after the survey. The VLF results from the Dighem survey are considered poor and are not as useful as the Dighem system responses in locating interesting conductors; they are not discussed in this report.

2.1 Survey layout

An airborne geophysical survey is quite similar to an equivalent ground survey. Survey lines are laid out perpendicular to strike at the desired line interval and readings taken along them at intervals of up to 10 readings per second. Line numbering in the Jakes Corner survey starts at 10010 at the north boundary and increases in increments of 10 to the south for a total of approximately 145 lines. For technical reasons, it is sometimes necessary to break up the lines into smaller segments. In these cases the segments are numbered, from west to east in whole numbers (eg. 10010, 10011, 10012 for a line consisting of three segments). Tie-lines are flown at frequent intervals across the grid to ensure that the EM readings are consistent from line to line.

The big difference between a ground and airborne survey is that the former has a fixed grid to work off. Airborne survey systems take readings at fixed time intervals and mark the charts on which the data is plotted with pointers every 25 readings. These are referred to as fiducial marks or "fids". After the survey, the geographic location of the fiducials must be established to permit ground crews to locate anomalies detected during the survey. This is now performed with global positioning systems (GPS) receivers. As a supplement, a video camera is installed in the floor of the helicopter to record the terrain below it and the behaviour of the bird during the flight. The survey maps show the locations of the survey lines as determined from the GPS data; they are considered accurate to within ± 5 metres.

2.2 Digital Profiles

The raw data from which the magnetic field, resistivity and anomaly maps are prepared is also plotted in digital stacked profiles. These are profiles showing all the data collected on each line, referenced to the fiducial marks on the chart. The profiles are stacked so that conductor responses which are besides each other in the field are stacked above or below each other on the profiles. A set of these profiles for the Jakes Corner survey is kept at the Canada/Yukon Geoscience Office and can be inspected there.

Although they may seem complicated, the digital profiles are perhaps the most useful survey product provided by the airborne contractor. The contour maps present the data in summary form, showing overall trends and summarizing the anomalous responses with interpretive symbols. Once an investigation has focussed in on a specific area, the profiles can be checked to get more information on the characteristics of an anomaly. Many features of an anomaly cannot be summarized in an interpretive symbol on the EM anomaly maps.

An excerpt from the stacked profiles is shown in Figure 2. This profile shows the data collected on Line 11430 in the southeastern end of the survey area. This line runs over the TOG vein - a high grade listwanite-gold vein (Anomaly 11430F at fid 5741). The stacked profiles consist of 20 channels of data, fiducial marks and EM interpretation annotations. Working from top to bottom, the following channels are plotted:

a. Power line channel (CXP) This line is normally flat and will only deflect if the bird crosses over an electrical transmission line.

b. Spherics channel (CXS) This channel measures the level of electromagnetic noise generated in the ionosphere at frequencies which could affect the readings. If this channel is particularly noisy (ie. contains large spikes or similar deflections) it is an indication that the EM data might be contaminated with signals generated in the atmosphere.

c. Radar altimeter (ALT) This channel displays the radar altimeter record and is also useful in assessing whether anomalies might be caused by bird motion rather than true ground effects. If the helicopter has to change its rate of climb rapidly, it can cause to bird to swing or to flex minutely. These can create false anomalies in extreme cases. The pilot attempts to fly the survey at a constant altitude of 30 m above ground level but this is not always possible. For example, at fid 5729 the helicopter cleared the crest of a hill and "overshot" a bit before returning to the nominal survey altitude.

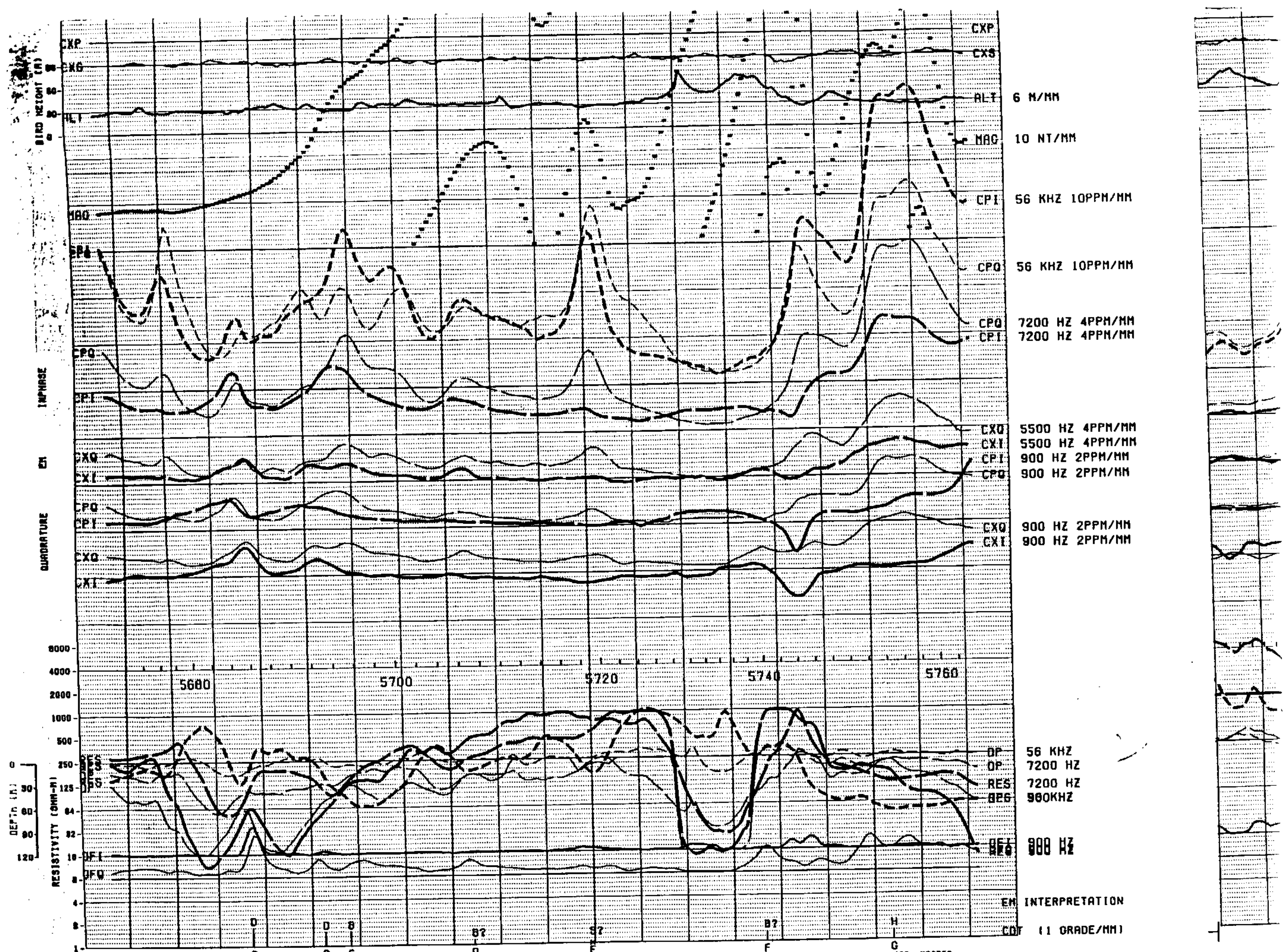

Figure 1.2 Digital flight line profile.

d. Magnetics (MAG) This channel shows the base station corrected total magnetic field. The relief in the magnetic field is often considerable and the profiles change base level frequently. When the line runs off the top of the page, the base level of the profile is increased by 1000 nT and the profile resumes at the bottom of the plotting area. In this manner is it possible to plot the 2200 nT relief between fids 5722 and 5741 at 10 nT/mm.

e. 56000 Hz coplanar (CPI 56 KHZ/CPQ 56 KHZ) These two channels show the 56KHz coplanar coil readings in ppm of the primary field. The thick dashed line (CPI) is the in-phase channel and the thin dashed line is the quadrature (CPQ) channel. Both are plotted at 10 ppm/mm.

f. 7200 Hz coplanar (CPI 7200 HZ/CPQ 7200 HZ) These two channels show the 7200 Hz coplanar in-phase and quadrature channels at 4 ppm/mm.

g. 5500 Hz coaxial (CXI 5500 HZ/CXQ 5500 HZ) These two channels show the 5500 Hz coaxial coil in-phase and quadrature channels at 4 ppm/mm.

h. 900 Hz coplanar (CPI 900 HZ/CPQ 900 HZ) These two channels show the 900 Hz coplanar in-phase and quadrature channels at 2 ppm/mm

i. 900 Hz coaxial (CXI 900 HZ/CXQ 900 HZ) These two channels show the 900 Hz coaxial coil in-phase and quadrature channels at 2 ppm/mm.

j. Fiducial marks These are shown with small ticks marking every even fid.

k. DP channels (DP 56 KHZ, DP 7200HZ, DP900HZ). It is possible fit the coplanar coil data to a model consisting of resistive overburden overlying conductive bedrock. Using this model, it is possible to calculate an apparent depth to the top of the conductive layer. These interpreted depths are useful in permafrost mapping but are subject to errors caused by changes in bird elevation which are not used in the calculation. These channels are often not used in bedrock interpretations. They are shown on the digital profiles as thin lines and are graduated in 6 m increments with depth increasing down scale.

l. Resistivity (RES 56 KHZ, RES 7200 HZ, RES 900 HZ) These channels display the calculated half-space apparent resistivity. It can be considered as an average resistivity of the bedrock and overburden but is subject to some errors caused either by complicated geology or by suppression of the in-phase channels caused by magnetite (see below).

m. Difference channels (DFI 900 / DFQ 900) These are two of the most important channels to watch in the profiles as they provide a way of discriminating between bedrock and overburden conductors. Over a thick flat-lying conductor, the response of the coplanar coils is *twice* the strength of the response from the coaxial coils. Over a thin steeply dipping conductor, the coplanar coil response is *half* the response of the coaxial coils. This suggests a means of discriminating between flat lying surficial conductors and steeply dipping bedrock conductors. The difference channels plot the 900 Hz coplanar response minus twice the 900 Hz coaxial response for both in-phase and quadrature channels. Over conductive overburden, this channel will register zero. Over a steeply dipping conductive fault or sulphide lens, this channel will be non-zero. The interpreters use this channel to determine the possible source of an anomaly. A bedrock anomaly will often show a sharp DFQ with or without a DFI deflection. Good bedrock conductors will show both DFI and DFQ deflections. Note the positive DFQ deflection over the TOG vein.

n. EM Interpretation This line shows the location of discrete anomalies together with an interpretive letter symbol and an anomaly identifier. Each anomaly intersection along a line is tagged with a letter identifier, generally incrementing from left to right across the profiles. This is also how anomalies are normally referred to in the reports (eg. anomaly at 5740 on line 11430 would be 11430F). The interpretive letter symbols used by Dighem interpreters are:

S - surficial conductor (flat lying overburden)
H - wide flat lying bedrock conductor (eg shallow dipping conductive bed)
B - bedrock conductor
D - thin steeply dipping bedrock conductor
E - edge of a wide horizontal conductor
L - cultural or man-made anomaly (eg. fence, pipeline)

The shape of the anomaly profiles together with the DFI/DFQ channel response can be used to determine what the source type is and what shape it might have. In general, any conductive feature will cause the in-phase and quadrature channels to deflect in the positive (upwards) direction. A summary of response shapes and associated conductor geometries, extracted from Smith (1994), is found in Figure 1.3. There is considerable overlap between the response types, particularly for weak conductors. Anomalies classified as surficial should be viewed with caution; fault zones and conductive horizons are frequently recessive and filled with overburden, leading to responses which are apparently surficial.

2.3 Using the survey results.

HEM surveys produce an intimidating amount of data and many users find they have difficulties in using the products. Here are a few suggestions:

1. **Determine the physical properties of your target and host rock.** An estimate of the physical property contrast between the host rocks and country rocks is essential in order to predict what the system response will be. Consider the range of resistivities that the target should have and the corresponding range for the host rock. Is there a contrast? (If not, the target is undetectable). Is there a contrast in magnetic susceptibility between the host and target rocks? Should the target produce a magnetic field high or low? Could it produce both? How strong an EM response should be expected? Keep in mind that the EM system measures the bulk conductivity of the rock and is insensitive to small concentrations of conductive minerals (eg. 1 or 2% sulphides).

2. **Know the geology of the area you are interested in.** The geophysical data must be interpreted in light of the local geology. Knowing the strike of rock units, for example, can help you discriminate between conductors which might be conformable (eg. contacts, bedded sulphides) and faults. The significance of a conductor is often determined by rock unit in which it lies. Listwanite gold occurrences for example are localized in or near faults cutting ultramafic rock units; a weak conductor in or near an ultramafic unit might therefore be of greater interest than a stronger conductor in a different rock unit.

3. **Check the models in this paper.** Most of the deposit types that are likely to be found in the Jakes Corner area are discussed in this paper. Their probable Dighem responses have been modelled and the effect of overburden is incorporated into these models. These should be checked when examining the digital profiles.

4. **Use the EM anomaly maps to determine conductor trends.** The anomaly maps show the flight lines together with the locations of discrete bedrock conductors. The symbols contain information on the strength and interpreted conductance, width, depth and dip of the conductors creating the anomalies. It is readily apparent that many of these anomaly intersections line up from line to line to create conductor trends. On the enclosed maps, approximately 50 conductor trends are identified of which 34 are described in more detail in Section 4.0. There are other possible trends not identified in this report.

5. Check the conductor trends against local topography. Most of the weak conductor trends have responses which are apparently surficial. Check the location of the conductors and the width of the responses against known water courses and waterbodies. If the responses are as closely associated with the size and location of wet, low ground, the conductor may be entirely surficial. On the other hand, the Jakes Corner area has been glaciated and recessive faults in low lying areas could have been eroded and filled with sediment. Some of the surficial conductor trends may be tracing out faults which are now covered by overburden. If there are one or two possible bedrock responses on a conductor trend composed primarily of surficial anomalies, this might be an indication that the anomaly is actually a covered bedrock feature. Naturally, the anomalies which appear to be bedrock intersections would be the logical place to investigate these conductors for economic mineralization and for evidence of a controlling fault or other bedrock feature.

6. Check the profiles for a magnetic response along the conductor axis. The magnetic field data provides information which complements the EM data. Faults often have magnetic lows associated with them caused by magnetite destruction accompanying hydrothermal alteration. In other situations, magnetite occurs in fault zones or slices of magnetite-rich rocks are brought up along faults to produce magnetic field highs. Also check for evidence that magnetic features have been offset along a conductor trend; this is hard evidence that the conductor is actually a fault. A magnetic response associated with a strong conductor is especially good news when prospecting in the lower Cache Creek Group and adjacent to gabbroic intrusions. Such a correlation generally rules out graphite as the source and indicates that there is a very good chance that the source is a body massive sulphides.

7. Check the profile shapes against responses over known mineralization. Figure 1.2 illustrates the response of the Dighem^{V} system over a known listwanite gold vein. This is an excellent guide to finding another such occurrence.

8. Use the digital profiles. The digital profiles should be the primary data source when planning follow-up work. The general shape and amplitude of the magnetic field and EM response can yield a lot of useful information. Look at the relief of the magnetic field data; in overburden covered areas, the magnetic profiles will become smoother and the EM responses over a bedrock conductor will be wider as the depth of overburden increases. The difference channels should be watched carefully as they are often more sensitive to changes in a conductor than the shape of the response profiles themselves. A weak conductor will only show in-phase and quadrature responses at the highest operating frequencies. As the conductance increases and/or the depth of overburden decreases, the EM profiles will sharpen and increase in amplitude - particularly at the lower frequencies. A good conductor associated with heavy sulphide mineralization will show both in-phase and quadrature responses at 900 Hz and will deflect on both difference channels.

9. Be aware of magnetite suppression. Strongly magnetic rock units produce negative in-phase responses which are particularly obvious at low frequencies. An example of this are the negative CPI and CXI 900 HZ anomalies centred at fid 5744 in Figure 1.2. Note how the are directly beneath the magnetic field peak. The apparent resistivity calculations assume that there is no magnetic material present and consequently, the magnetite suppression of the in-phase creates a false resistivity high. In addition, it will cause the DFI channel to deflect. If a conductor is coincident with a strongly magnetic feature, the conductance will be underestimated.

Keep in mind that the prospector who assiduously follows up the HEM anomalies on the ground will soon become far better at interpreting the HEM data than the brightest geophysicist equipped with the most powerful computers and imaging software in some office. The HEM survey data is a useful tool in prospecting; not a substitute for it.

3.0 TYPE MINERAL DEPOSITS AND DIGHEM RESPONSES

The complex bedrock lithology and structure in the survey area have created conditions favourable for the development of several types of economic mineral deposits. These include ultramafic hosted Ni-Cu massive sulphide and chromite deposits, quartz-carbonate precious metal deposits in or near ultramafic rocks (listwanites), replacement deposits in limestones and structurally-controlled epithermal precious metal vein deposits.

Each deposit type has a distinctive geophysical signature and forward modelling of the target response is necessary to determine the likely responses.. Dighem resistivity modelling software (DIGRES) was used to predict the response of each of the type deposits in the area. This package calculates the response of two dimensional physical models to the Dighem V system. The most serious limiting assumption in the modelling process is that of infinite strike length. Applying the model to targets with relatively short strike length relative to the bird length (ie. less than about 100 m) results in an overestimation of the response from these smaller targets. The magnetic responses of the targets were also modelled.

The true average magnetic susceptibility and electrical resistivity of the rock types in the survey area can only be determined from measurements made on a representative suite of samples. Physical property measurements made on a limited number of samples are tabulated in Table 3.1. Unfortunately, this sample size and distribution is not useful in making reliable estimates of physical properties throughout the survey area. Consequently, average magnetic susceptibilities selected from compilations in Telford *et al.* 1990 and Palacky 1987 were used in the modelling. The Dighem 56000 and 7200 Hz coplanar data provided estimates of average bedrock and overburden conductivities. High frequency half-space resistivities over the high ground in the survey area averaged about 2500 ohm-m; this is taken as the average bedrock resistivity. High frequency half-space resistivities in the lowlands averaged about 250 ohm-m and this value is used as the average overburden resistivity.

3.1 Magnetic field responses

The magnetic field responses of the various deposit types can be grouped into one of three classes:

a. Positive magnetic susceptibility contrast between host and target (deposit) rocks.

b. Targets with reversed remnant magnetism

c. Targets with lower positive magnetic susceptibility than host.

With the possible exception of skarns, most deposit types are relative thin, tabular bodies whose response can be modelled by a dyke-like body of variable dip and depth extent. In the subsequent modelling, mean magnetic field conditions at the survey site were used; viz. a magnetic field inclination of 76° and field strength of 57700 nT. In all cases, the modelled structures were presumed to be roughly orthogonal to the survey lines (ie. striking 145°). The depth to the targets are relatively deep and thus show the response at the limits of the HEM detection system.

Table 3.1 Physical Properties of selected samples

Sample	**Rock type**	**k (SIx10^{-3})**	**r (ohm-m) (dry)**	**r (ohm-m) (wet)**
MDA1	Andesite (Lewes River)	41.60	2690	1740
MDA2	Serpentinite (Cache Creek)	74.50	5300	8650
MDA3	Andesite	23.60	4910	3320
MDA4	Silicified listwanite (Cache Creek)	0.34	3620	3560

Pyrrhotite and magnetite have high magnetic susceptibilities and deposits containing them often have a strong positive susceptibility contrast. The response of thin (3 m) tabular bodies with this susceptibility are shown in Figures 3.1 and 3.2 for the case of steep and shallow dip respectively. Steeply dipping targets will have a strong positive magnetic field peak over the top of the target and a trough of much lesser negative amplitude on the north side of the target. Flat-lying targets will show a positive peak over the centre of the target and a smaller negative trough on the north side of the target.

In some cases, magnetic minerals may exhibit remnant magnetism. In the author's experience, at this magnetic latitude, this often takes the form of anomalies which appear to result from bodies which display negative or reversed magnetic susceptibility. A body which is reversed magnetized exhibits an inverted response. An example is the case shown in Figure 3.3. The small magnetic field high on the north side of the low is a diagnostic feature of this type of anomaly.

Listwanite and epithermal veins and chromite deposits generally contain minerals with lower magnetic susceptibility than the surrounding host rocks. In the case of chromite deposits, the enclosing peridotite has a high magnetic susceptibility relative to the average susceptibility of chromite. The alteration associated with listwanites and epithermal veins tends to destroy magnetite in the wall rocks. This creates a situation

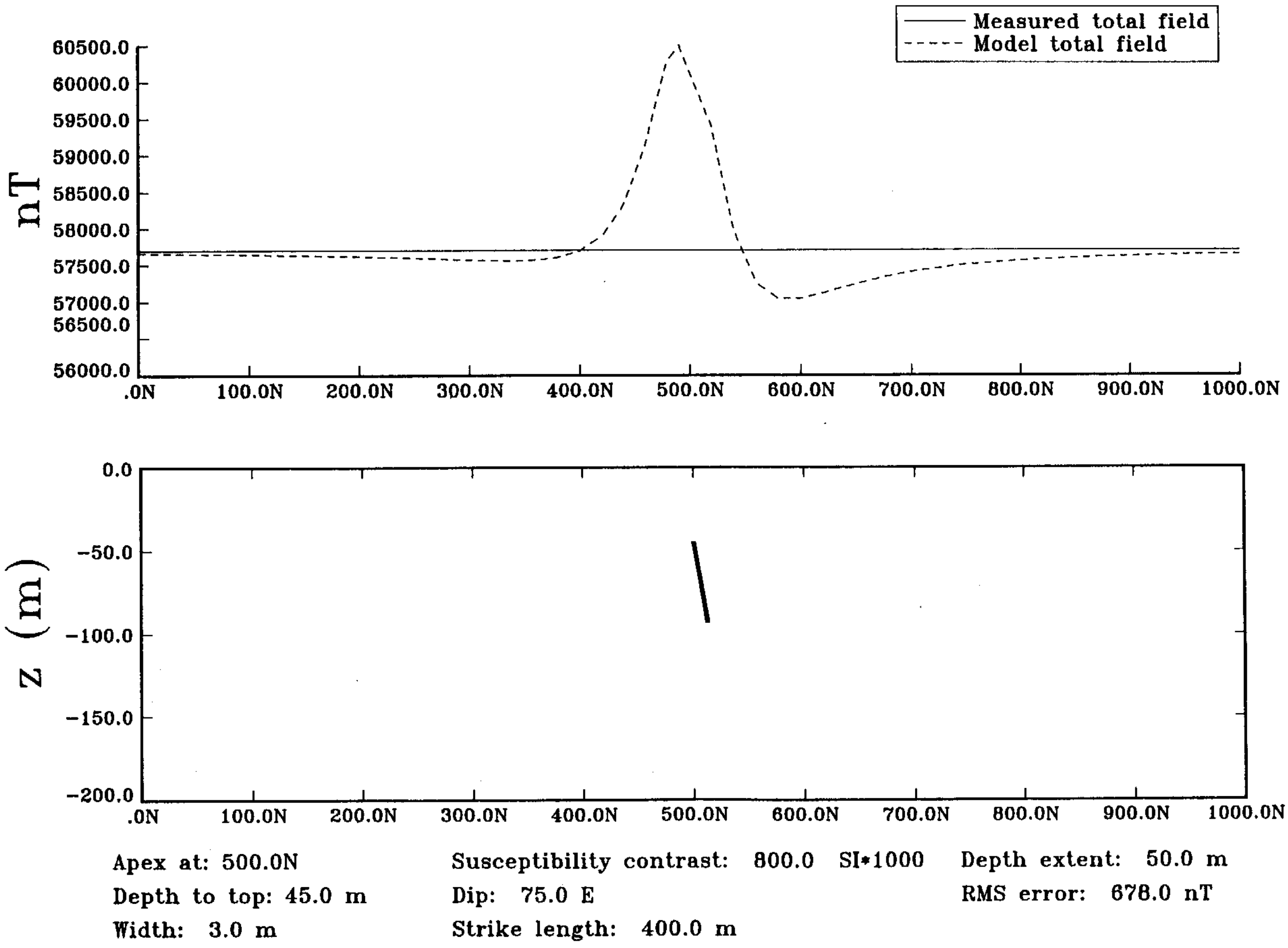

Figure 3.1 Normally magnetized steeply dipping dike model and response

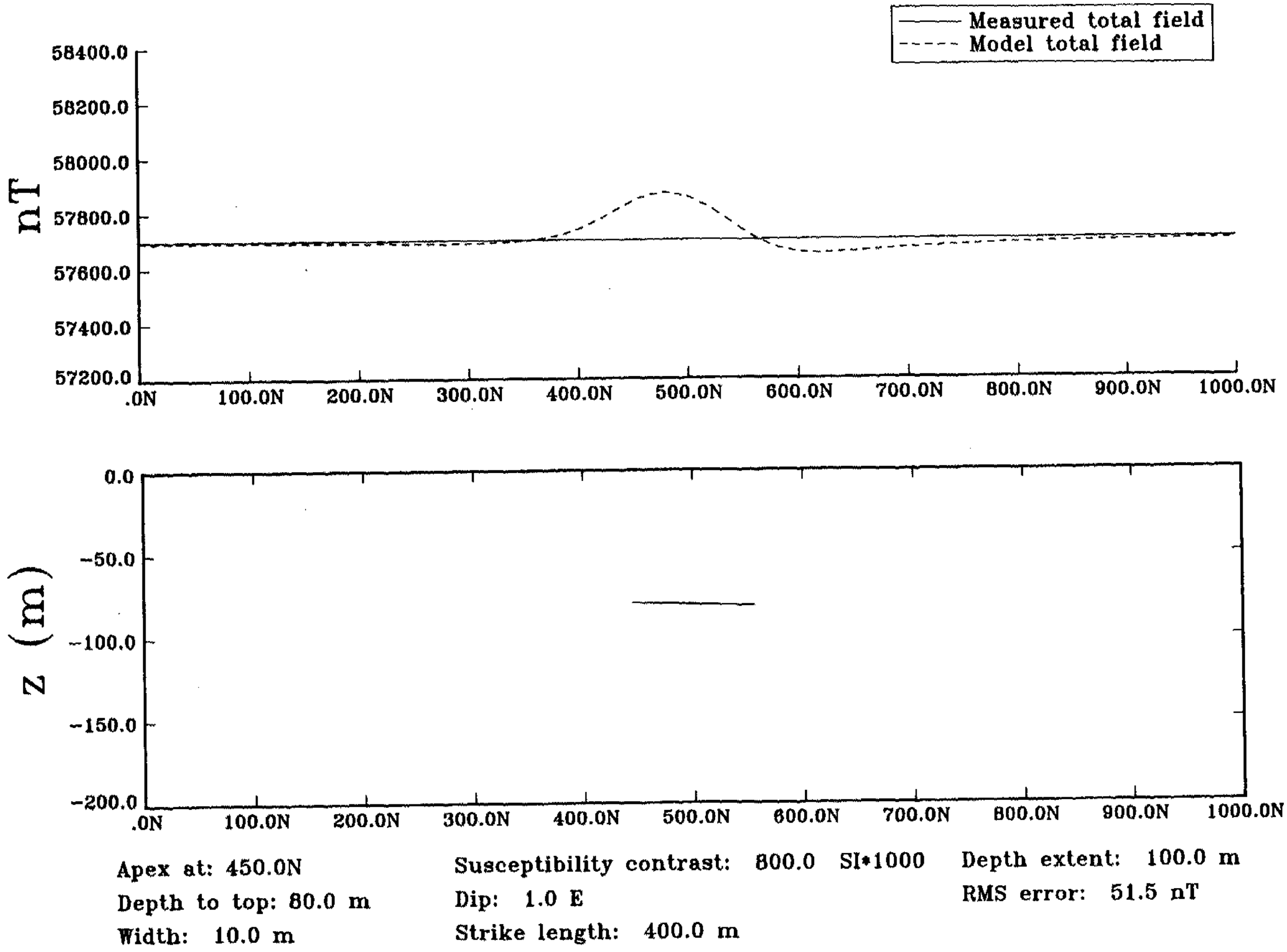

Figure 3.2 Normally magnetized shallow dipping dike model and response

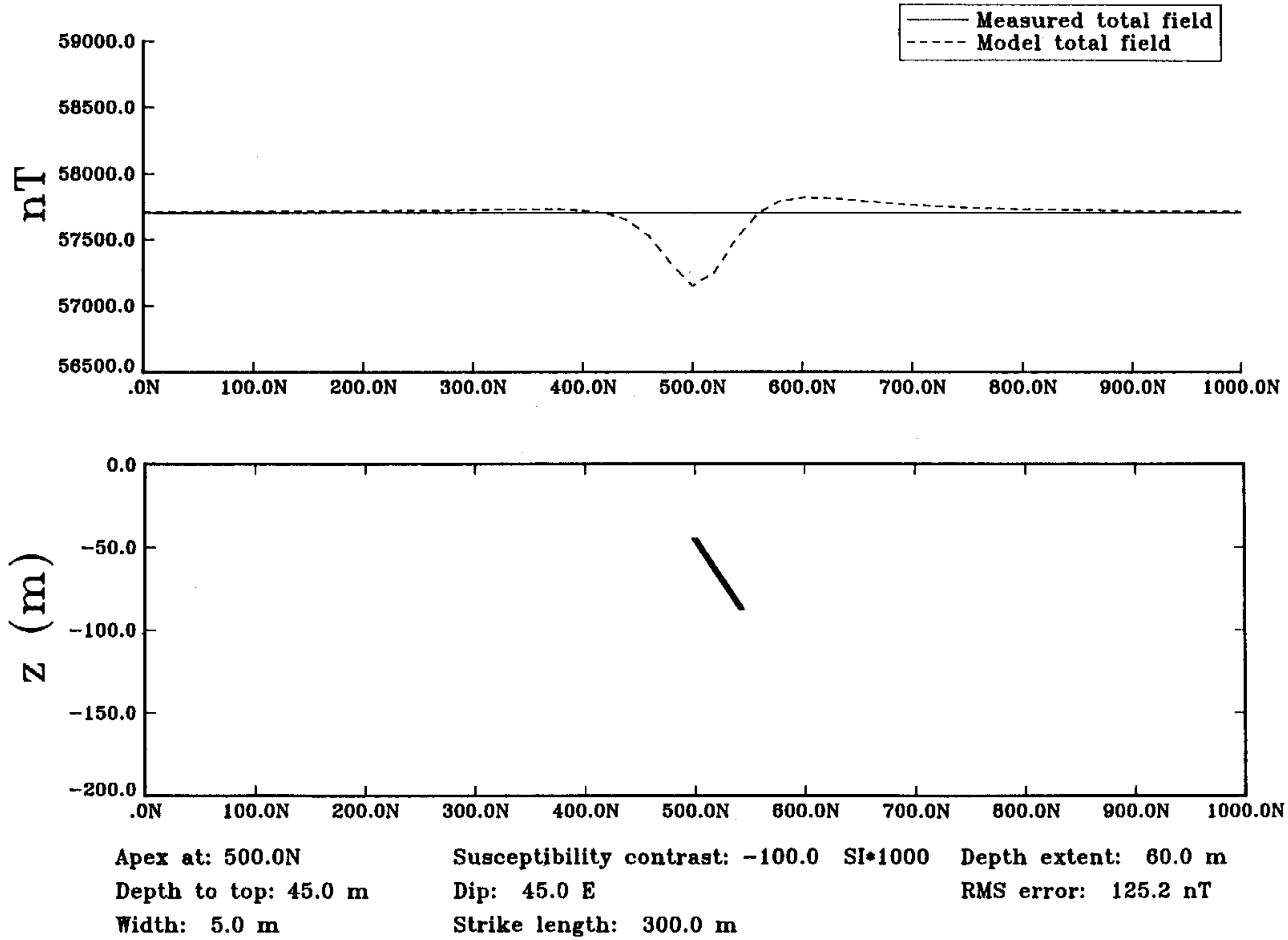

Figure 3.3 Reversed magnetized, steeply dipping dike model and response.

where rocks of low susceptibility are sandwiched between larger bodies of rock with higher susceptibility. This contrast is particularly high in the case of listwanite veins in ultramafic rocks and epithermal veins in calc-alkaline volcanics. An example of the response expected in these situations is shown in Figure 3.4. Here, the dyke shown at 500N has a lower magnetic susceptibility than the surrounding country rocks. The limits of the surrounding rock are at 15N and 985N creating edge effect anomalies at either end of the profile. The low amplitude (200 nT) low is caused by the 30 m wide dyke centred at 500N. The magnetic susceptibility contrast listed in the modelling is a relatively low $8x10^3$ SI units to account for demagnetization effects in the country rocks; the actual susceptibility contrast is $100x10^3$ SI units. The absence of a magnetic field high on the north side of the anomaly distinguishes it from the response of reverse magnetized body.

3.2 HEM response - base metal deposits in ultramafic rocks

Ultramafic-hosted Ni-Cu massive sulphide deposits and chromite deposits could be found in serpentinized peridotites, gabbros and dunites of the Cache Creek Group. Gabbro-hosted Ni-Cu deposits found at Noril'sk, Russia and Wellgreen, Y.T. serve as the best model for a type deposit. These deposits are flat-lying massive sulphide bodies at the base of gabbroic intrusions with zones of disseminated mineralization and massive sulphide veining in the adjacent footwall (Naldrett 1981). Ore mineralization consists of pyrrhotite, chalcopyrite and pentlandite. (Palacky 1987). Individual deposit dimensions include thickness ranging from 1 to 30 m and areal dimensions of up to 300 m by 300 m. Deposits are commonly clustered and appear to form in low areas on the original depositional surface (Green and Naldrett 1981). Post-emplacement tectonism during ophiolite emplacement would tend to rotate the deposits and possibly dismember them along faults. Mineralization may be remobilized into steeply dipping hanging-wall veins during these events. In outcrop, these deposits and the underlying peridotites are commonly recessive.

Possible Dighem^V system responses over a Ni-Cu massive sulphide deposit are shown in Figures 3.5 and 3.6. The thin irregular top layer with a resistivity of 1,000,000 ohm-m simulates the effect of variations in the bird to ground clearance in the data. The target has a width of 3 to 10 m and resistivity of 0.1 ohm-m (10 S). Since sections of these deposits can be both flat-lying and steeply dipping, the model geometry contains sections with both attitudes. Figure 3.5 shows the system response over the deposit in the case where overburden is thin or absent. The relatively shallow, steeply dipping section of the model produces a strong, obvious response. The flat-lying section occurs at an apparent depth of 100 m: 70 m below ground and a further 30 m from the bird to the ground. Even at this depth, there is a 30 ppm in-phase response attributable to the deposit. In the absence of instrument drift, it would be possible to detect targets to a depth of at least 50 m without much trouble in this resistive environment. Figure 3.6 shows the system response over the

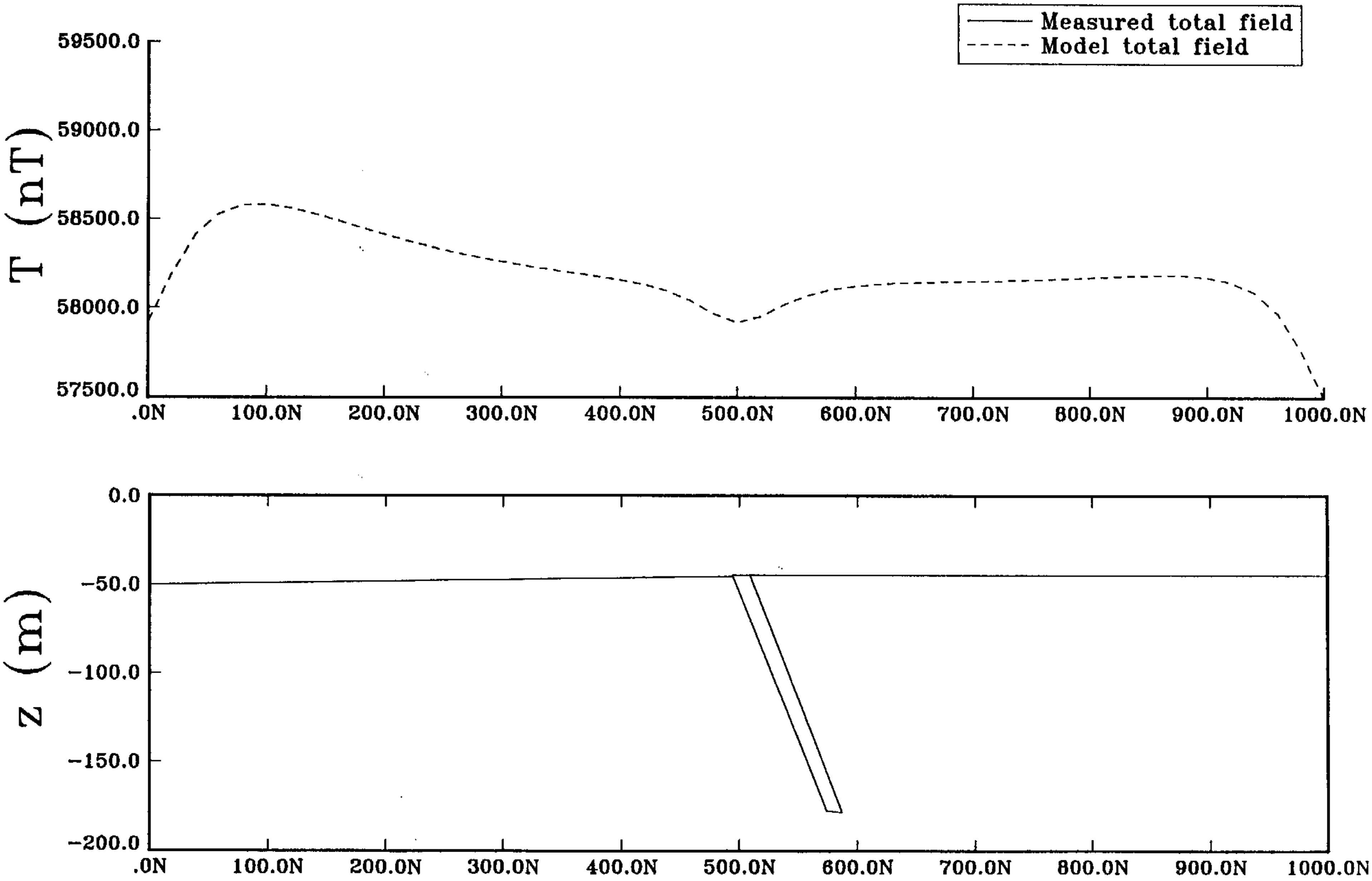

Figure 3.4 Zone of low magnetic susceptibility within area of high magnetic susceptibility: model and response.

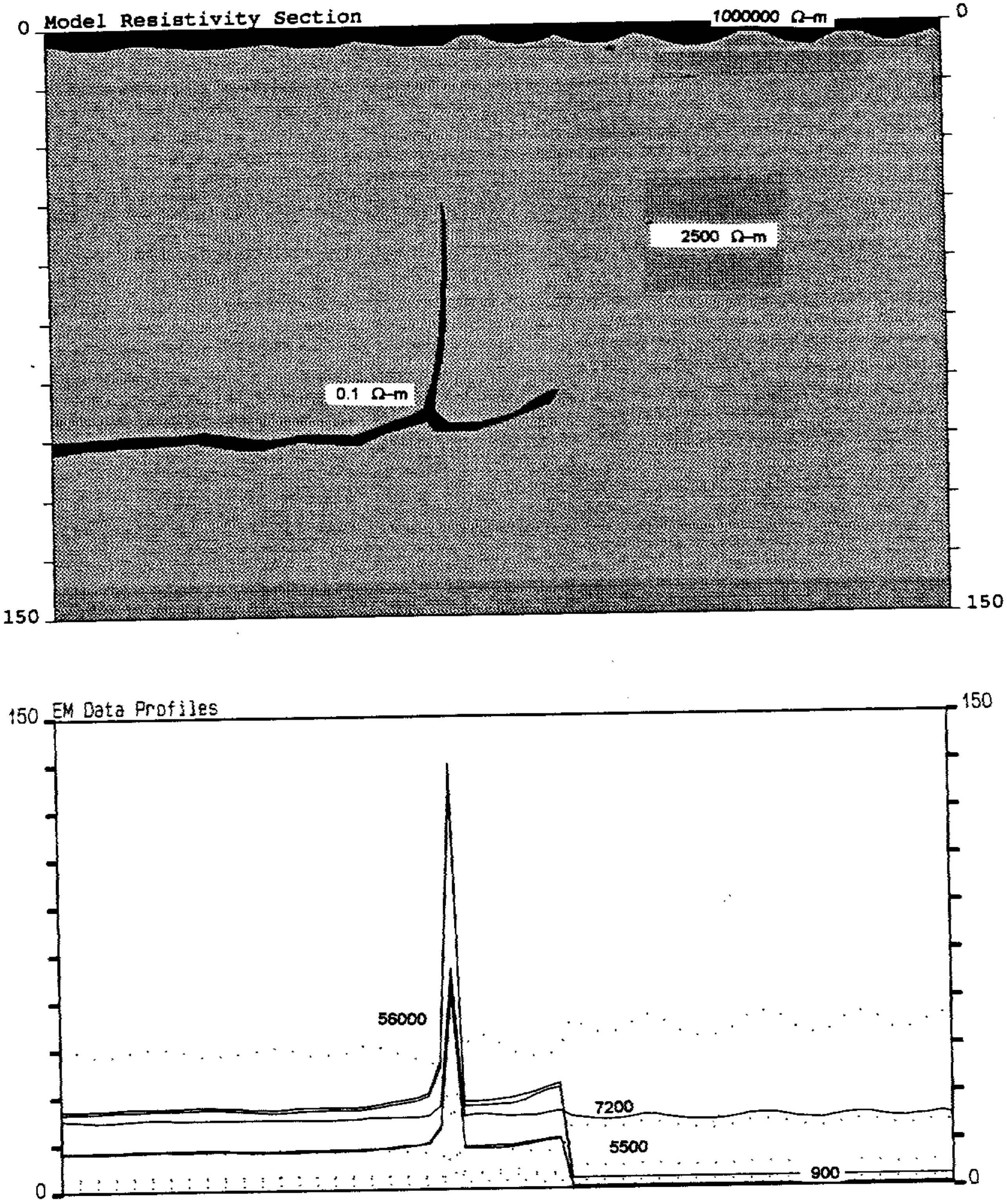

Figure 3.5 Ni-Cu massive sulphide target model and response: no overburden present.

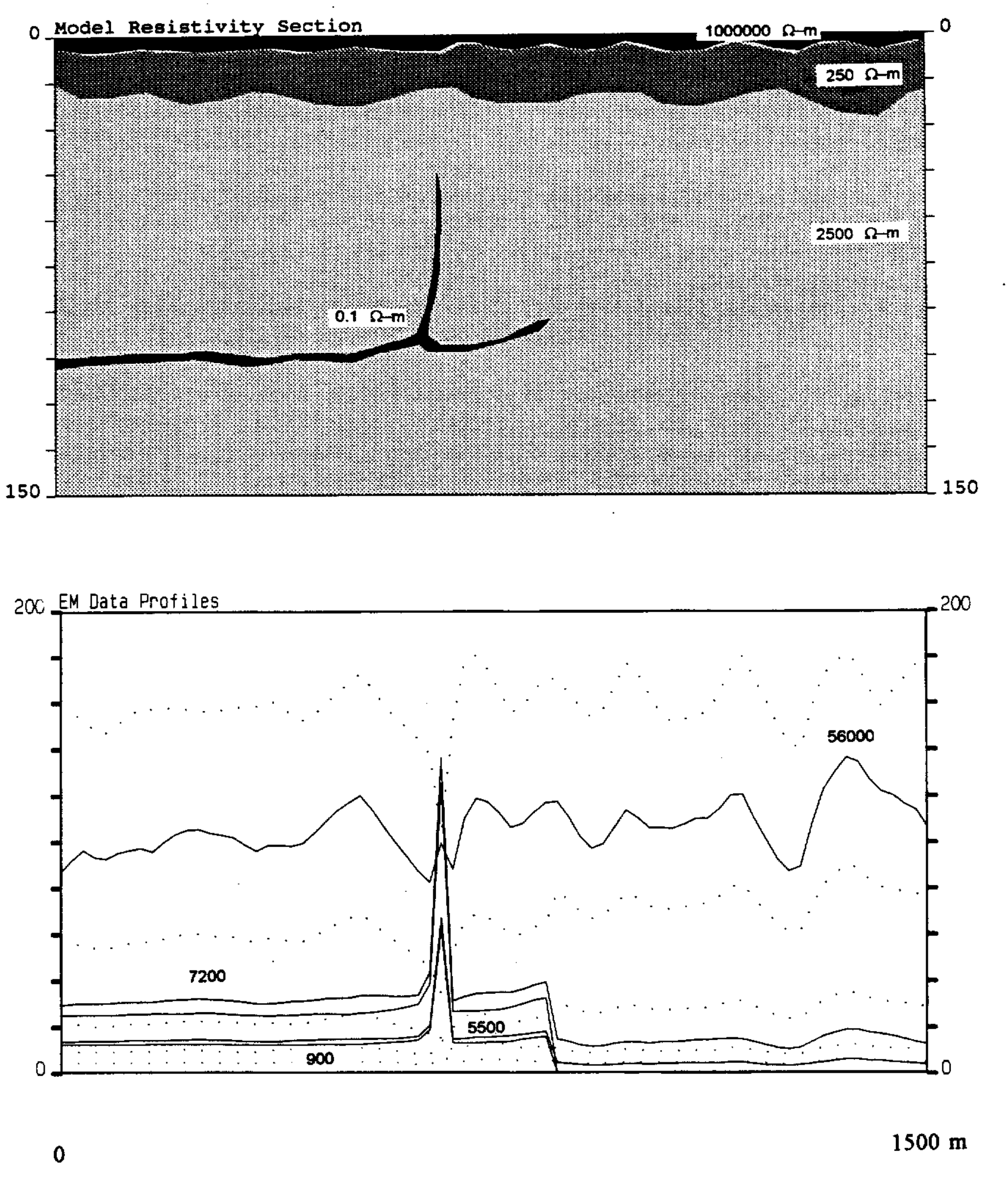

Figure 3.6 Ni-Cu massive sulphide target model and response: with conductive overburden.

same deposit with a conductive till cover. In this case, the 56000 Hz response if effectively screened by the till cover; clear responses occur on the lower frequency channel. Magnetic field responses over this type of deposit would be similar to those shown in Figures 3.1 and 3.2.

Ultramafic-hosted chromite deposits may be found in serpentinized peridotite rocks of the Cache Creek Group. These deposits occur in thin lenticular pods. Deposits in New Caledonia have areal dimensions ranging from 25 m x 300 m to 150 m x 60 m and thicknesses ranging from 0.4 to 5 m (Cassard *et al.* 1981). In these deposits, chromite ore is enclosed by dunites within harzburgite sills. Ore mineralogy consists of chromite, olivine and orthopyroxene with little or no sulphide mineralization.

The Dighem V system response over an ultramafic-hosted chromite deposit are shown in Figures 3.7 and 3.8 for the case of no overburden and the case of a 15 m layer of conductive till. Figure 3.7 illustrates that a chromite body would only be detectible on the highest system frequency and then, only at a very shallow depth.. If the deposits are covered by till, these types of deposits are basically undetectable. The magnetic field response of a chromite body would probably consist of a weak magnetic low centred over the top of the deposit (eg. Figure 3.4).

3.3 HEM response - listwanite assemblage Au-Ag deposits

Listwanite assemblage precious metal deposits are found in veins in or near ultramafic rocks in the Atlin and Cassiar districts of northern B.C. (Ash and Arksey 1989). These deposits are found near large faults in tectonically disrupted ophiolite sequences. Serpentinized ultramafic rocks serve as a carbon dioxide sink, thereby forcing the precipitation of gold from hydrothermal fluids migrating along plumbing within the fault systems. Vein systems commonly develop as extensional faults in the hanging wall of faults bounding serpentinized ultramafic rocks. The alteration assemblage often extends quite a distance from the veins and is distinctive. Veins are filled by quartz and calcite with small amounts of sulphides and wall rocks are altered to talc and carbonate with quartz adjacent to the vein systems. Carbonitization destroys magnetite within ultramafic rocks adjacent to the vein systems. Sulphide mineralization is weakly disseminated with locally heavy concentrations in ore shoots and stringers. Sulphide mineralogy varies from district to district and includes pyrite, galena, sphalerite, chalcopyrite, arsenopyrite, pyrargyrite and tellurides. In the Atlin area, the vein at Imperial Mines consisted of a vein from 0.3 to 3 m thick striking northeast, dipping 50° to 60° southeast and extending 150 m along strike (Cairnes 1910). The vertical extent of veins in the Atlin District is not well known but appears to be at least 150 m on the Boulder Claims near Surprise Lake. In the McDame area, listwanite veins up to 8 m wide have been traced over distances up to 300 m (Gabrielse 1960) and are currently being mined near Table Mountain.

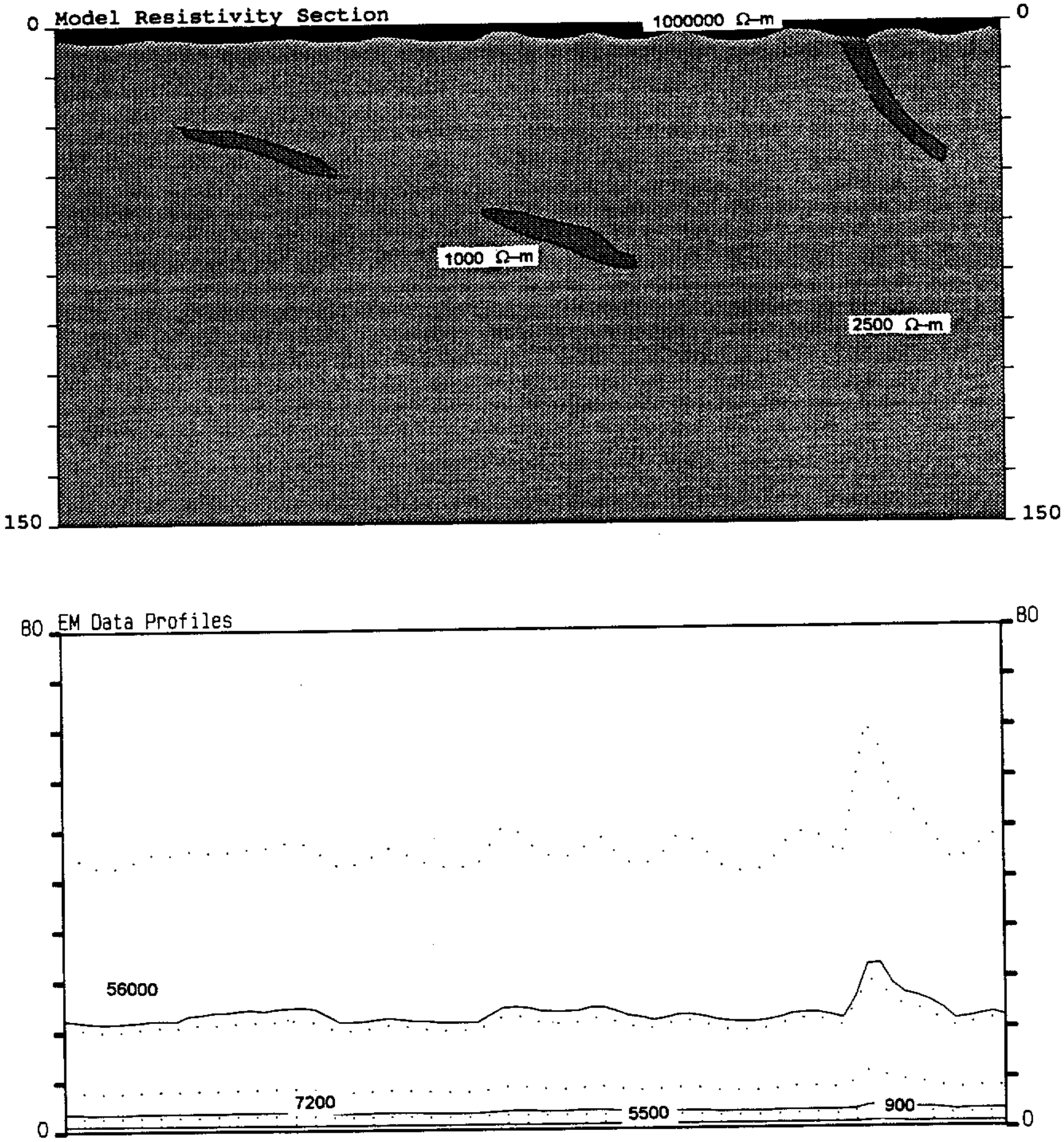

Figure 3.7 Chromite deposit model and response: no overburden.

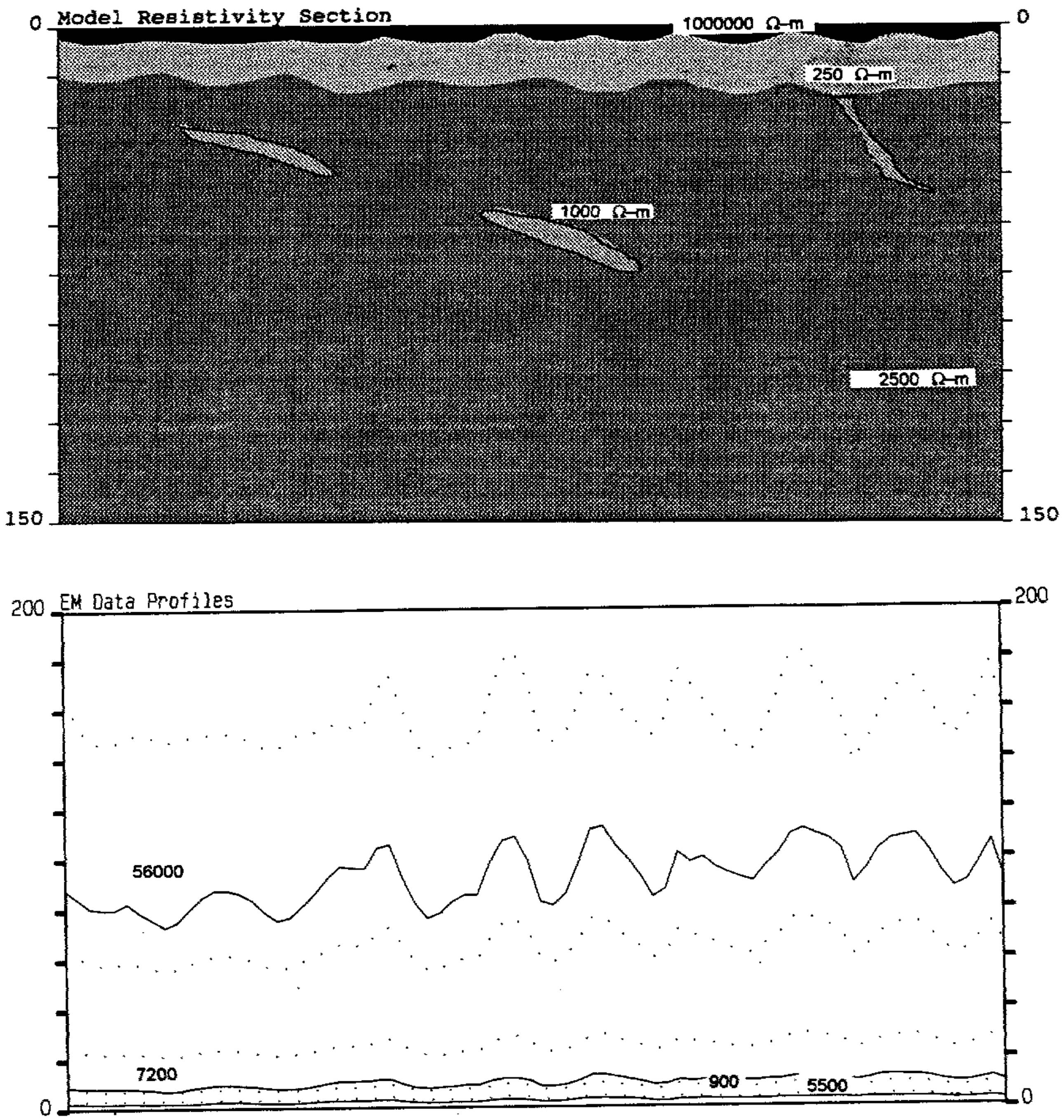

Figure 3.8 Chromite deposit model and response: with overburden.

Predicted HEM responses over listwanite deposits are shown in Figures 3.9 to 3.12. All models incorporate a 3 m wide vein but Figures 3.9 and 3.10 also include a 30 m wide alteration zone centred on the vein whereas Figures 3.11 and 3.12 model only the response of the central vein. The veins dip 60° and subcrop. The vein is assumed to be have a relatively low resistivity, reflecting the presence of graphite, sulphide mineralization and its alteration products and secondary water-filled fractures. This assumption may be invalid in the case of silica-flooded systems with few open fractures (see sample in Table 3.1). In the case of a relatively conductive vein, Figures 3.9 and 3.10 illustrate that it would be readily detectible by the Dighem V system, even under conductive overburden. Without the alteration envelope, the vein becomes a difficult target. In areas with no overburden, the vein might be detectible at 56000 and 7200 Hz (Figure 3.11) but a thin layer of overburden obscures the vein response (Figure 3.12). The magnetic response expected from a listwanite vein is shown in Figure 3.4. As noted above, it consists of a 200 to 300 nT magnetic low with no flanking highs.

3.4 HEM response - skarn deposits in limestones.

Wheeler (1960) mapped several granitic intrusions and thin beds of Lewes River Group limestone north of Mt. Mitchie suggesting that skarns or replacement deposits might be found here. Such deposits may also be fault-controlled. Limestone beds in the southern part of the survey area are favourably oriented with respect to northwest-striking faults and the limestone strata to the north are favourably oriented with respect to east-west striking faults. Many of the mapped faults appear to be steeply dipping normal or transcurrent faults. Replacement deposits which might develop along them would probably be localized in steeply dipping masses within the fault zones. Magnetic minerals such as pyrrhotite and magnetite in addition to conductive minerals such as pyrite, chalcopyrite and galena could be found in skarn or replacement deposits.

Possible HEM responses from replacement or skarn deposits are shown in Figures 3.13 and 3.14. Figure 3.13 illustrates the case of a deposit within a limestone bed in an area with thin or absent overburden; Figure 3.14 illustrates the case of a deposit beneath overburden. Limestones can display a very wide range of electrical resistivities (50 - 100K ohm-m; Telford *et al.* 1990). The worst case shown is for a conductive limestone bed hosting a skarn or replacement deposit in a compact mass at a depth of 30 m. Skarn rocks surrounding such a deposit are presumed to have an average value of 250 ohm-m. In this case, the 56000 Hz channel basically maps the limits of the limestone unit with a subsidiary peak over the skarn rocks. The 7200 and 5500 Hz channels respond to both the skarn rocks and the sulphide mineralization while the 900 Hz channel maps the extent and geometry of the sulphide mineralization. If magnetic minerals were present in the deposit, the magnetic response would be similar to those shown in Fig. 3.1 (reversed magnetized, Fig. 3.2).

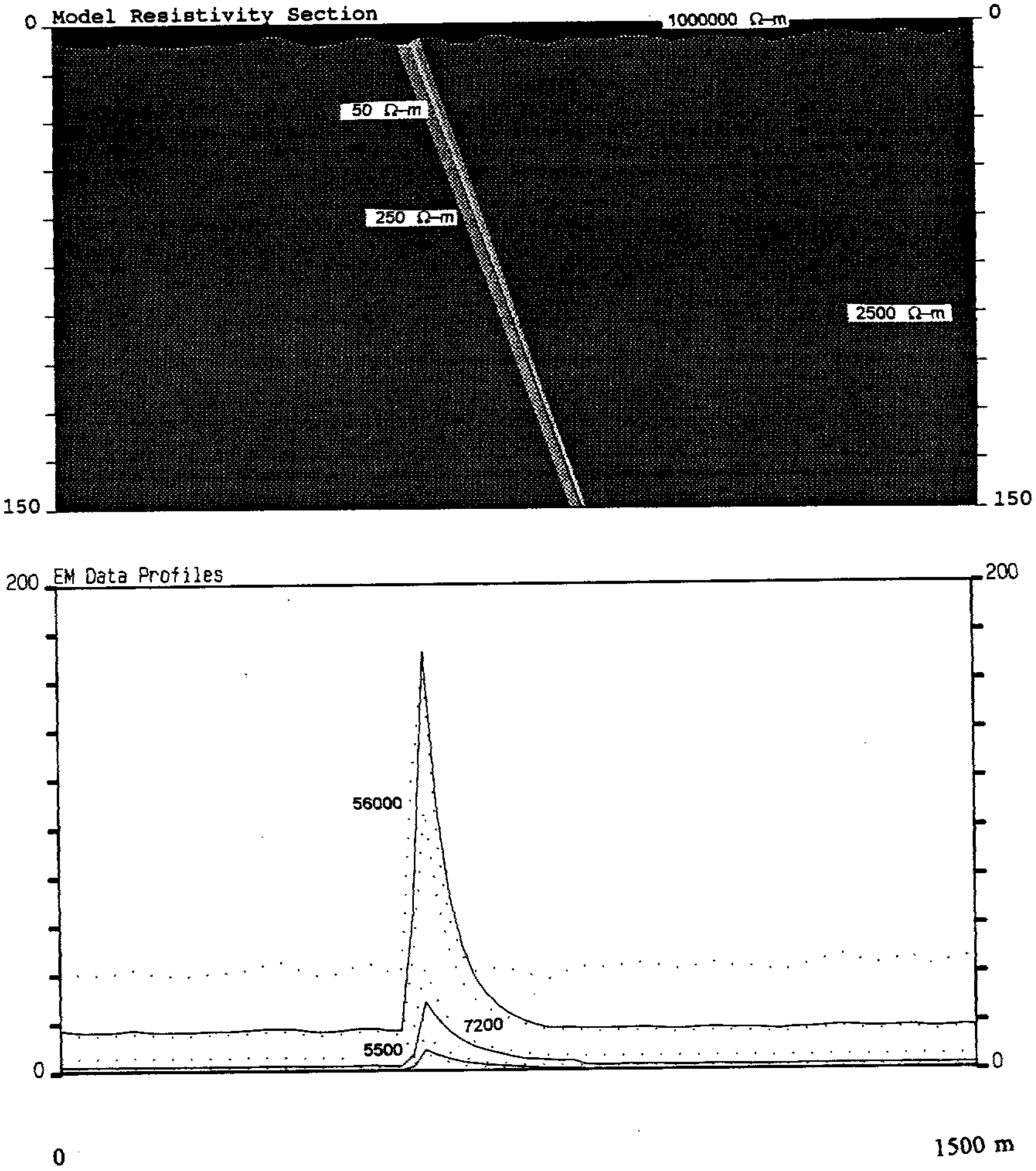

Figure 3.9 Listwanite vein with alteration halo and no overburden: model and response.

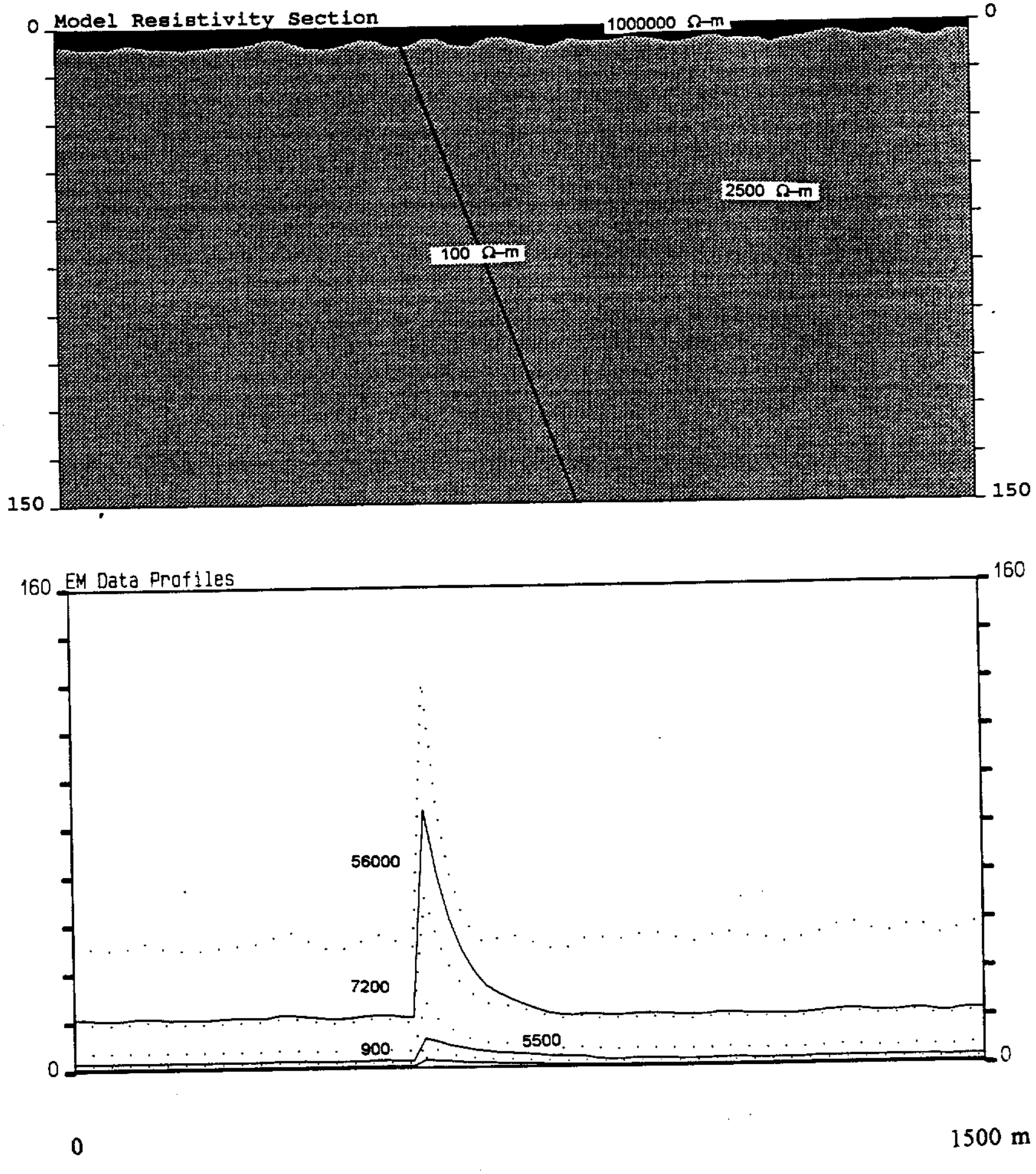

Figure 3.11 Listwanite vein with no alteration halo and no overburden: model and response.

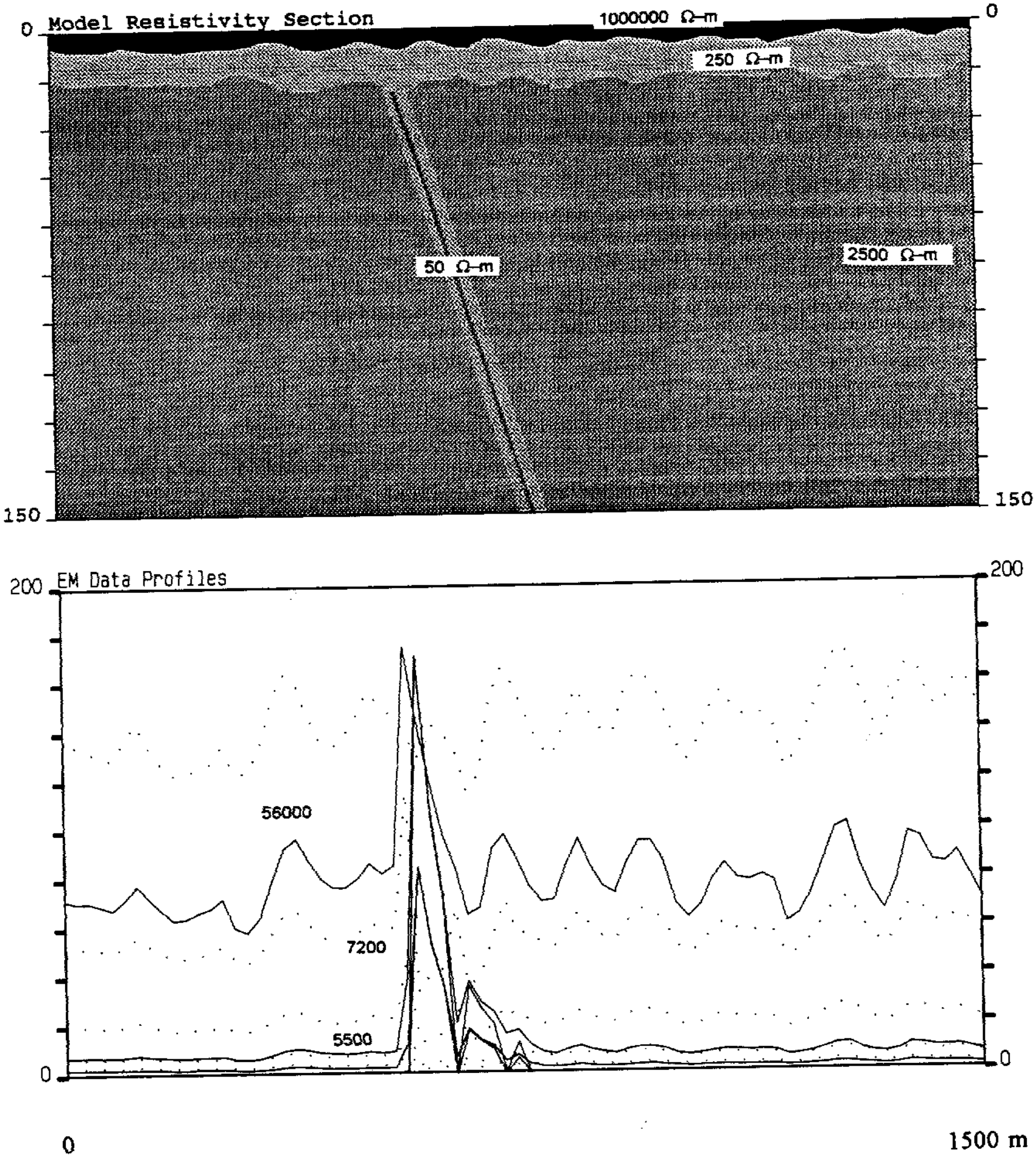

Figure 3.10 Listwanite vein with alteration halo and conductive overburden: model and response.

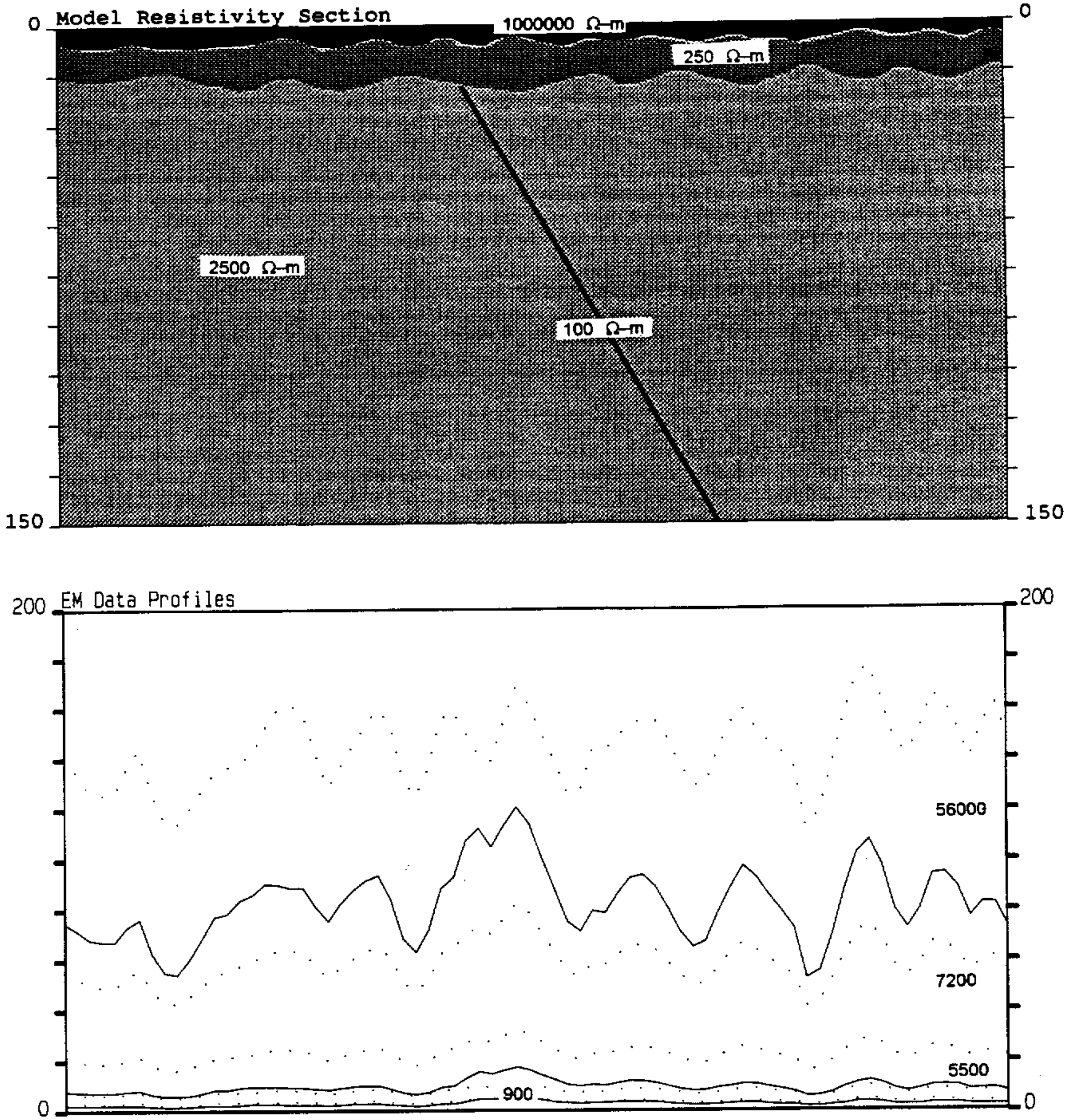

Figure 3.12 Listwanite vein with no alteration halo and conductive overburden: model and response.

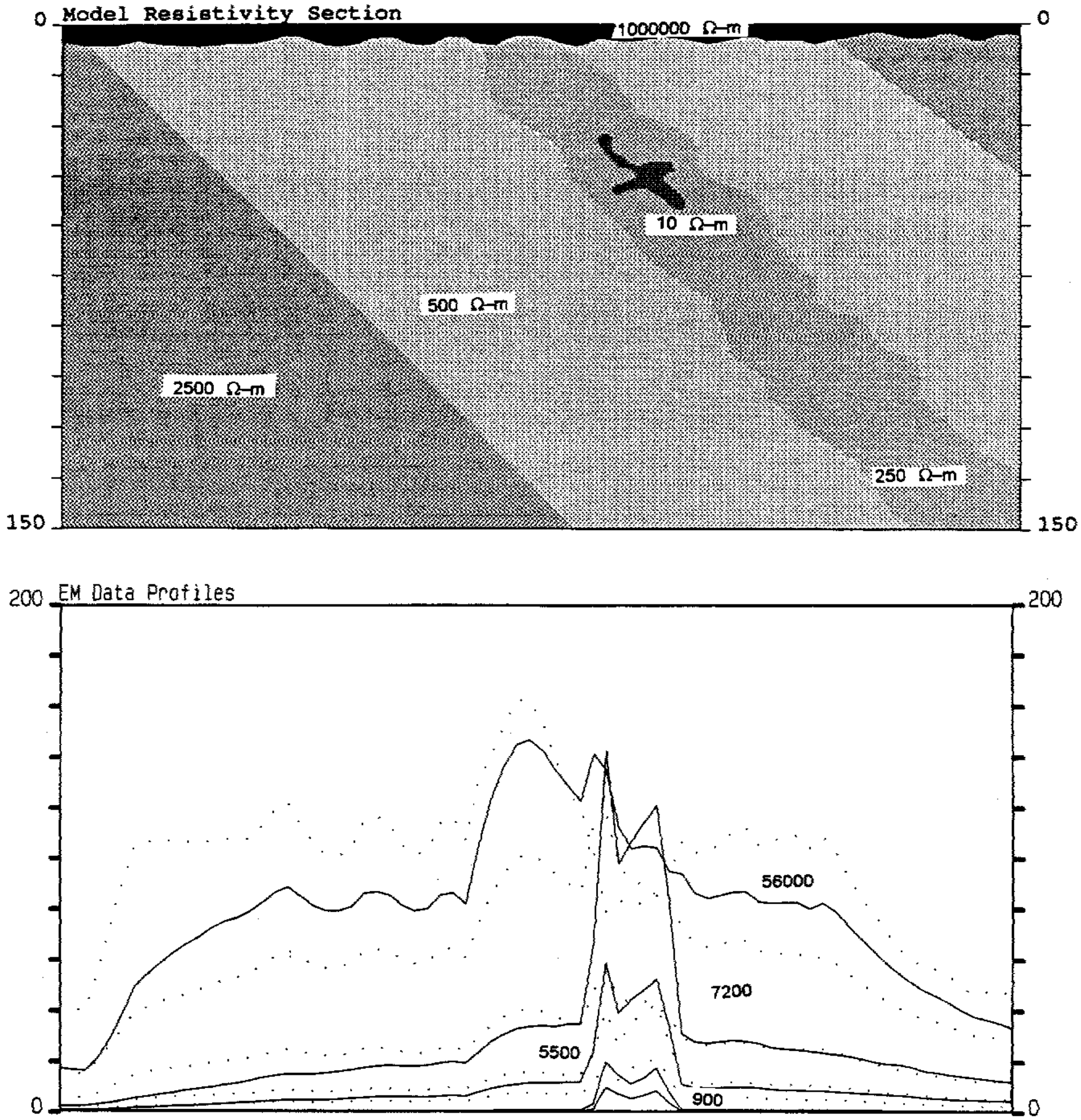

Figure 3.13 Skarn in conductive limestone with no overburden: model and response.

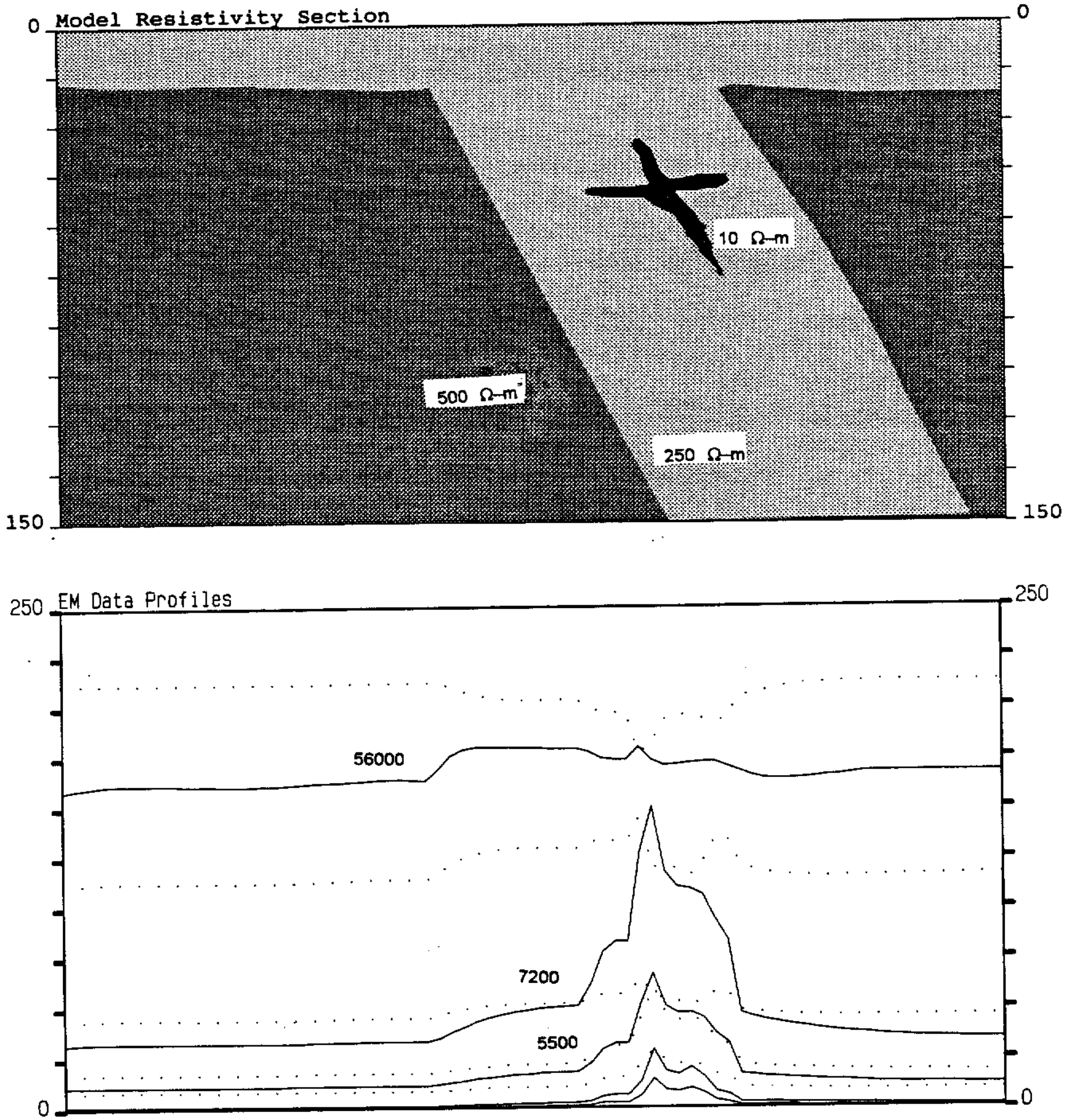

Figure 3.14 Skarn in conductive limestone with conductive overburden: model and response.

3.5 HEM response - epithermal precious metal vein deposits.

Epithermal precious metal vein deposits have produced significant quantities of gold and silver in northern British Columbia and southern Yukon. Many of the epithermal deposits in the Wheaton River and Tagish Lake areas west and south of the survey site were formed during Eocene deformation associated with volcanic activity near Mt. Skukum (Hart and Pelletier 1989; McDonald 1990). The high grade gold mineralization found at the Engineer Mine on Tagish Lake developed near steeply dipping, northwesterly trending faults reactivated during Eocene tectonism. While most of the fault displacement appears to have occurred on the northwesterly trending structures, dilatational veining and precious metal deposition is often found on east striking conjugate faults (eg. Carbon Hill, Mt. Stevens). Epithermal veins near Mt. Skukum are composed of quartz and calcite with lesser amounts of sericite, ankerite, fluorite, rhodochrosite and adularia (McDonald 1990) while those near the Engineer Mine are generally of quartz and calcite with small amounts of chlorite and limonite. Sparsely disseminated pyrite, native gold and galena are found in the Mt. Skukum complex veins while other veins in the area have abundant stibnite, galena or arsenopyrite. In general however, the sulphide content is low and contributes little if anything to the electrical conductivity of the vein rocks. Wall rock alteration is often quite intense and extends many metres from the vein contacts. At Mt. Skukum, McDonald (1990) noted that propylitic alteration formed the most widespread halo around the vein systems. Of particular note was the alterations of magnetite by leucoxene and the alteration of most mafic minerals to chlorite. Intense phyllic alteration near the veins caused the alteration of K-feldspar to sericite. The net effect of the wallrock alteration is to destroy magnetite and lower the bedrock resistivity significantly. Near Mt. Anderson, the author has observed altered granodiorite with resistivities as low as 150 ohm-m in the halo of an epithermal vein while the resistivity of the fresh rock was 2000 to 3000 ohm-m.

The HEM response of epithermal vein systems is basically the same as that of listwanite veins. Associated magnetic field lows will only be present if the veins cut rocks with above average magnetic susceptibility. In the survey area, this would include volcanic rocks of the Cache Creek and Lewes River Groups.

4.0 INTERPRETATION

Six 1:20,000 EM anomaly maps accompany this report. A series of conductors have been identified on these maps based on line-to-line continuity and similarities in responses. Thirty four of these anomalies were examined in detail and are described in Appendix A. In the interpretation, the author was guided by the recent compilation of the local geology by Hunt *et al.* (1994). That map is also included in this report. The anomalies described in this report have been assigned to one or more several descriptive classes based upon their geophysical responses and geological settings. These descriptive classes include:

T - Contact related or conformable conductor. This class would include conductors at the contact between different formations and conductors conformable with local bedding. Syngenetic sulphide and intrusive-hosted massive sulphide deposits would fall in this class. Most of the conductors in this class are weak conductors. North-trending conductors in this class could host epithermal or listwanite gold veins.

F - Conductor interpreted to be a fault. The general trend of these conductors is often not conformable with local strike but there are some situations where it appears that the conductor could be either a fault or a geological contact. These are generally weak conductors. North-trending conductors in this class could host epithermal or listwanite gold veins.

C - Conductor with conductances in the range of massive sulphides or graphite. Those conductors in this class with coincident positive magnetic responses in the Cache Creek Group have a good chance of hosting Ni-Cu massive sulphide mineralization.

I - Conductor close to and possibly related to a nearby intrusion. This would include skarn mineralization, intrusive hosted massive sulphide occurrences and veins close to intrusive rocks.

The anomalies are numbered sequentially working from Sheet 1 through 6. The map legends describe the anomaly description protocol used by Dighem to summarize information for each anomalous response along the survey lines.

5.0 RECOMMENDATIONS

Any of the north-trending **F** type conductors which cut ultramafic rocks of the Cache Creek Group (**cPu**) could host listwanite gold veins. They should be prospected near and within areas underlain by these rocks. Conductive thrust fault contacts (eg. anomalies 14, 15 and 33 (east)) should also be prospected for similar mineralization. The strong conductors west of the intrusion near Mt. Mitchie could be caused by skarn mineralization or by remobilized sulphides in the Cache Creek volcanics and merit detailed follow-up. Any strong conductor - even if it is isolated - which occurs near the basal contact of the gabbro intrusions should also be investigated. Anomaly 13 appears to be the most favourable of these conductors.

It is the author's firm belief that any significant new gold or base metal occurrences which remain to be found in the survey area will be associated with EM anomalies and magnetic field features contained in the Dighem survey results.

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APPENDIX A. CONDUCTOR DESCRIPTIONS

Anomaly:	CI_1
Start / End:	10010F - 10080D
EM response:	May be an along strike response since anomalies do not extend to adjacent lines. Conductance 10-100S, no mag suppression.
Magnetics:	Conductor follows west side of magnetic high.
Geology:	Conductor is within Cache Creek group volcanics within 2 km of the nearest contact with pegmatitic syenite intrusion and close to the BRONCO showing.

Anomaly:	FT_2
Start / End:	10140K - 10320K
EM response:	Wide low amplitude response, apparently surficial over much of its length with discrete bedrock conductor intersections at several points. Possible weak alteration halo to the west is suggested by changes in HF quadrature responses.
Magnetics:	Coincident with magnetic high in north, no association in the south.
Geology:	In the north, curved section follows magnetic high along the inferred igneous contact with syenite to the west. Possible contact or limit of hornfels in metamorphic aureole. To the south, possibly a contact or fault parallel to bedding in Laberge Group.

Anomaly: **IC_3**

Start / End: 10010F - 10080D

EM response: Partially screened by overburden (HF response obscured). Bedrock type anomaly with strong DFI/DFQ

Magnetics: Follows magnetic high to the east.

Geology: Conductor occurs on margin of interpreted hornfels in Cache Creek Group, possible skarn.

Anomaly: **I_4**

Start / End: 10290D-10330D

EM response: Bedrock conductor (**B** or **D**) along its length with strong 900 Hz responses. Occurs in a broad zone of low resistivity.

Magnetics: No association

Geology: Immediately east of BRONCO showing and on the margin of hornfels.

Anomaly: **IF_5**

Start / End: 10130A-10330E

EM response: Type **B,D,E,H** anomalies of weak amplitude. HF response difficult to discriminate from overburden. Follows eastern edge of broad resistivity low

Magnetics: Cross-cuts mag high and passes through a saddle in a second mag high (alteration?)

Geology: West of/parallel to the contact with a pegmatitic syenite intrusion in Cache Creek Group volcanics. May indicate the margin of the metamorphic aureole. Magnetics suggest it is a fault.

Anomaly: F_6

Start / End: 10180D-10340B

EM response: Type **B,D,H** in the middle and **S** at the ends of conductor axis. Highest conductance only 4S but sharp, narrow bedrock responses at 10240C, 10210E.

Magnetics: No association

Geology: Possible fault.

Anomaly: F_7

Start / End: 10310K-10480H

EM response: Type **H,S** and **B?**. Conductor apparent width up to 150 m, possibly caused by shallow dip. Weak 900 Hz response with 56 KHz response obscured by overburden.

Magnetics: Follows broad magnetic low.

Geology: Conductor is at a high angle to local strike of Laberge Group rocks. No association with local drainages; possibly a fault.

Anomaly: FT_8

Start / End: 10060J-10140L
19060C-19060B

EM response: Type **D,B** and **S**. Appears to be the junction of 2 conductors. Best conductance - 14 S at 10080G near junction with cross structure. South branch response is weak with only 900 CPQ. Wide responses on this branch.

Magnetics: Each segment lies in broad magnetic lows.

Geology: At contact between Lewes River and Laberge Groups. N-S strand is parallel to bedding in Laberge Group, NW-SE strand follows inferred contact between the two units.

Anomaly: **F_{8}**

Start / End: 10390G-10470H (possibly a splay from anomaly 7)

EM response: Type **B,D** and **H**. with maximum conductances less than 5 S. Narrow response on both in-phase and quad at 900 Hz. Both DFI and DFQ channels deflect.

Magnetics: 100 to 150 m west and parallel to magnetic peak originating on FL10380.

Geology: Conductor is within Laberge Group rocks north of NE-SW striking normal fault and discordant with respect to local bedding.

Anomaly: **FT_{10}**

Start / End: 10270M-10310O

EM response: Type **D**, **B** and **H**. No in-phase response at 900 Hz. Appears to be 2 conductors 50-100 m apart. Only DFQ deflects. Weak response may be partly due to high angle of conductor with respect to survey lines.

Magnetics: Flat magnetics

Geology: Conformable with local bedding and schistosity in Cache Creek Volcanics.

Anomaly: F_{11}

Start / End: 10380I-10470M

EM response: Type **S**. Sharp 56 KHz response, poor low freq response. Quadrature responds on all channels. Broad, weak DFQ, no DFI.

Magnetics: Follows east boundary of magnetic low inferred to be a gabbroic plug. Generally in low ground and may be entirely surficial or a very weak bedrock conductor covered by overburden.

Geology: Discordant with respect to local bedding in Cache Creek Group volcanics. Truncated to the south by NE-SW trending normal fault.

Anomaly: F_{12}

Start / End: 10570L-10660M

EM response: Types **D, B?** with **S** at southeast end. Quadrature only at 900 Hz. DFQ response. Very high surficial type response at 56KHz at south end.

Magnetics: Flat magnetics except at southeast end where it is coincident with a weak (50 nT) low.

Geology: Discordant with respect to Lewes River Group in which it occurs.

Anomaly: IFT_{13}

Start / End: 11040M-11110O (A)
11100S-11140Z (B)

EM response: Strong bedrock conductors, possibly sulphides (maximum conductance 21 S on 11080S). Sharp high amplitude responses, apparent dip to west (response is strongly asymmetric)

Magnetics: Section A follows a mag low to the east. Section B follows east side of a zone of high magnetic relief.

Geology: Section A follows contact between gabbro (east) and Cache Creek Group volcanics and ultramafic rocks. Section B cuts into gabbro along a possible slice of included **cPv** (mag high within larger mag low).

Anomaly: $\mathbf{F_{14}}$

Start / End: 10330A - 10400B

EM response: Type **H,B** and **S**. Maximum conductance 9 S (10390A). Weak amplitude response with apparent widths to 100 m.

Magnetics: Follows sharp 100-600 nT low.

Geology: Follows thrust fault separating **cPu** and **cPv**.

Anomaly: $\mathbf{F_{15}}$

Start / End: 10500H-10590F

EM response: Type **B,H** and **S**. In-phase response suppressed by magnetite (eg FL10560 (4006)). Response is sharpest on the south side and widens to the north. Conductor follows the west side of a broad resistivity low. Maximum conductance of 9S.

Magnetics: Follows line of maximum inflection between magnetic unit to the west and mag low to the east.

Geology: Follows thrust fault bounding **cPu** and **cPv**.

Anomaly: F_{16}

Start / End: 10590L-10680K

EM response: Type **S, B?**. Wide response with only quadrature at 900 Hz. DFQ but no DFI. Best conductance 3.1 S.

Magnetics: No magnetic association.

Geology: Discordant with respect to Laberge/Lewes River Groups. Two parallel extensions of this anomaly lie to the north.

Anomaly: F_{17}

Start / End: 10461B-10600D

EM response: Type **S, H** and **B**. Wide high frequency in-phase and quadrature response. Minimal deflection at 900 Hz. Maximum conductance 2.9 S. Serious magnetite suppression of the in-phase at 900 Hz where anomaly cuts across a magnetic high.

Magnetics: Cuts across mag high at a very shallow angle.

Geology: Conductor cuts across **cPv** at a low angle down into underlying **cPu**.

Anomaly: F_{18}

Start / End: 10710H-10760J

EM response: Type **S,H** and **B?** Weak response with broad low amplitude DFQ response. Maximum conductance 2.1 S. Possibly entirely surficial.

Magnetics: Generally coincident with mag high.

Geology: Lies within **cPu**.

Anomaly: TF_{19}

Start / End: 10520C - 10770C

EM response: Type **S, H** and **B?** No in-phase response at 900 Hz, in-phase and quadrature response at higher frequencies. Wide, weak amplitude deflections. Maximum conductance 4.3S with average <1 S.

Magnetics: Conductor follows weak 50 nT positive mag anomaly

Geology: Conductor follows fault or contact between **cPv** and Laberge Group rocks.

Anomaly: TF_{20}

Start / End: 10730D-10780B

EM response: Type **B?, D**. Weak narrow response. In-phase suppressed by magnetite. Both in-phase and quadrature at 900 Hz with accompanying DFI and DFQ. Maximum conductance 3.4S.

Magnetics: Follows eastern edge of mag high.

Geology: May be the trace of the Marsh Lake Fault or contact immediately west of it. Conformable with bedding of **cPv** but lies within **cPu**. BUG showing lies immediately to the west, perhaps along one of a series of short bedrock conductors.

Anomaly: F_{21}

Start / End: 10870D-11000A

EM response: Type **S?** and **B?** No in-phase response at 900 Hz, DFQ only. Response is wide and high amplitude at 56 KHz. Source appears deeper to south; response widens, response relief (mag/EM) is subdued.

Magnetics: Coincident with 200 nT high in north and follows east side of mag high to the south.

Geology: Conductor lies in **cPv**. It is possibly a thrust fault bringing up magnetic rocks to the west over less magnetic rocks to the east.

Anomaly: $\mathbf{F}_{22}$

Start / End: 10790E-11061B

EM response: Types **S, B?** and **H**. Both 900 Hz in-phase and quadrature but only DFQ deflection. Broad response on all channels with best conductance of 5 S. Apparent depth of 32 m but one bedrock conductor lies at south end of the anomaly.

Magnetics: Conductor follows weak mag low coincident with lakes at north end of anomaly. No association with magnetics in the south. Anomaly terminates in a zone of active magnetics at the north end.

Geology: Conductor trends NW-SE, cutting across bedding through **cPv** into **cPu**. The anomaly follows a chain of lakes and low ground and may only be surficial. There is one bedrock conductor however.

Anomaly: $\mathbf{F}_{23}$

Start / End: 10620L-10690K

EM response: Types **H, S** and **S?** No in-phase response at 900 Hz. Wide response, strongest at the north end with best conductance of 4.0 S.

Magnetics: Follows magnetic high

Geology: Orthogonal to bedding, cutting across contact between Lewes River and Laberge Groups. Possible fault.

Anomaly: F_{24}

Start / End: 10890(960)-10961(B)

EM response: Types **D, H** and **S**. In-phase magnetite suppression at north end. No in-phase response at 900 Hz. Response widens and dies off to south.

Magnetics: Coincident with mag high in north.

Geology: This conductor together with another section to the northwest Appears to be a fault (?contact) between **cPu, cPv** and **uTLc**.

Anomaly: F_{25}

Start / End: 10930R-11120C

EM response: Type **S, B?** and **H**. Some sharp 900 Hz deflections on both in-phase and quadrature channels. DFI/DFQ deflections as well. Serious in-phase magnetite suppression at south end. HF response is quite wide, perhaps reflecting only overburden.

Magnetics: No strong mag correlation

Geology: Follows drainage along its length but anomaly terminates before the drainage does. No adjacent drainages have similar conductors. Some anomalies appear to be bedrock conductors. Possibly a fault.

Anomaly: F_{26}

Start / End: 10860L-10940O

EM response: Sharp bedrock conductor responses. In-phase magnetite suppression. Maximum conductance 2.5 S but this is unreliable because of in-phase suppression. This conductor and another to west bound a zone of low resistivity, coincident with magnetic field highs.

Magnetics: Conductor follows mag high

Geology: Conductors appear to be faults bounding a block of **cPu** within **uTLc** limestone.

Anomaly: F_{27}

Start / End: 10870I-11000D

EM response: Types **S, B?** Strongest response at 10930J where conductance is 6.3 S. Possible mag suppression. Response widens to southeast.

Magnetics: Conductor follows small amplitude mag high.

Geology: Conductor is within **cPu** and extends a short distance into **cPv** through a thrust fault. The conductor is truncated against anomaly 28. Several strong bedrock conductors southwest of this anomaly are worth investigating as they lie within **cPu**.

Anomaly: F_{28}

Start / End: 10991H-11260C

EM response: Type **B, B?, H, S**. Broad response with in-phase at high frequencies only. Weak bedrock response at 900 Hz at 11080E.

Magnetics: Cuts across large mag high through a small coincident relative mag low.

Geology: Cuts across **cPu** and overlying **cPv**. Conductor appears to be a large fault, open on strike at the south end. In part, it captures drainages along its axis.

Anomaly: **TF$_{29}$**

Start / End: 11030C-11150B

EM response: Types **B?, H, S, S?** Broad response with very weak in-phase at 900 Hz and DFQ only in the north. West side more conductive than east here. To the south, anomaly strengthens. On FL 11100 in-phase deflects on all channels and both DFI and DFQ deflect. At the extreme south end, the response widens and dies off.

Magnetics: Conductor follows regional mag gradient but there is a very small low amplitude (30 nT) inflection in the mag profiles at the north end coincident with the anomaly.

Geology: Conductor is within **cPv** parallel to contact with **cPu**. Either a fault or contact type anomaly.

Anomaly: **F$_{31}$**

Start / End: 10961H-11050K

EM response: Types **S, S?**. Broad (200m) high frequency anomaly with only quadrature at low frequencies. Minimal DFQ no DFI so it may be entirely surficial.

Magnetics: Cuts across regional mag gradient.

Geology: While apparently surficial, the anomaly does not follow any drainages and cuts through **cPu** into **cPv** and across a thrust fault into **cPu**. Possibly a fault.

Anomaly: **F$_{32}$**

Start / End: 11110L-11260AB

EM response: Types **S, H, B?** and **B**. Broad response narrowing where bedrock type conductors are recorded. Some 900 Hz in-phase recorded along with both DFI and DFQ. Best intersection is at 19090J on the south side of a magnetic feature where conductance of 14 S was recorded. Good response relief at 11260AB in both mag and EM; the conductor might be shallow here.

Magnetics: Conductor follows mag low at north end and cuts across mag high at south end.

Geology: Conductor lies in **cPv** and is not parallel to strike (fault?).

Anomaly: $\mathbf{F_{33}}$

Start / End: 11340A-11450C

EM response: Types **B?, D, S,** and **H**. Strong 900 Hz responses with DFI and DFQ. Response widens, weakens and dies to north - perhaps in part due to overburden effects.

Magnetics: North trending conductor cuts across broad northeast trending mag low.

Geology: Roughly coincident with mapped thrust fault separating **cPv** and **cPc**. The conductor immediately to the east has similar characteristics and follows the thrust fault contact between **cPv** and **cPu**.

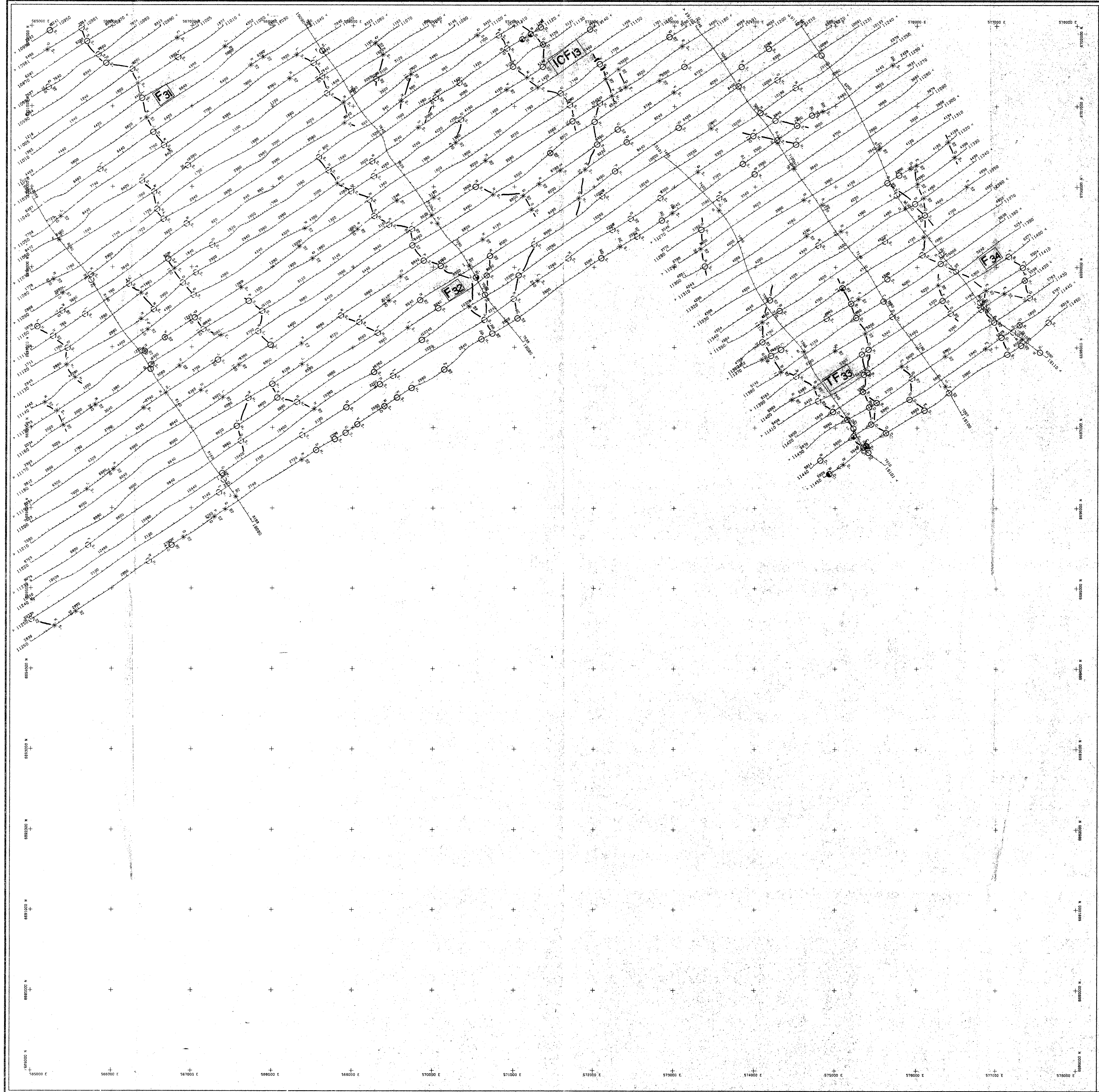
Anomaly: $\mathbf{F_{34}}$

Start / End: 11320B-11450G

EM response: Types **B, D** and **H**. Narrow high amplitude response with in-phase suppression and multiple conductors present. Best conductance was 5.7 S at 11440F. DFI/DFQ both deflect but only weak 900 Hz in-phase due in part to suppression.

Magnetics: Cuts across a zone of high magnetic relief into a broad magnetic low; no consistent mag association

Geology: Conductor runs from **cPu** in south across a thrust fault into **cPv.** The TOG showing occurs at 11430F.



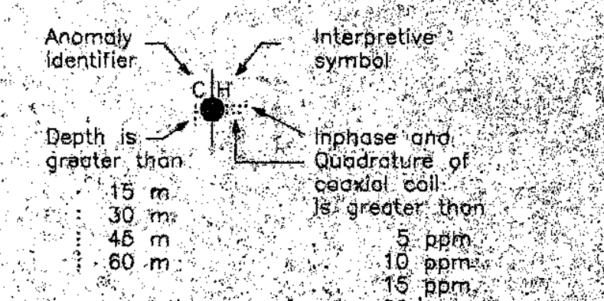
TECHNICAL SUMMARY

Navigation	Sercel real time differential GPS positioning
Data reduction grid interval	50 metres
Terrain clearance	Helicopter 60 m Electromagnetic sensor 30 m Magnetometer VLF receiver 40 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Scintrex cesium / 0.01 nT
VLF receiver / sensitivity	Herz 2A / 1%
Electromagnetic system	DIGHEM^V

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	1.0 ppm	Horizontal coplanar

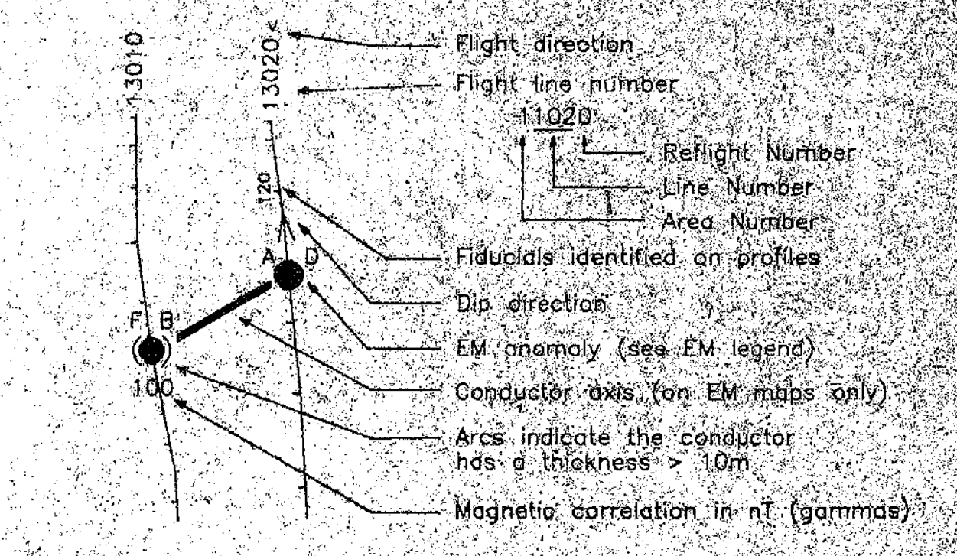
ELECTROMAGNETIC ANOMALIES

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



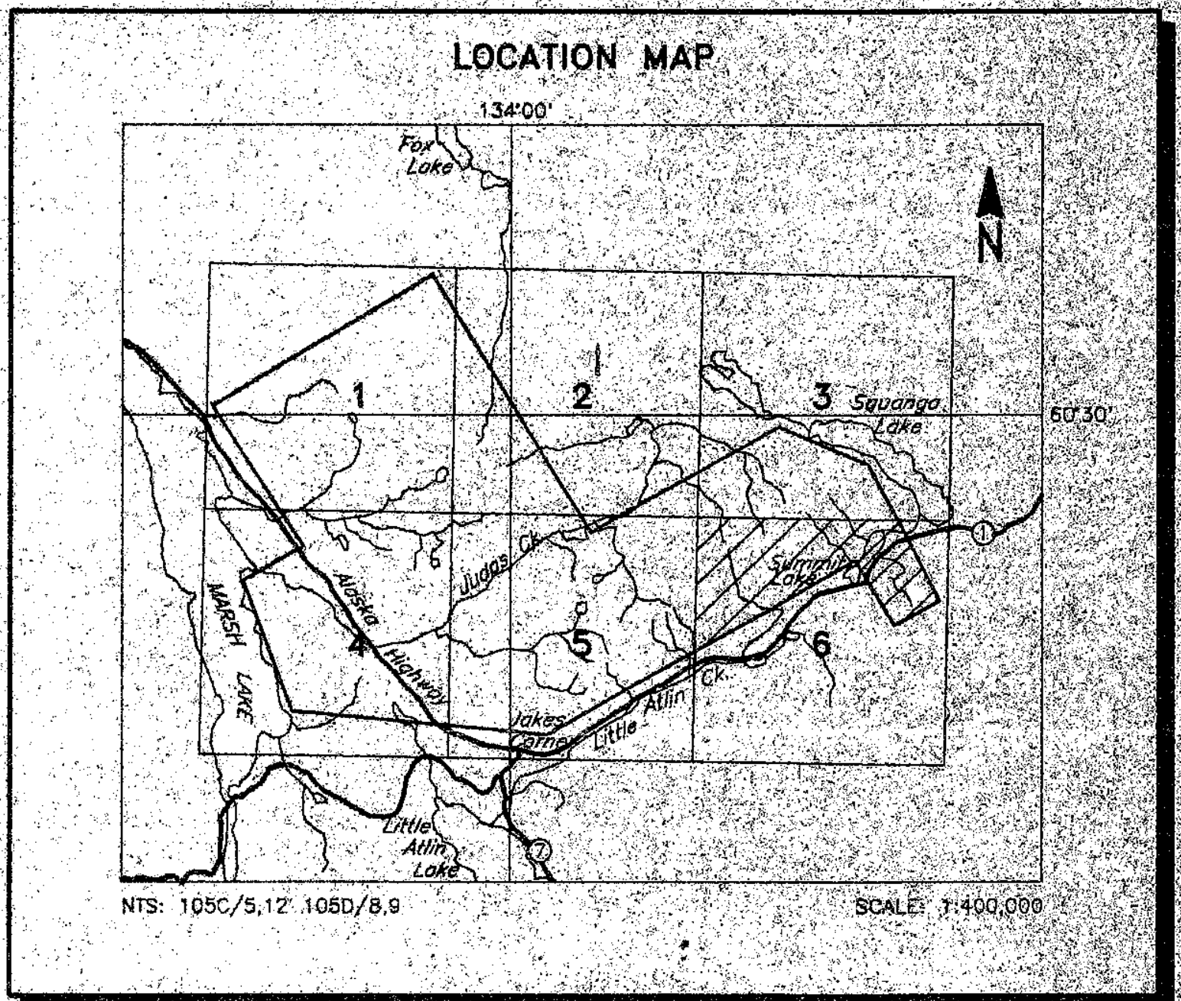
Interpretive symbol	Conductor ("model")
B	Bedrock conductor
D	Narrow bedrock conductor ("thin dike")
S	Conductive cover ("horizontal thin sheet")
H	Broad conductive rock unit, deep conductive weathering, thick conductive cover ("half space")
E	Edge of broad conductor ("edge of half space")
L	Culture,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

FLIGHT LINES WITH EM ANOMALIES



INTERPRETATION LEGEND

T Geological contact
F Fault
C Sulphide or graphite conductor
I Igneous
32 Conductor number (see text)



YUKON PROSPECTORS' ASSOCIATION
JAKES CORNER, YUKON

ELECTROMAGNETIC ANOMALIES

DIGHEM^V SURVEY	NTS: 105C/5,12 105D/8,9	GEOPHYSICIST:
DATE: MARCH, 1994	JOB: 1168	SHEET: 6

DIGHEM, A division of CGG Canada Ltd.

0 1 2 Km
Scale 1:20 000

DIGHEM
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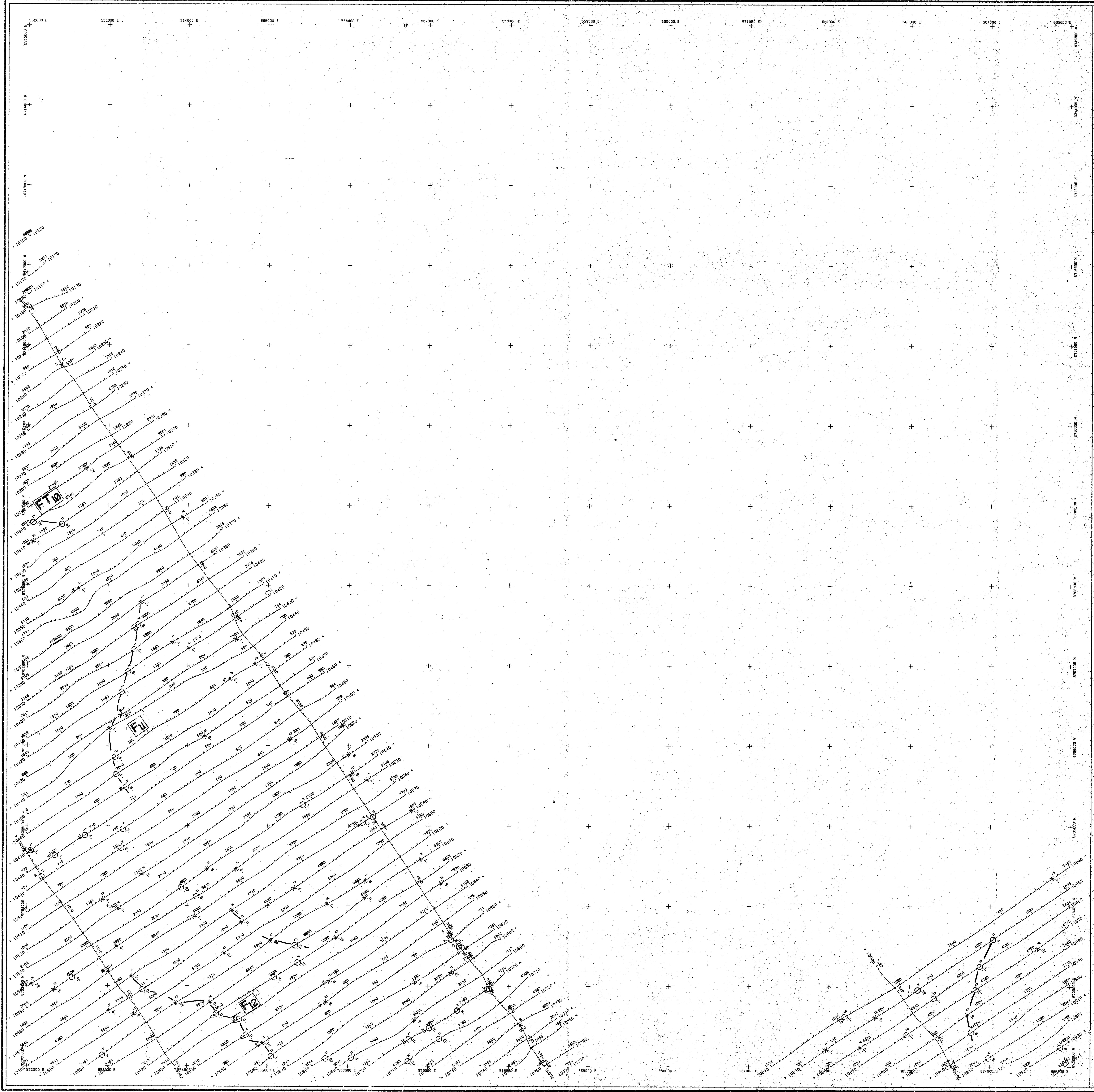


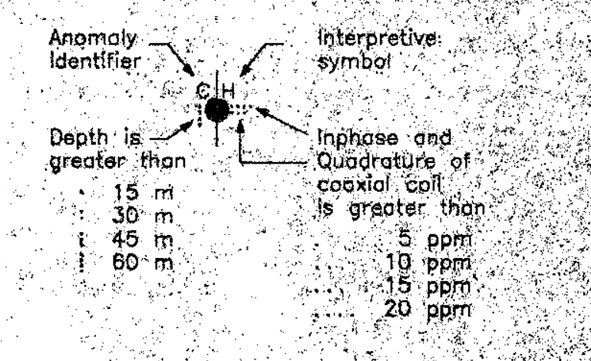
TECHNICAL SUMMARY

Navigation	Sercel real time differential GPS positioning
Data reduction grid interval	50 metres
Terrain clearance	Helicopter 60 m Electromagnetic sensor 30 m Magnetometer VLF receiver 40 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Scintrex cesium / 0.01 nT
VLF receiver / sensitivity	Herz 2A / 1%
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	1.0 ppm	Horizontal coplanar

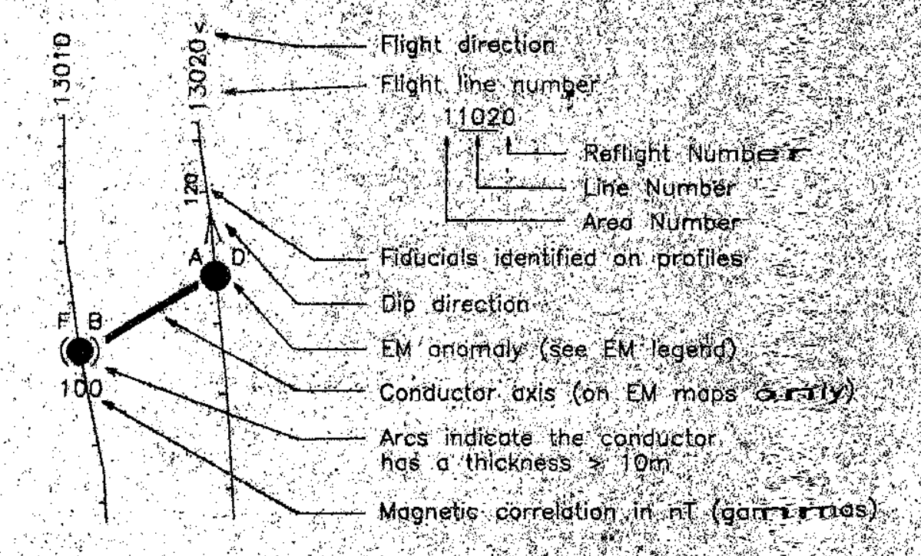
ELECTROMAGNETIC ANOMALIES

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



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

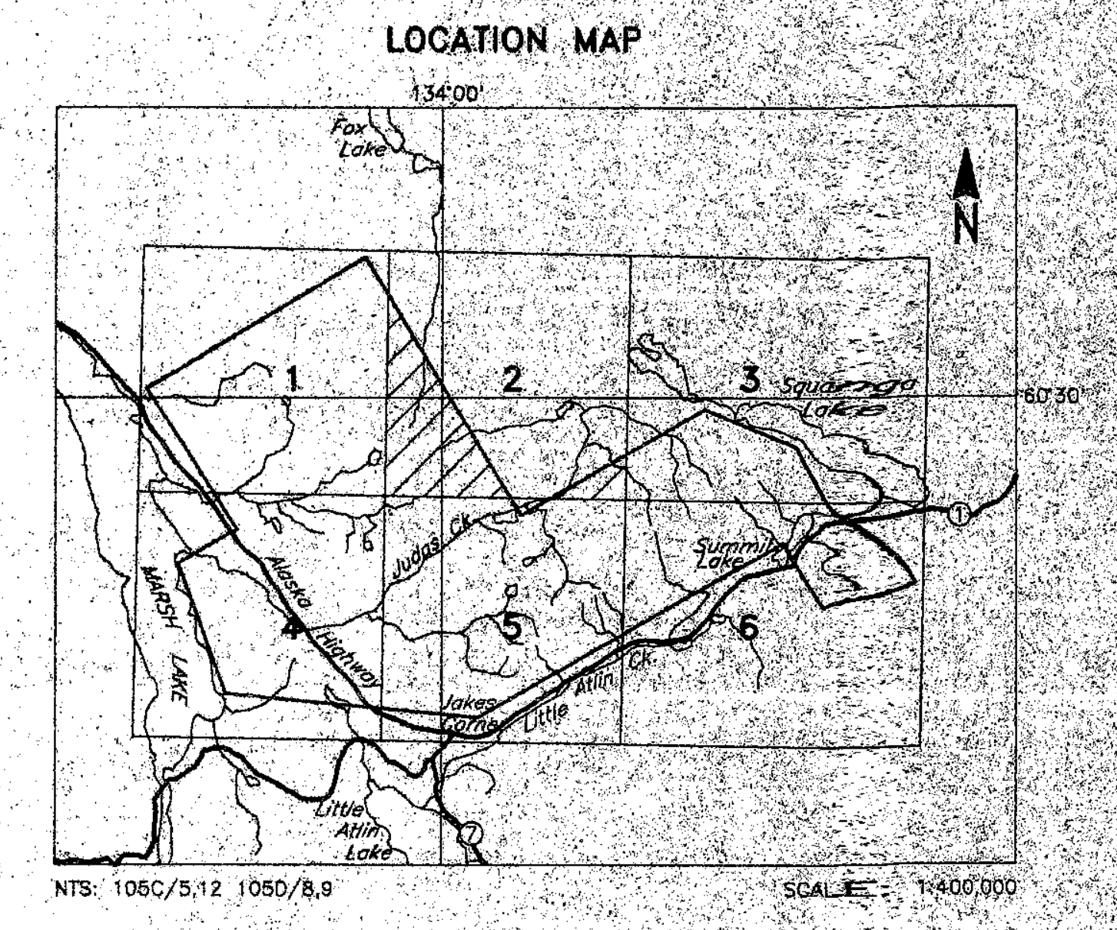
FLIGHT LINES WITH EM ANOMALIES



INTERPRETATION LEGEND

T Geological contact
F Fault
C Sulphide or graphite conductor
I Igneous
32 Conductor number (see text)

LOCATION MAP



NTS: 105C/5,12 105D/8,9 SCALE: 1:400,000

YUKON PROSPECTORS' ASSOCIATION
JAKES CORNER, YUKON

ELECTROMAGNETIC ANOMALIES

DIGHEM* SURVEY	NTS: 105C/5,12 105D/8,9	GEOPHYSICIST:
DATE: MARCH, 1994	JOB: 1168	SHEET: 2

DIGHEM, A division of CGG Canada Ltd.

0 1 2 Km
Scale 1:20 000

DIGHEM
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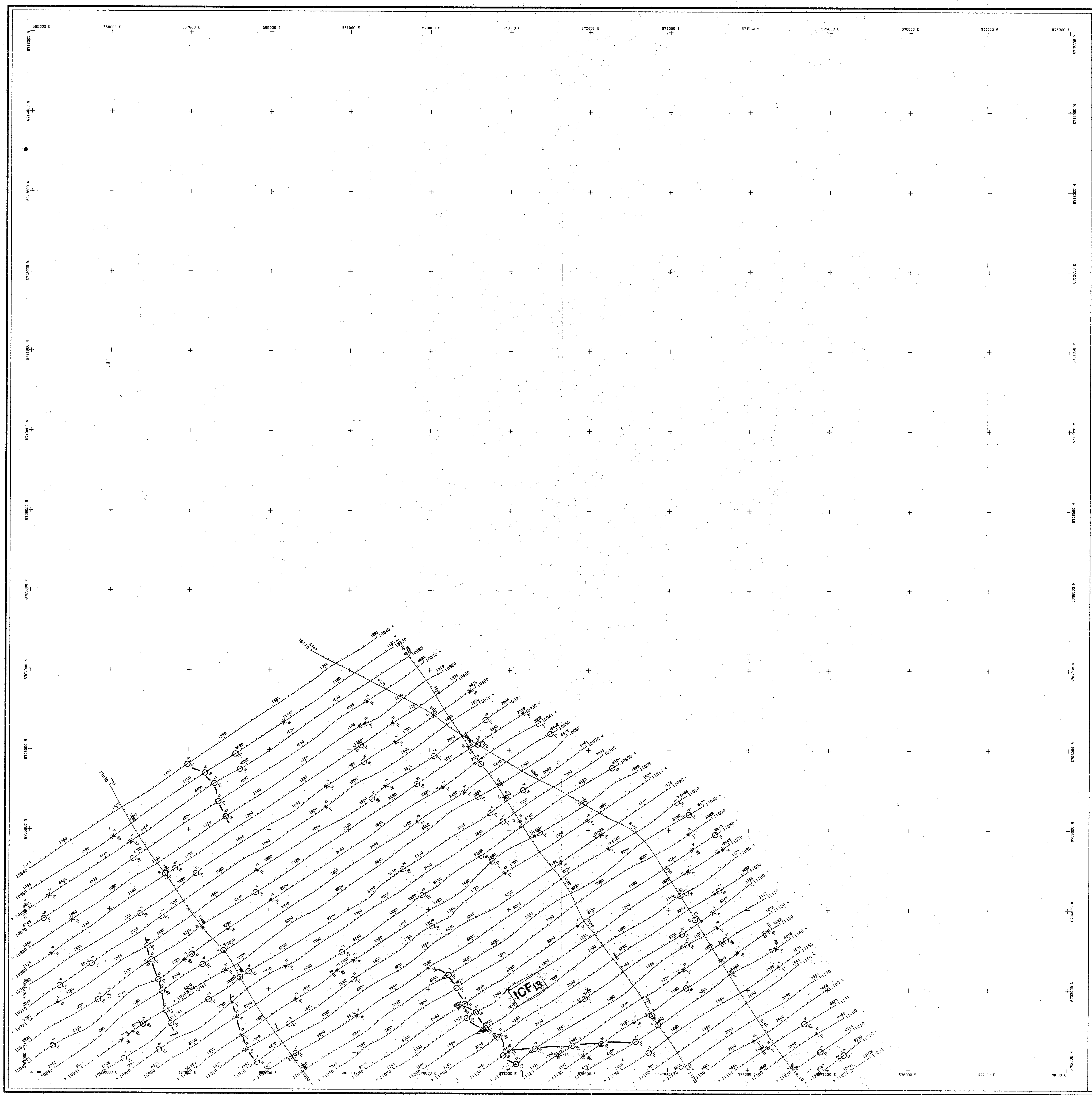


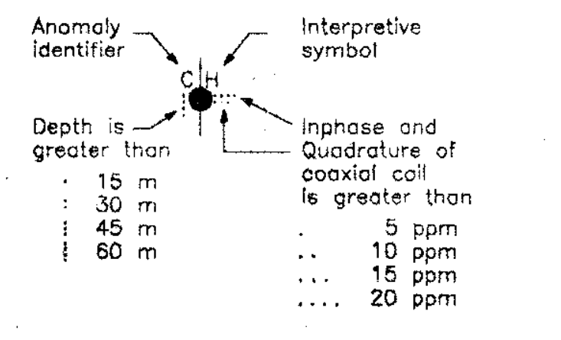
TECHNICAL SUMMARY

Navigation	Sercel real time differential GPS positioning
Data reduction grid interval	50 metres
Terrain clearance	Helicopter 60 m Electromagnetic sensor 30 m Magnetometer, VLF receiver 40 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Scintrex cesium / 0.01 nT
VLF receiver / sensitivity	Herz 2A / 1%
Electromagnetic system	DIGHEM^V

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	1.0 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



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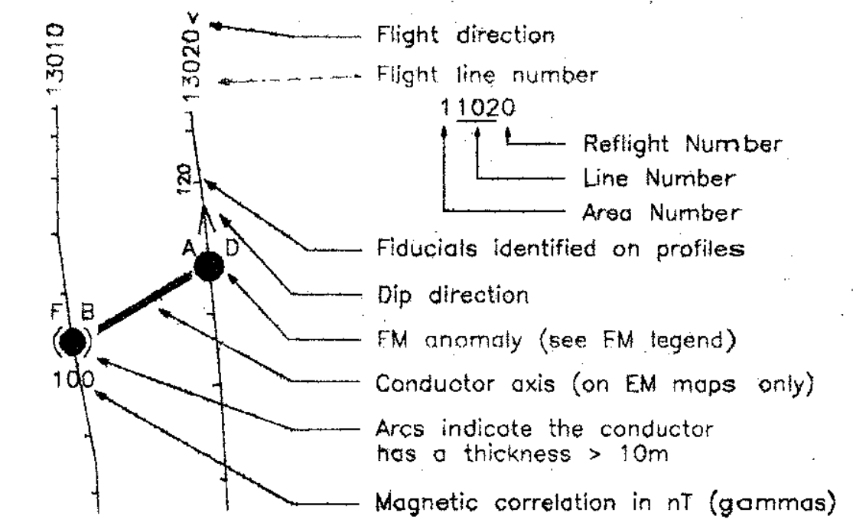
S	Conductive cover ("horizontal thin sheet")
H	Broad conductive rock unit, deep conductive weathering, thick conductive cover ("half space")
E	Edge of broad conductor ("edge of half space")
L	Culture, e.g. power line, metal building or fence

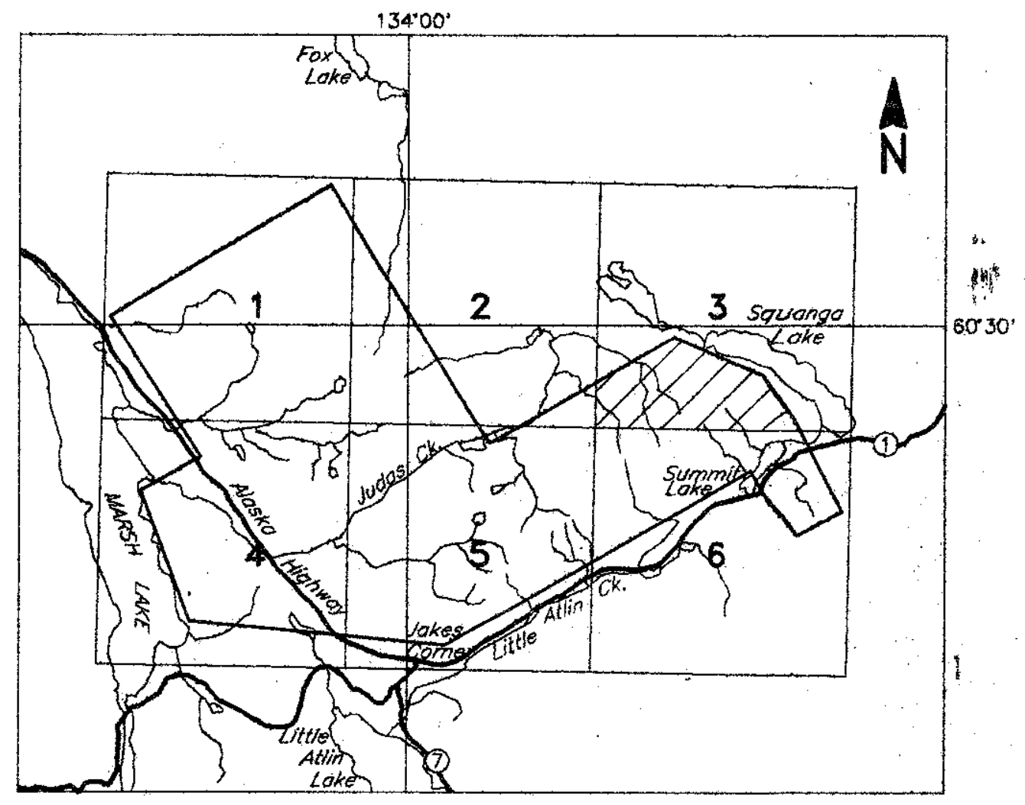
FLIGHT LINES WITH EM ANOMALIES



INTERPRETATION LEGEND

T	Geological contact
F	Fault
C	Sulphide or graphite conductor
I	Igneous
32	Conductor number (see text)

LOCATION MAP



NTS: 105C/5,12 105D/8,9

SCALE: 1:400,000

YUKON PROSPECTORS' ASSOCIATION
JAKES CORNER, YUKON

ELECTROMAGNETIC ANOMALIES

DIGHEM^V SURVEY	NTS: 105C/5,12 105D/8,9	GEOPHYSICIST:
DATE: MARCH, 1994	JOB: 1168	SHEET: 3

DIGHEM, A division of CGG Canada Ltd.

0 1 2 Km

Scale 1:20 000

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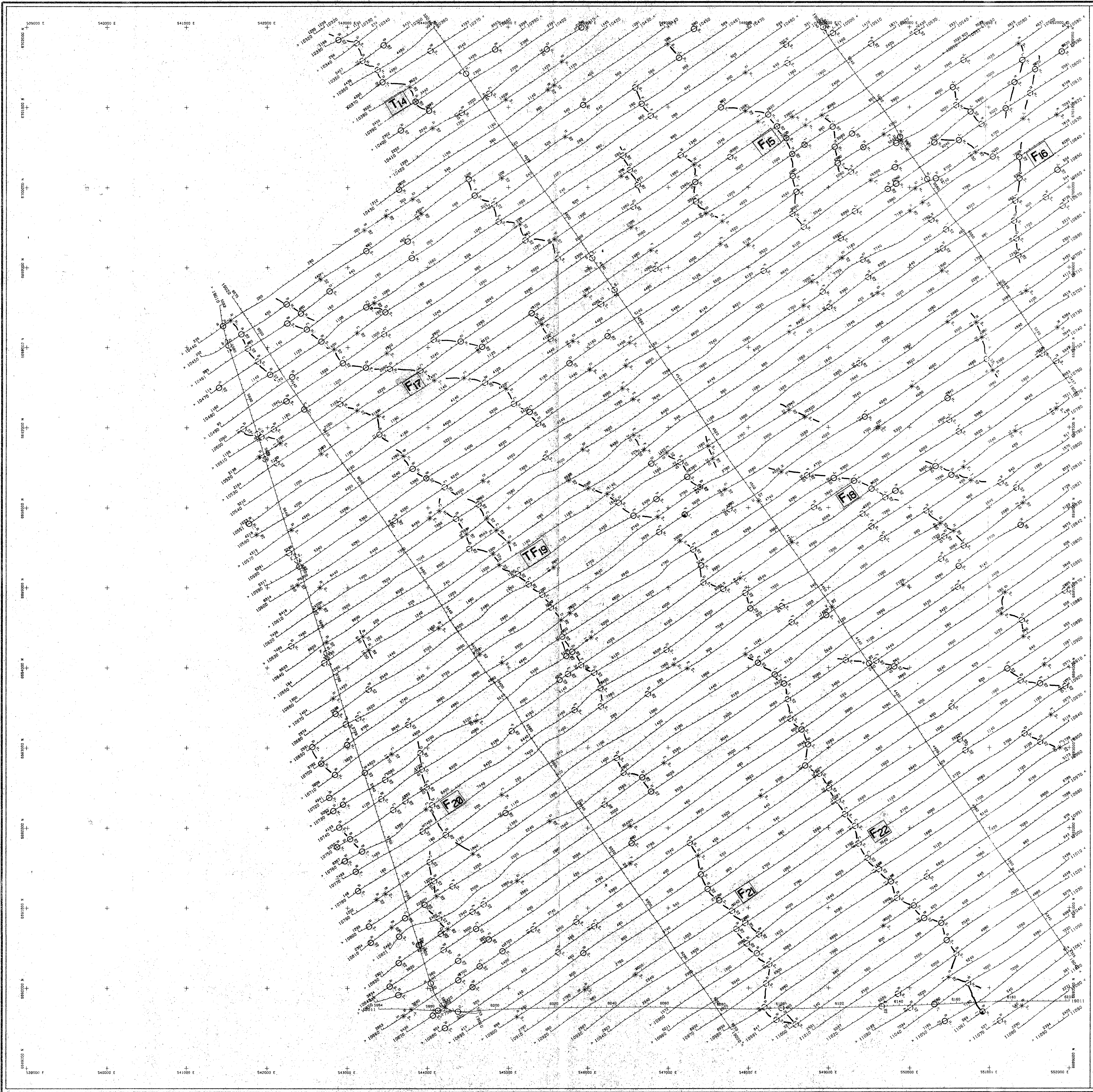

TECHNICAL SUMMARY

Navigation . . . . Sercel real time differential GPS positioning
Data reduction grid interval . . . . 50 metres
Terrain clearance . . . . Helicopter 60 m
Electromagnetic sensor 30 m
Magnetometer, VLF receiver 40 m
Data sampling interval . . . . 0.1 second
Magnetometer / sensitivity . . . . Scintrex cesium / 0.01 nT
VLF receiver / sensitivity . . . . . Herz 2A / 1%
Electromagnetic system . . . . . . DIGHEM^V

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
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ELECTROMAGNETIC ANOMALIES

Grade	Anomaly	Conductance
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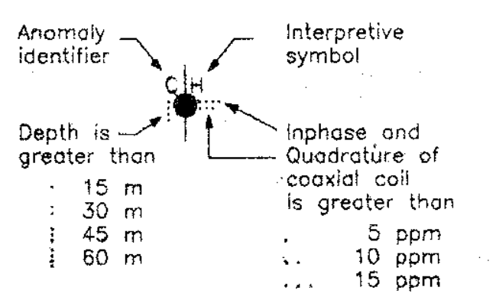
2	○	1–5 siemens
1	◌	< 1 siemens
–	✳	Questionable anomaly



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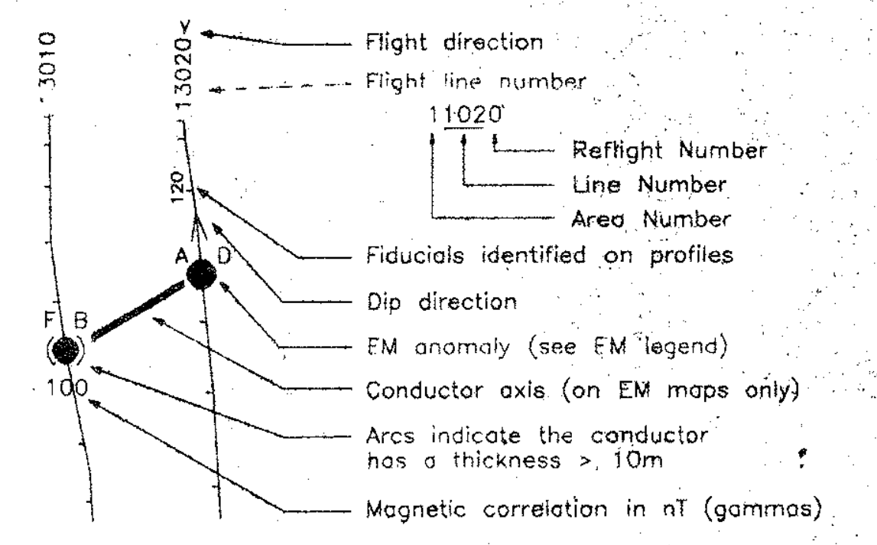
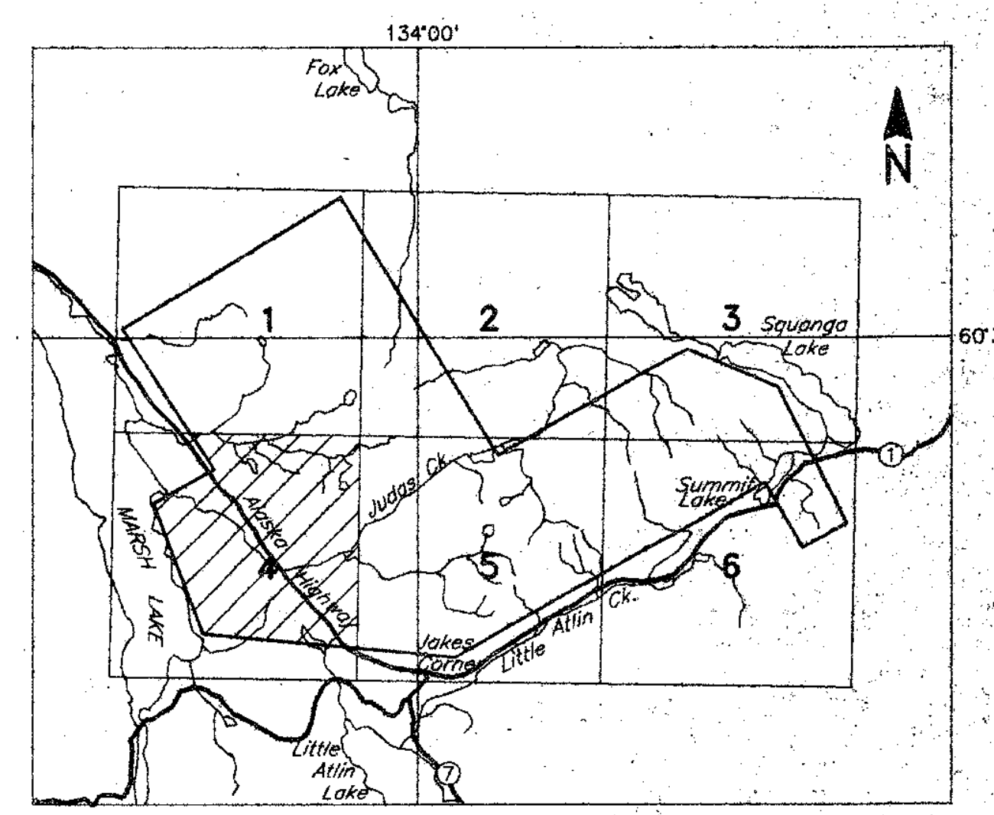
FLIGHT LINES WITH EM ANOMALIES



INTERPRETATION LEGEND

T Geological contact
F Fault
C Sulphide or graphite conductor
I Igneous
32 Conductor number (see text)

LOCATION MAP



NTS: 105C/5,12 105D/8,9
SCALE: 1:400,000

YUKON PROSPECTORS' ASSOCIATION
JAKES CORNER, YUKON

ELECTROMAGNETIC ANOMALIES

DIGHEM^V SURVEY	NTS: 105C/5,12 105D/8,9	GEOPHYSICIST:
DATE: MARCH, 1994	JOB: 1168	SHEET: 4

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0 1 2 Km
Scale 1:20 000

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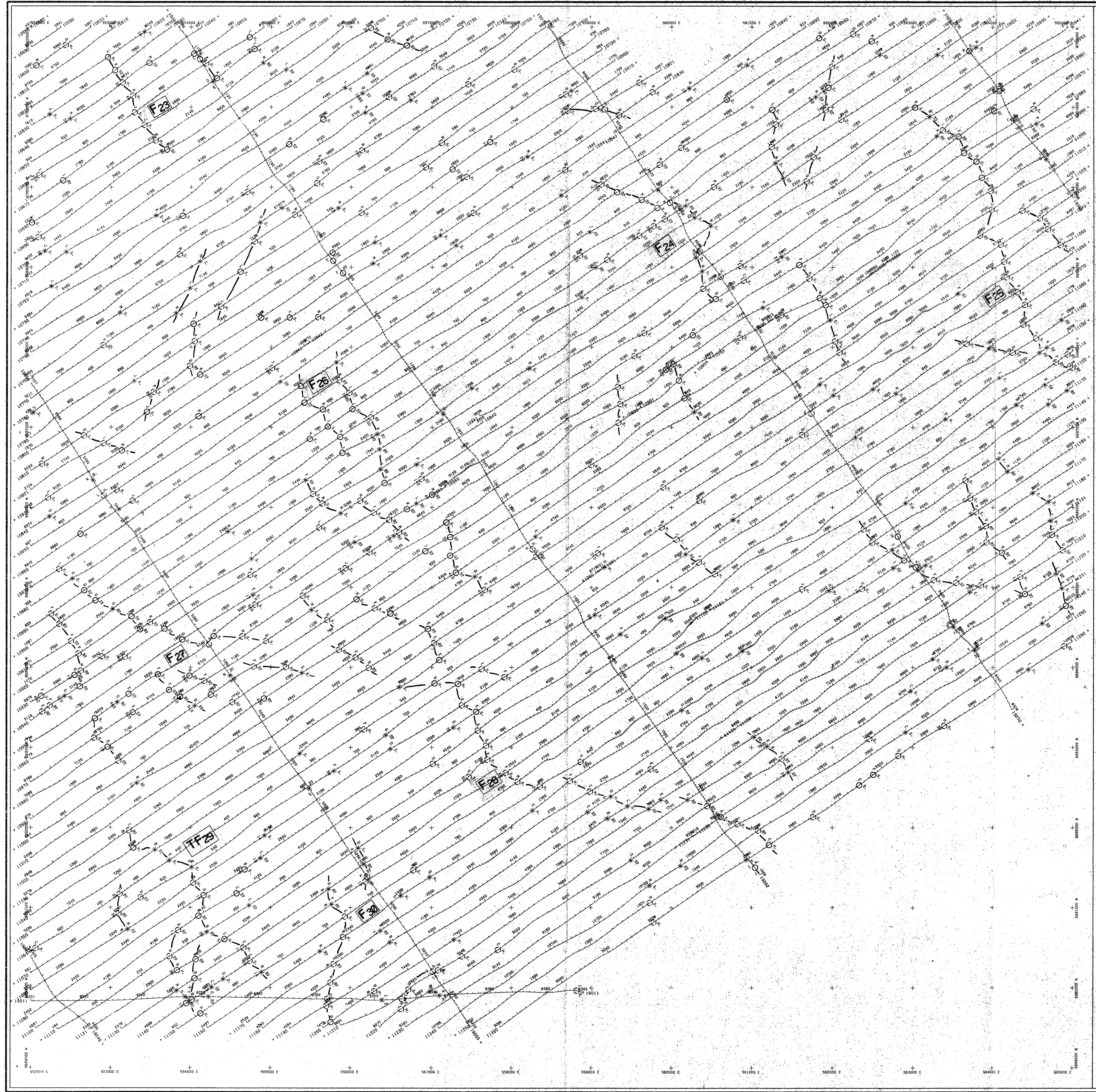

TECHNICAL SUMMARY

Navigation	Sercel real time differential GPS positioning
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Terrain clearance	Helicopter 60 m Electromagnetic sensor 30 m Magnetometer, VLF receiver 40 m
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ELECTROMAGNETIC ANOMALIES

Grade	Anomaly	Conductance
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3	⊕	5–10 siemens
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1	◌	<1 siemens
–	✳	Questionable anomaly

Interpretive symbol	Conductor ("model")
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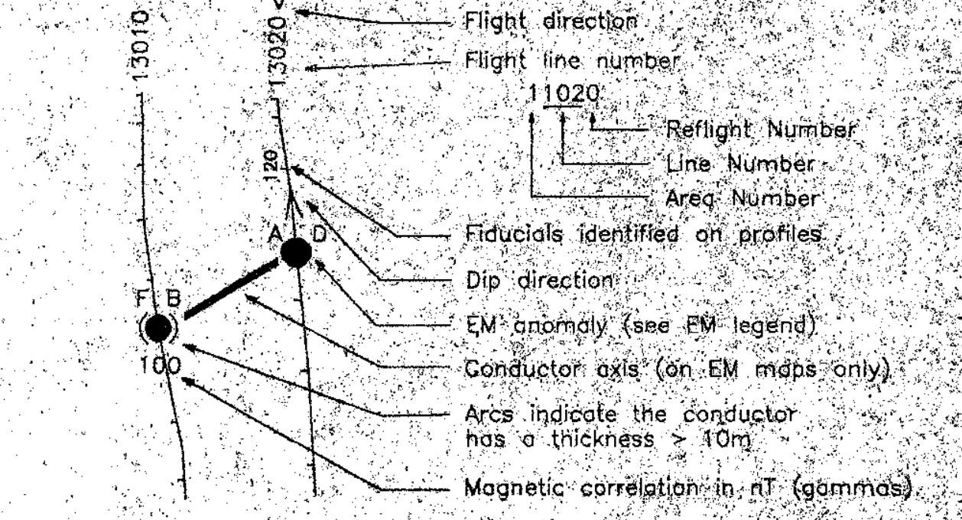
E	Edge of broad conductor ("edge of half space")
L	Culture, e.g. power line, metal building or fence

Anomaly identifier
Interpretive symbol
Depth is greater than
15 m
30 m
45 m
60 m
Inphase and Quadrature of coaxial coil is greater than
5 ppm
10 ppm
15 ppm
20 ppm

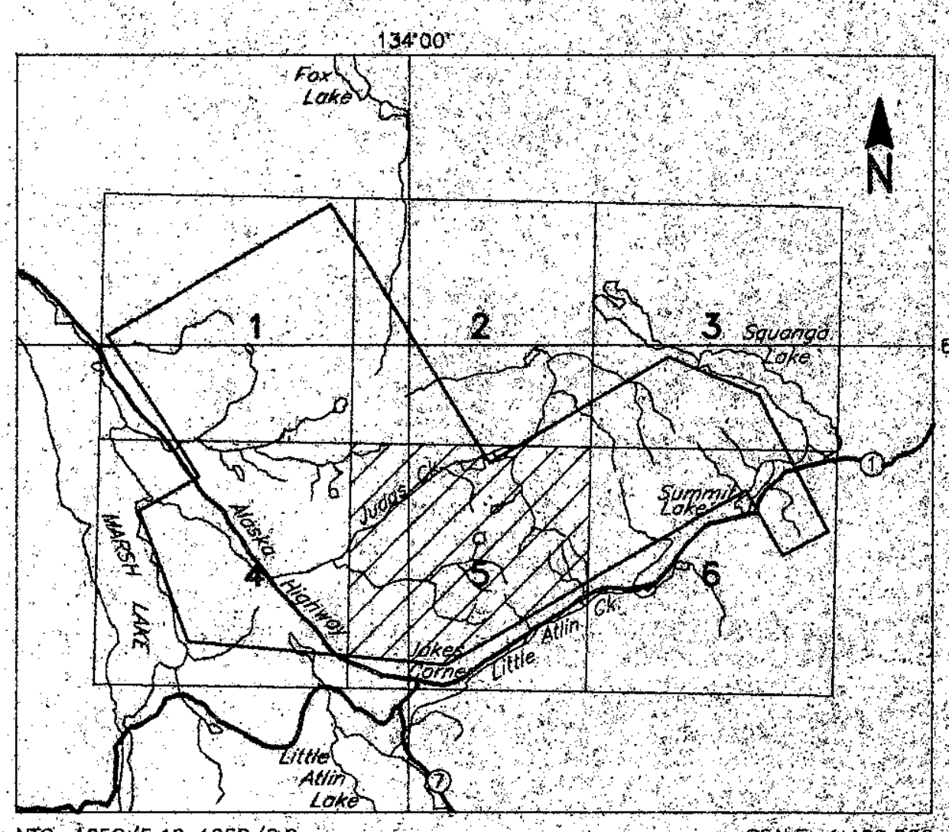
FLIGHT LINES WITH EM ANOMALIES



INTERPRETATION LEGEND

- T Geological contact
- F Fault
- C Sulphide or graphite conductor
- I Igneous
- 32 Conductor number (see text)

LOCATION MAP



NTS: 105C/5,12 105D/8,9 SCALE: 1:400,000

YUKON PROSPECTORS' ASSOCIATION
JAKES CORNER, YUKON

ELECTROMAGNETIC ANOMALIES

DIGHEM V SURVEY	NTS: 105C/5,12 105D/8,9	GEOPHYSICIST:
DATE: MARCH, 1994	JOB: 1168	SHEET: 5

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0 1 2 Km
Scale 1:20 000

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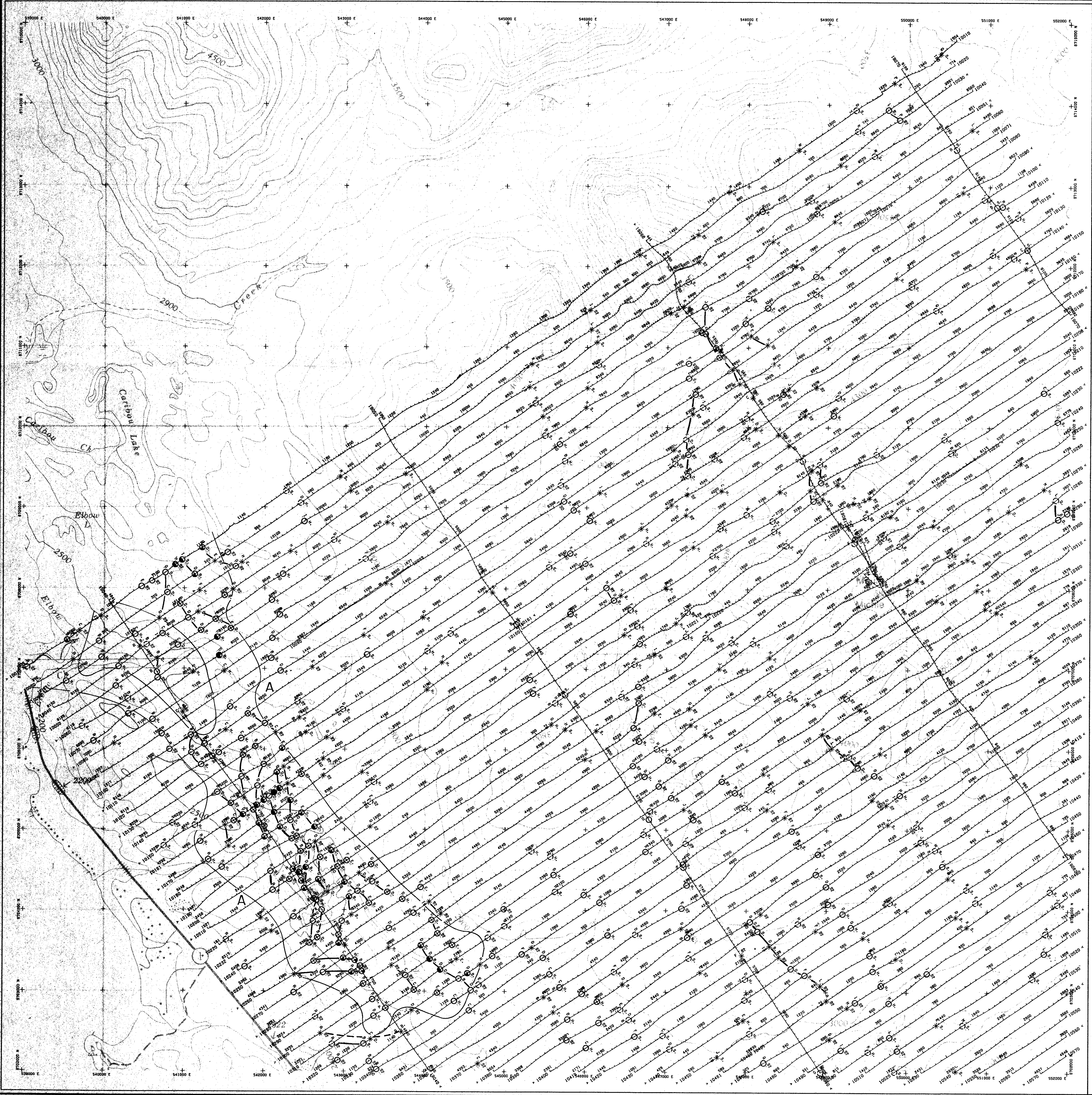

TECHNICAL SUMMARY

Navigation	Sercel real time differential GPS positioning
Data reduction grid interval	50 metres
Terrain clearance	Helicopter 60 m Electromagnetic sensor 30 m Magnetometer. VLF receiver 40 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Scintrex cesium / 0.01 nT
VLF receiver / sensitivity	Herz 2A / 1%
Electromagnetic system	DIGHEM^V

Frequency	Sensitivity	Coil Orientation
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5500 Hz	0.2 ppm	Vertical coaxial
900 Hz	0.1 ppm	Horizontal coplanar
7200 Hz	0.2 ppm	Horizontal coplanar
56000 Hz	1.0 ppm	Horizontal coplanar

ELECTROMAGNETIC ANOMALIES

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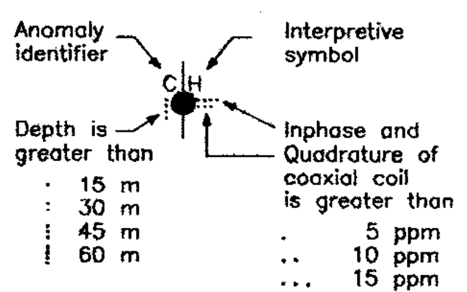
4	⊕	10–20 siemens
3	⊕	5–10 siemens
2	○	1–5 siemens
1	◌	< 1 siemens
–	✳	Questionable anomaly



Depth is greater than
· 15 m
: 30 m
⁝ 45 m
! 60 m

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

Interpretive symbol	Conductor ("model")
B	Bedrock conductor
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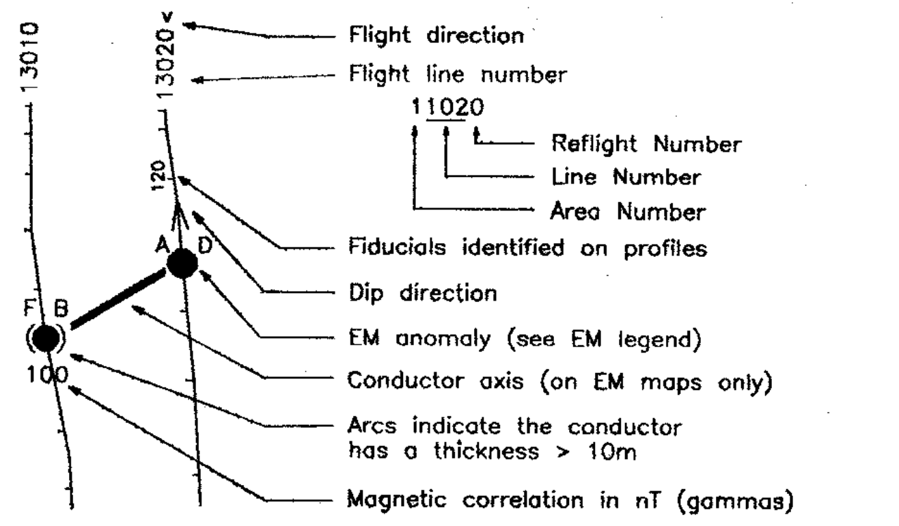
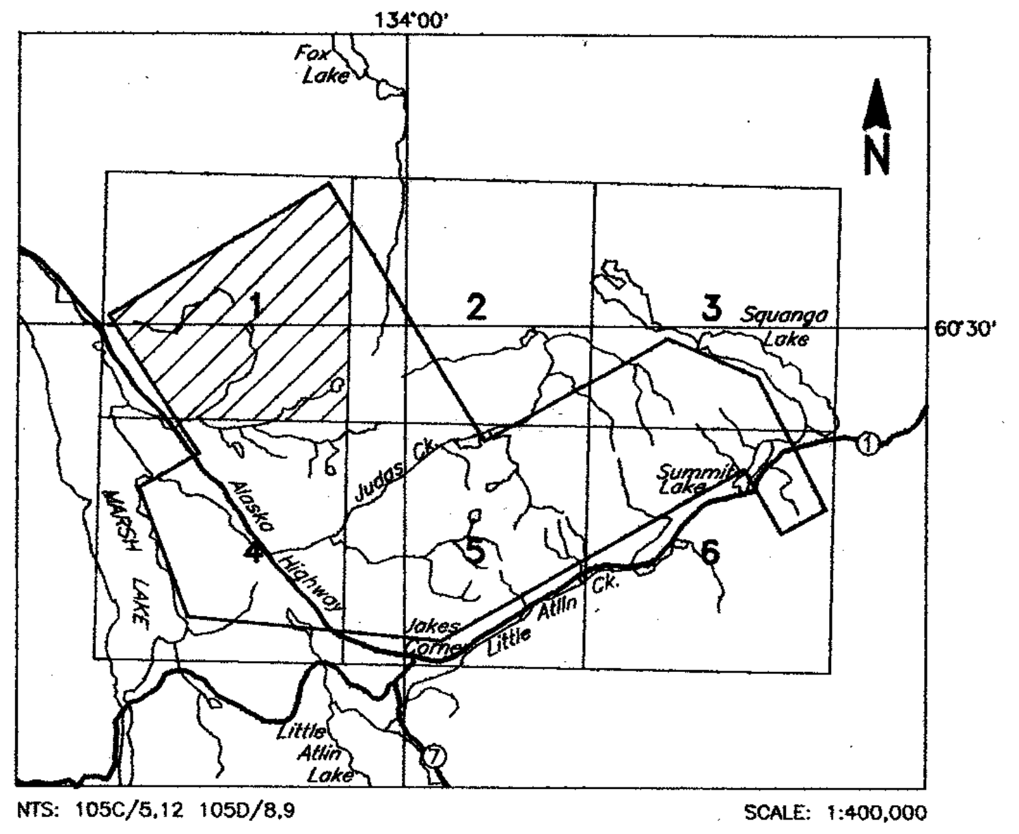
E	Edge of broad conductor ("edge of half space")
L	Culture, e.g. power line, metal building or fence

FLIGHT LINES WITH EM ANOMALIES



LOCATION MAP



NTS: 105C/5,12 105D/8,9

SCALE: 1:400,000

YUKON PROSPECTORS' ASSOCIATION
JAKES CORNER, YUKON

ELECTROMAGNETIC ANOMALIES

DIGHEM^V SURVEY	NTS: 105C/5,12 105D/8,9	GEOPHYSICIST:
DATE: MARCH, 1994	JOB: 1168	SHEET: 1

DIGHEM, A division of CGG Canada Ltd.

0 1 2 Km

Scale 1:20 000

DIGHEM

Quality and Service in Airborne Geophysics