Iron Mountain

827060

INTERPRETATION REPORT

on a

MOVING COILS SURFACE PEM SURVEY

for

CHEVRON STANDARD LIMITED

MINERALS DIVISION

on

IRON MOUNTAIN

NICOLA PROVINCIAL FOREST, BRITISH COLUMBIA

GEOTERREX LIMITED

PROJECT 85-907

OTTAWA, ONTARIO

AUGUST 1982

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INTRODUCTION

During the period from September 21, 1981 to October 19, 1981 a moving coils PEM survey was carried out on IRON MOUNTAIN, near Merritt, British Columbia, by Geoterrex Limited, of 2060 Walkley Road, Ottawa, Ontario for Chevron Standard Limited, Minerals Division, of Vancouver, British Columbia. The purpose of the PEM survey was to locate any anomalous readings which might be indicative of possible mineralized zones.

THEORY

The Crone PEM system is a time domain, transient EM system. The system configuration employed used a transmitting loop 15m in diameter, with a constant separation of 100 metres between the receiver and the transmitter. The transmitter frequency used was 21.65 Hz. The primary current waveform is a train of rectangular pulses with build up and shut off ramps of 1.4 msec (see figure 1).

When the primary pulse is turned off the resultant ramp induces eddy currents in any nearby conductors, these eddy currents and the secondary magnetic field associated with them then decay. The PEM receiver samples the secondary field over eight different time periods or "windows".

In the moving coils survey configuration the system measures the voltage induced in a ferrite coiled receiver coil by the vertical

CHANNEL	TIME		
1	100 µs	-	200 µs
2	200 µs	-	400 µs
3	400 µs	-	700 µs
4	700 µs	-	1.1 ms
5	1.1 ms	-	1.8 ms
6	1.8 ms	-	3.0 ms
7	3.0 ms	-	5.0 ms
8	5.0 ms	-	7.8 ms

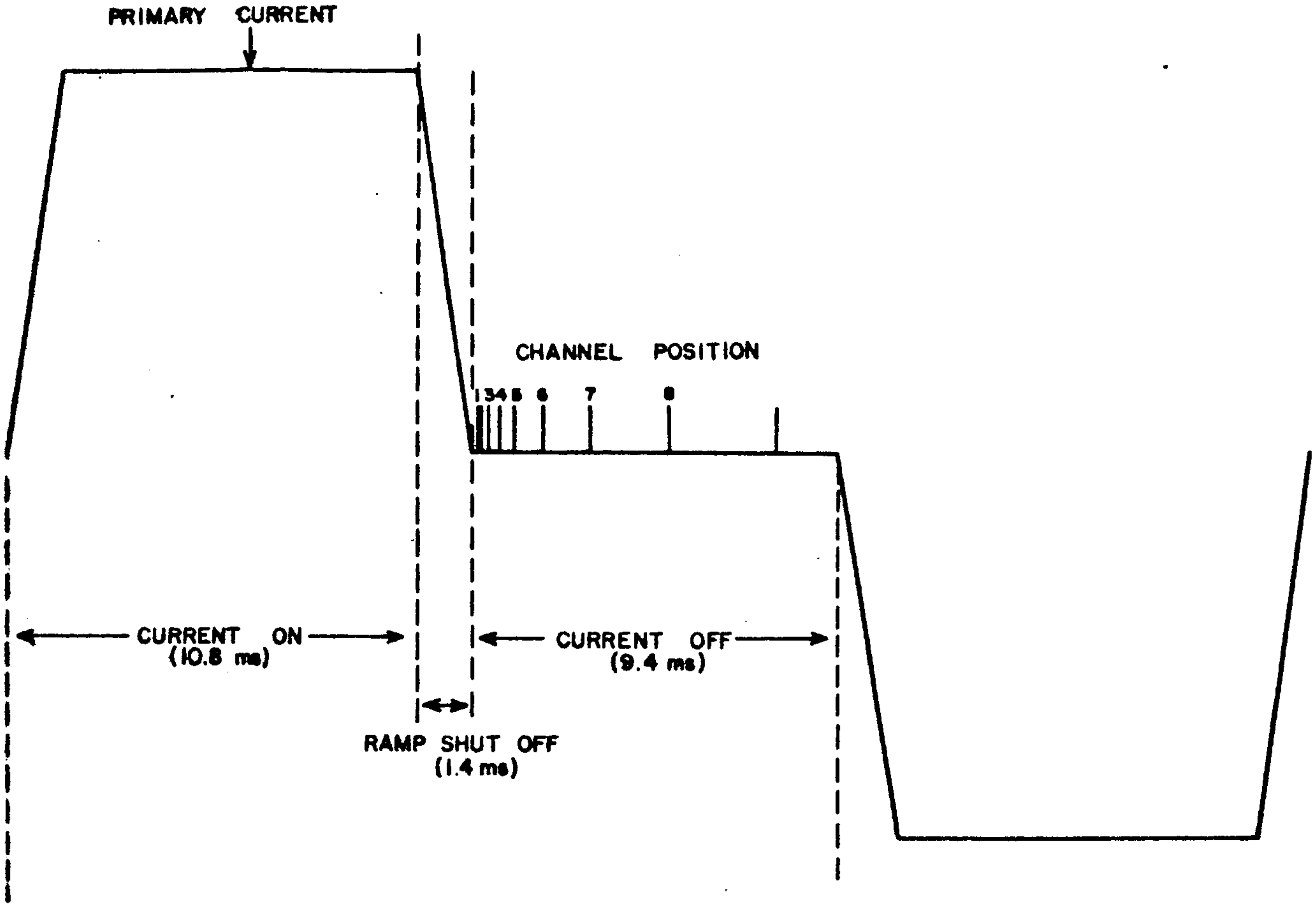


FIG. 1 PRIMARY CURRENT AND CHANNEL TIMES FOR CRONE PEM SYSTEM

component of the decaying secondary magnetic field. Because a coil is used the system measures the time rate of change of the magnetic flux density dB/dt or $\dot{B}z$ (volts/m).

While the results of the survey are presented in both receiver output voltage and nanovolts per meter squared this report shall discuss results in terms of $\dot{B}z$ due to the universal applicability of such units and to the fact that they are more closely related to the physical reality of the situation. The receiver output voltage measurements for the individual windows are distorted by having a different gain for each window.

$\dot{B}z$ is calculated using the following formula:

$$\dot{B}z = \frac{(\text{instrument reading} \times 6\text{mV})}{(\text{P.P. Gain} \times \text{Channel gain} \times 1000)} \times \frac{(1)}{(\text{area of Rx coil})}$$

where Area of receiver coil = 400m^2

Channel Gain	Channel	Gain
	1	1
	2	1.39
	3	1.96
	4	2.68
	5	3.70
	6	5.68
	7	7.19
	8	10.0

P.P. Gain is P.P. Gain Pot Reading 0 to 10

It should be noted that this equation, by dividing out the P.P. Gain, removes the normalization to a standard primary pulse that normally occurs during a moving coils survey. This normalization is meant to account for irregularities that occur in the transmitter loop as it is moved from station to station. However, due to a number of factors, particularly the extremely rough terrain encountered during the survey, it was decided that this normalization procedure would not be valid. This is due to the fact that if the transmitter and receiver coils are not coplanar the change in coupling between the two coils is not necessarily the same as the change in coupling between the transmitter and any conductor in question.

For a bounded conductor, when in late time, the magnetic field and its derivative decay exponentially.

This decay takes the form

$$\dot{B}z \quad \alpha e \; -t/\tau$$

where ρ is a time constant indicative of the conductivity and the shape of the target. For example, for a sperical target in late time

$$T = \sigma\mu a^2/\pi^2 \quad \text{(from Geonics TN 7)}$$

when a = radius of the sphere

σ = conductivity of sphere

u = free space permittivity

In order to obtain τ a logarithmic-linear plot of $\dot{B}z$ vs time is made and the shape of the later, linear portion of the plot is used to get τ. Typical values of τ for orebodies range from 100-200 usec to 10-20 msec.

As well as the responses from bounded conductors the response from the surrounding conductive media must also be considered. In order to do this the apparent resistivity (ρa) for all the channels was plotted. In this case ρa is defined by equation 16 in Geonics TN-7. (see bibliography).

$$\rho a\ (\tau) = \mu/4\pi t((2\mu m)/(5\ t\ \dot{B}z))^{2/3} \quad (16)$$

μ = Free Space permittivity = 4 x 10^{-7} h/m

t = Midpoint of channel gate

$\dot{B}z$ = Rate of change of magnetic flux density

M = Transmitter dipole moment = Area x current x no. of loops

It should be noted that this equation is only valid in the absence of anomalous conductors (i.e. a half space or layered earth response) and for late time. Where late time is defined as when

$$d/r > 10$$

where

r = Tx - Rx spacing

$d = 2\pi \frac{(2t)^{1/2}}{(\mu\sigma)}$ (from Geonics TN-7)

When this condition is met the vertical magnetic field is independent of source receiver separation.

In certain specific cases it is also desirable to plot the calculated thin sheet conductance, and this was done for the Iron Mountain data. A thin sheet is defined as being so thin that there is no variation in current flow across the thickness of the sheet. For transient techniques this means that sufficient time has elapsed so that current density is uniform throughout the cross section of the sheet.

If these criteria are met the following equation (21 from Geonics TN-7) is valid

$$\dot{B}z = (3M\ S^3 . \mu^4)/(16\pi t^4)$$

M = Transmitter dipole moment

μ = Free space permittivity = $4\pi \times 10^{-7}$ h/m

t = Mid point of channel gate

S = Thin sheet conductivity

It is then a simple matter to solve the above equation for S.

DISCUSSION

Since the survey data is presented on two separate grid plots each one is discussed separately.

GRID A.N.

First the plots of $\dot{B}z$ for the grid are examined. The most striking feature of these plots is the almost total lack of signal.

There are two eight channel anomalies which are due to powerlines. They are listed below;

CO-AXIAL CABLE for ANTENNAE - WAH

Line 5400N	east end
Line 5200N	650E

NB the 'anomaly' does not show up each time the "powerline" is crossed. ∴ is anomaly due to "powerline"? - WAH.

There are also several extremely low amplitude anomalies which only last one to two channels. These anomalies are of such low amplitude and of such short duration that they may be regarded as negligible.

No other anomalous responses were noted. Therefore it can be stated that no conductors of any importance were detected on Grid A.N.

At first glance the fact that the powerline response did not show up on all lines intersected by the powerline is disturbing. However, it was noted in the field that, due to the severity of the terrain, on some lines the powerlines were tens ? of metres above the receiver while on other lines the wires were practically touching the ground.

plausible cause??

poles on trees greater than 66 feet high?? - No!! WAH

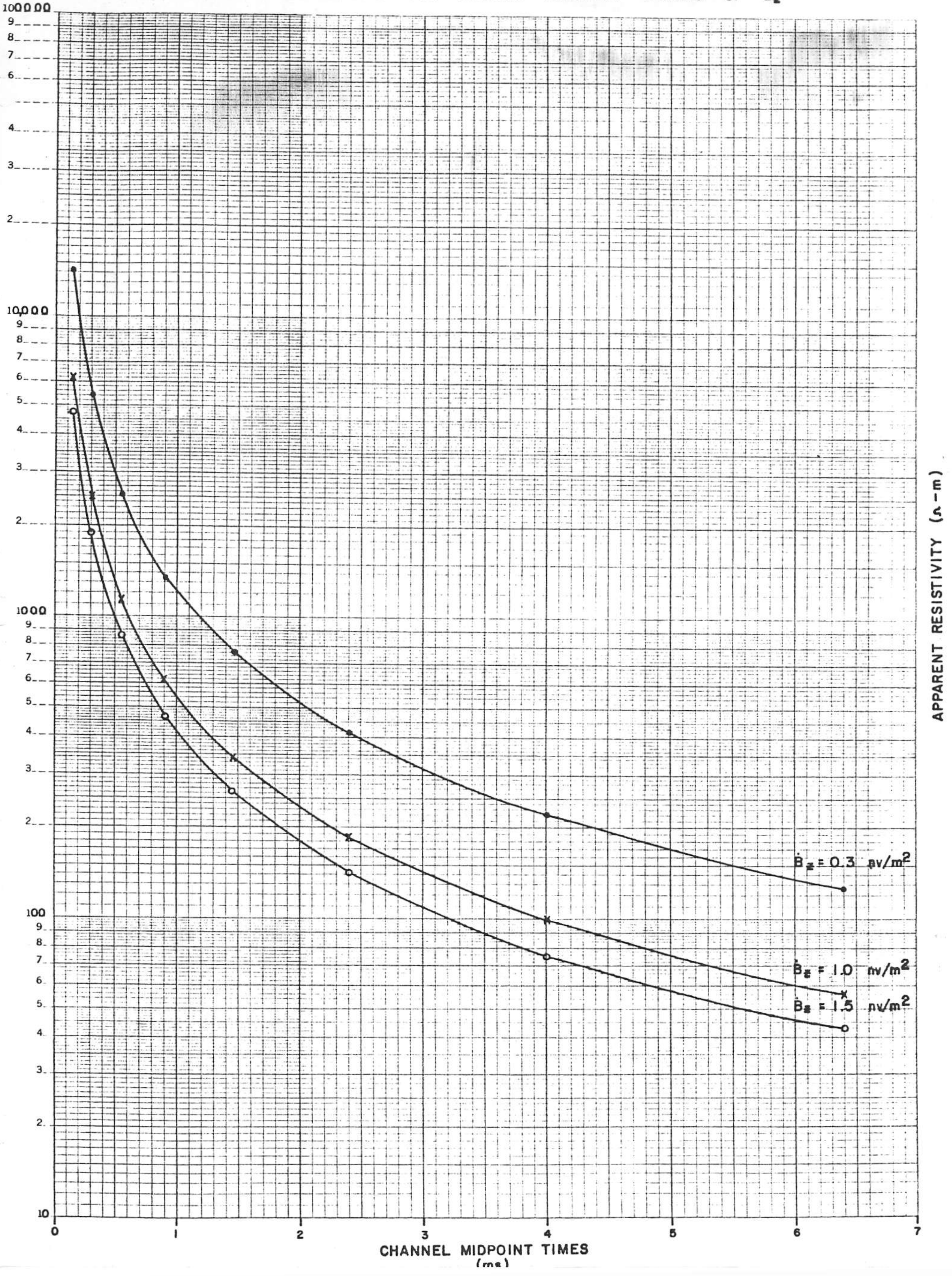
Plots of apparent resistivity for the grid were produced. Due to the almost complete lack of signal in the area these plots are not as useful as they otherwise might be. Equation 16 is such that very small instrument readings cause it to "blow up". In order to avoid this, receiver readings between +0.2 and -0.2 inclusive were replaced by readings of +0.3 if positive and -0.3 if negative.

In effect what was done was to arbitrarily set the noise level of the receiver to +/- 0.3. In retrospect this was quite optimistic. In fact most of the readings (between +1.5 and -1.5 receiver units) could be considered to fall within the noise level of the receiver.

By the nature of equation 16, when the value of Bz is held constant throughout the time measured, the apparent resistivity appears to decrease.

This is illustrated in Figure 2 where the apparent resistivities for channels one to eight are calculated for the constant instrument reading values. It should be pointed out that, since readings between +/- 0.2 were not allowed and readings that were outside this range fall within the noise level of the receiver, in this survey the readings could be considered constant at a low level. The calculated values of figure 2 could be thought of as the highest apparent resistivities that could be determined for a given channel, and a given noise level, providing that the signal drops into that noise level at that particular channel. For example, since all the values measured on grid A.N. were within the noise level. all that can be said about the area is, that as far as this system is concerned, the grid is a uniform half space with an apparent

FIG. 2 APPARENT RESISTIVITIES FOR VARIOUS CONSTANT VALUES OF $\dot{B}_z$



resistivity in excess of the value calculated for channel 1 (generally 10,000 Ωm.). Apparent resistivities for channels two to eight essentially have no meaning even though they appear to decrease uniformly with time, also with depth in a half space situation.

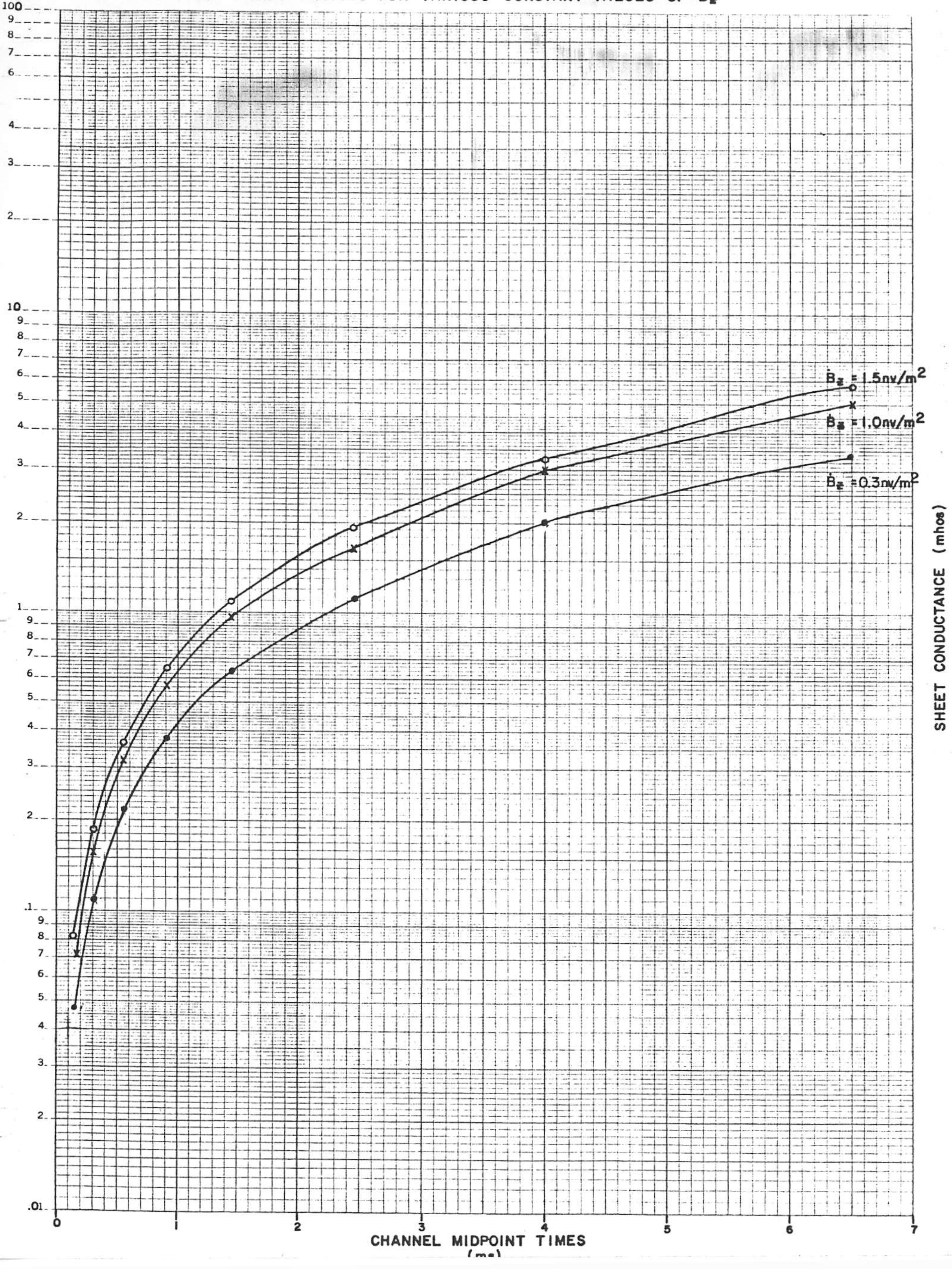
With the thin plate conductance calculations there is the same problem that exists with the apparent resistivity. Even though the plots seem to indicate that the thin plate conductance increases with increasing time (depth) this is not true. This effect is merely what happens when equation 21 is calculated using constant values for $\dot{B}z$ (see figure 3) (which is, again, essentially what is happening since all the $\dot{B}z$ values fall into the noise level of the receiver).

Thin plate conductivity calculations might be useful in situations where layering is present. However, since the readings in this case are down to the noise level, the system can only "see" a half-space. Therefore, the model used to develop equation 21 is not valid and equation 21 is not valid. The numbers generated are therefore, in this instance, of no use.

The basic problem for both calculations is not enough signal induced in the ground.

∴ is survey meaningless?
& what value are the conclusions?

FIG. 3 SHEET CONDUCTIVITIES FOR VARIOUS CONSTANT VALUES OF $\dot{B}_z$



CONCLUSIONS (For Grid A.N.)

This survey was originally commissioned in order to detect anomalies which might be indicative of possible mineralized zones. In this respect the survey was successful in that it indicated no anomalous zones. In order to extract as much information as possible from the data obtained, plots of apparent resistivity and thin sheet conductivity were also produced. These plots were not as successful as they might have been in providing information, for reasons that have already been discussed. If more information were required about the half-space resistivity (or layering) of the area a system with a much larger dipole moment is required to "pump" more signal into the ground. This system would also have to have a greater bandwidth than PEM in order to measure earlier time, before the ground response has had time to decay down to noise levels.

despite an "inadequate signal" a meaningless conclusion - WAH

GRID B.N.

First the plots of Bz for the grid are examined.

There are several extremely low amplitude anomalies which only last one to two channels. These anomalies are of such low amplitude and of such short duration that they may be disregarded.

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On Lines 6400N, 6300N, 5800N, 5700N, 500N, 5000N, and 4600N there are small anomalies centred at 550E. Both positive and negative anomalies are seen. The anomalies generally last from 5-8 channels, appearing to indicate highly conductive material.

When decay curves from these anomalies were plotted it was found that the curves were not sufficiently into late time to determine the decay constant (τ) accurately but rough values of between 40 ms and 75 ms were obtained.

On Lines 5000N and 4600N the signal died out after the first channel, indicating very weak conductors.

On Line 4100N an 8 channel anomaly was detected at 450E. Once again the decay curve indicated that sufficient time had not elapsed to accurately determine the decay constant.

Due to the low amplitudes and narrow responses, the conductor is thought to be physically very small. It should be noted that the anomaly at 550E differs in shape on some lines and disappears completely on interim lines. This appears to indicate that the conductor changes shape, depth and/or disappears along its strike length.

ie podiform?

Once again, due to the fact that instrument readings were into the noise level apparent resistivity plots convey no more information than that the area appears to be a half-space with a resistivity in excess of that indicated by the Channel 1 value (5,000-10,000 Ω-m).

The same comments about the thin plate conductivities for grid A.N. apply to grid B.N.

CONCLUSIONS (for Grid B.N.)

The situation at grid B.N. is one of an extremely resistive environment with a possibly highly conductive, physically small conductor running parallel to the baseline at 550E and possibly swinging west 100 metres at line 4100N. The survey crew reports having found a small deposit of high grade galena (a few inches thick) on grid A.N. This sort of deposit might account for the results obtained at grid B.N., although its presence there is pure conjecture.

As is the case for grid A.N., in order to improve the response measured in the survey, a system with a greater bandwidth that would also induce more signal in the ground is required.

* all preceding conclusions re sig ∴ valid??

Respectfully submitted,

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