Geophysical Report
on an
Borehole Pulse EM Survey
MINNOVA INC.
MT. SICKER PROPERTY, Hole MTS-34
Latitude: 48°52 Longitude: 123°47
N.T.S. 92B/11
AUTHOR: Dennis V. Woods, Ph.D.,P.Eng.
Geophysicist
DATE OF WORK: 25 June 1987
DATE OF REPORT:28 July 1987

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TABLE OF CONTENTS **PAGE**

ILLUSTRATIONS:

INTRODUCTION:

On 25 June 1987, a one-day, borehole Pulse EM survey was carried out on Minnova Inc. boreholes MTS-33 and MTS-34 on the Mt. Sicker property, Vancouver Island.

Both holes were probed with a dummy weight to determine whether they were open. Hole MTS-33 was blocked at 267 metres depth and was not surveyed with PEM system. Hole MTS-34 was open to the bottom at 264m depth and was surveyed with the borehole PEM system.

PROPERTY LOCATION AND ACCESS:

The Mt. Sicker property is located about 10 km northeast of Duncan, B.C. on Vancouver Island. Access is via logging roads off the Lake Cowichan highway 1.5 km east of the Trans Canada highway.

BOREHOLE PULSE EM TECHNIQUE

The borehole Pulse EM system is a time domain downhole EM instrument capable of detecting conductive mineralization intersected by the drillhole or lying off-hole. The borehole Pulse EM system utilizes a special downhole receiver coil, 700m cable and winch gear in conjunction with

the PEM receiver electronics and 500 watt or 2000 watt transmitter apparatus normally employed in ground PEM surveys.

The primary field is produced by a 150m or 500m square surface loop which is driven by the PEM transmitter with a 20 amp reversing pulsed current of 10.8 ms or 21.6 ms on to off time. The receiver obtains eight samples of the time derivative of the secondary field at times, on the 10.8 ms time base, ranging from .15 to 6.40 ms after primary field shut off.

Multiple transmitter loops may be used to provide various loop to conductor coupling geometries in order to obtain conductor attitude and position information. A complete survey of a given borehole may entail logging the hole from five transmitter loop setups. One of these loops would be approximately centered over the area of interest with the remaining four loops away from and distributed around the borehole.

When an anomalous response is observed in a borehole log from a single transmitter loop, the nature of this anomaly allows the determination of the location of the conductive source relative to the drillhole. As shown by Woods and Crone (1980, Figs. 7 & 8), the response can indicate whether

the borehole is intersecting the center of the conductor, the margin of a conductor, with the bulk of conductive material away from the hole, or whether the conductor is entirely off-hole.

Model study curves for various conductor to borehole geometries from Woods (1975) are employed in the interpretation. Quantitative analysis of the conductor's attitude, position and conductance is made using nomograms presented by Woods, et al. (1980). Computer plate modelling can be used to confirm the interpretation.

In the case of a dike-like or tabular conductor, the magnitude of the anomaly obatained varies with the angle that the primary field cuts the conductor. Thus, the degree to which coupling is obtained to the conductor, in coverage of a borehole from several loop setups, will provide information on the attitude and position of the conductive mineralization.

If the conductor tends towards a more spheroidal shape, the anomaly character will change, as well as its magnitude, when the primary field angle is altered. This occurs because the eddy currents are not constrained to flow within a conductive sheet but tend to align perpendicular to the

primary field direction. Thus, multiple transmitter loop coverage can also provide information on the shape of a conductive body.

In practice the responses observed in field situations are much more complex than those of simple models, but these results are sufficiently interpretable that the method has general acceptance and a number of discovery case histories exist.

BOREHOLE SURVEY:

Hole MTS-34 was surveyed using the Crone 500W P.E.M. 8 - channel transient EM system.

A square 150m x 150m transmitter loop was laid out around the hole as shown in Figure 1. This loop position gives maximum EM coupling for the geologic structures encountered in hole MTS-34. Primary and secondary field readings were taken every 10m down the hole with the instrument set at a constant maximum gain of 100%. The data plot is shown in Figure 2.

DISCUSSION OF RESULTS:

No anomalies are noted in the borehole data. The secondary field profiles display the common pattern of diminishing amplitude with depth down the hole, typical of the response due to conductive overburden on surface.

CONCLUSIONS AND RECOMMENDATIONS:

Although sulphides were encountered in the hole at the contact with the diorite intrusive at about 100m to 120m depth, there is no indication of a conductive zone at that depth. The borehole P.E.M. system has an effective search radius of about 50m to 100m depending on the size of the conductive target, hence it can be concluded that no conductive sulphide zone exists in the vicinity of hole MTS-34.

Massive sulphide occurrences are known to be quite localized in the Sicker Group volcanics (e.g. Abermin Coronation zone), hence it is recommended that other Minnova Inc. drill-holes on the Mt. Sicker property be surveyed using borehole Pulse E.M. to search for small, massive sulphide zones not intersected by the drilling.

REFERENCES:

Woods, D.V., 1975; A model study of the Crone borehole pulse electromagnetic (PEM) system; unpublished M.Sc. thesis, Queen's University, Kingston, Ontario.

Woods, D.V. and Crone, J.D. 1980; Scale model study of a borehole pulse electromagnetic system; C.I.M. Bulletin, vol. 73, no. 817, pp. 96-104.

Woods, D.V., Rainsford, D.R.B. and Fitzpatrick, M.N. 1980; Analogue modelling and quantitative interpretation of borehole PEM measurements (abstract only); EOS Transactions of the American Geophysical Union, vol. 61, no. 17, pp. 414-415.

SPECIFICATIONS – CRONE BOREHOLE PULSE EM EQUIPMENT

PROBE:
- Measures dB/dt of axial-component of borehole
- Ferrite cored antenna with preamplifier and self contained power supply (Ni.-Cd. rechargeable)
- 30 hours continuous operation
- Weight: 3.6 Kg.
- Length: 1.63 M.
- Diameter: 2.9 cm (for "E" holes and larger)
- Pressure tested to 13.8 MPa (2000 PSI)

WINCH ASSEMBLY:
- 3 speed gear box, gear ratios 1:1, 2:1, 3:1
- Optional power winching for deep holes
- Borehole cable capacity of up to 2000 meters
- Portable

BATTERY SUPPLY:
±12 VDC, two internal, rechargeable, 12V gel type batteries

MEASURED QUANTITIES:
Primary shut-off voltage pulse (PP). Time derivative of the transient magnetic field by integrative sampling over eight, contiguous time gates (microseconds).

CH. NO.	WINDOW	WIDTH	MID PT.	REL. GAIN	WINDOW	WIDTH	MID PT.
PP	-100 to 0	100	-50	1.00	-200 to 0	200	-100
1	100 to 200	100	150	1.00	200 to 400	200	300
2	200 to 400	200	300	1.39	400 to 800	400	600
3	400 to 700	300	550	1.93	800 to 1400	600	1100
4	700 to 1100	400	900	2.68	1400 to 2200	800	1800
5	1100 to 1800	700	1450	3.73	2200 to 3600	1400	2900
6	1800 to 3000	1200	2400	5.18	3600 to 6000	2400	4800
7	3000 to 5000	2000	4000	7.20	6000 to 10K	4000	8000
8	5000 to 7800	2800	6400	10.00	10K to 15.6K	5600	12.8K
	10.8ms. Time Base				21.6ms. Time Base		

READOUT:
Readings are output on an analog meter (6V FSD), over three sensitivity ranges (X1, X10, X100). Data retrieval made by channel select switch.

TIMING:
A telemetry link ("sync.") is maintained by radio signal, or a back-up cable, between the transmitter and the receiver, and is meter monitored.

SENSITIVITY:
Adjustable through a ten turn, calibrated gain pot.

SAMPLING MODES:
"S & H" (Sample & Hold)
The receiver averages 512 (10.8 ms), or 256 (21.6ms), readings for all channels, and stores the results for display.
"CONT" (Continuous)
A running average for all channels is stored, enabling the operator to reject thunderstorm spikes and power line noise by visual inspection.

SPECIFICATIONS – PULSE EM TRANSMITTER EQUIPMENT

MOTOR GENERATOR:

4-1/2 H.P. Wisconsin, 4 cycle engine with belt drive to D.C. alternator; maximum output 120V, 30 amps; external gas tank; frame unit weight: 33 kg, shipping: 47 kg.

REGULATOR:

Controls and filters the alternator output; continuously variable between 24V and 120V D.C.; 20 amp maximum current; weight: 10 kg, shipping: 24 kg.

PEM WAVEFORM TRANSMITTER:

Controls bipolar, on-off waveform and linear current shut-off ramp time. Radio and cable time synchronization with housing for optional crystal clock sync system; on-off times for 60 Hz areas 8.33ms, 16.66ms, 33.33ms; for 50 Hz areas 10.0ms, 20.0ms, 40ms; for analog PEM operation 10.9ms, 21.8ms; linear controlled current shut-off ramp times of 0.5, 1.0 and 1.5ms; monitors for shut-off ramp operation, instrument temperature, Tx loop continuity, and overload output current; automatic shut-down for open Tx loop. Weight: 12.5 kg, shipping: 22 kg.

REMOTE RADIO, ANTENNA AND MAST:

Used for radio timing synchronization on large survey grids; range up to 2 km; radio has 12V rechargeable gell cell battery supply; antenna is fiberglass mounted on a 4 section aluminum mast each 2m long. Radio weight: 2.7 kg, shipping: 6.0 kg; mast and antenna shipped as bundle: 6.4 kg.

OPTIONAL CRYSTAL CLOCK TIMING LINK:

Installed in the Digital Rx and external box mounted to be plugged into PEM-Tx. Gel rechargeable power supply. Weight: 10 kg, shipping: 15 kg.

WIRE, SPOOLS AND WINDERS:

Transmitter wire is usually No. 10 or No. 12 AWG copper in 310m or 410m lengths, 1 length per spool; 2 spools in a shipping box; winder is mounted on a magnesium packframe.

MULTI-TURN MOVING COIL:

7 turn, 13.7 meter diameter Tx loop with plugs to break into 2 sections. Aluminum or copper wire and various coverings depending on area being used.

BATTERY POWER SUPPLY:

24V, 20 amp hour; rechargeable battery supply for use with PEM-Tx as power source rather than motor-generator-regulator. In aluminum case, with clamp connectors. Weight: 20.5 kg, shipping: 29 kg.

- Battery chargers supplied for all rechargeable battery units.
- All instruments and equipment operational from -40°C to +50°C.
- Shipping boxes are reusable plywood construction with closed cell foam shock protection.

STATEMENT OF QUALIFICATIONS

NAME: WOODS, Dennis V.

PROFESSION: Geophysicist

EDUCATION: B.Sc. Applied Geology
Queens' University

M.Sc. Applied Geophysics
Queen's University

Ph.D. Geophysics
Australian National University

PROFESSIONAL ASSOCIATIONS: Registered Professional Engineer
Province of British Columbia

Society of Exploration Geophysicists

Canadian Society of Exploration Geophysicists

Australian Society of Exploration Geophysicists

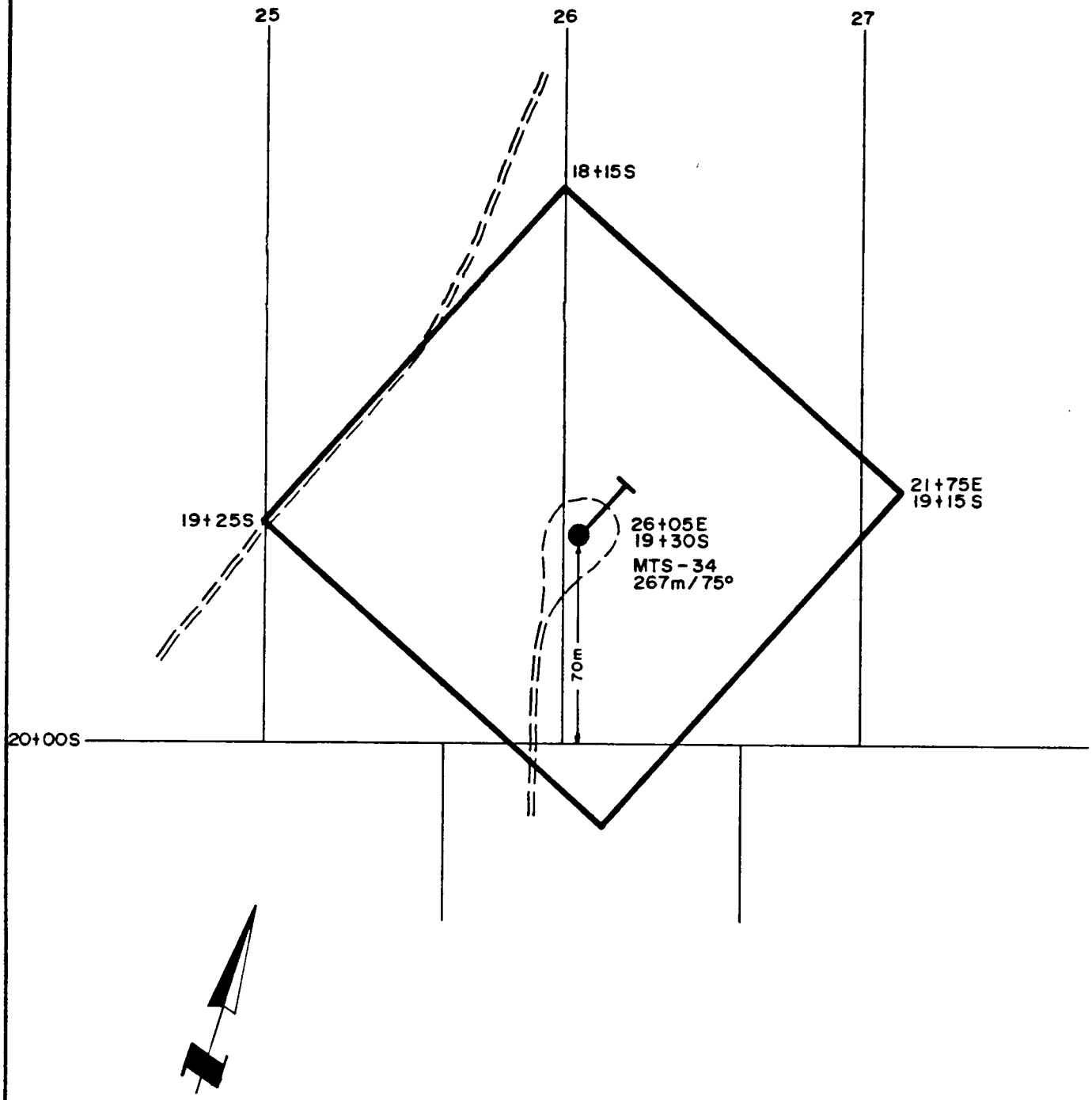
President, B.C. Geophysical Society

EXPERIENCE:

1971-79 - Field Geologist with St. Joe Mineral Corp. and Selco Mining Corp. (summers).
- Teaching assistant at Queen's University and the Australian National University.

1979-86 - Professor of Applied Geophysics at Queen`s University.
- Geophysical consultant with Paterson Grant & Watson Ltd., M.P.H. Consulting Ltd., James Neilson and Assoc. Ltd., Foundex Geophysics Geophysics Ltd.
- Visiting research scientist at Geological survey of Canada and the University of Washington.

1986-87 - Project Geophysicist with Inverse Theory and Applications Inc.
- Chief Geophysicist with White Geophysical Inc.



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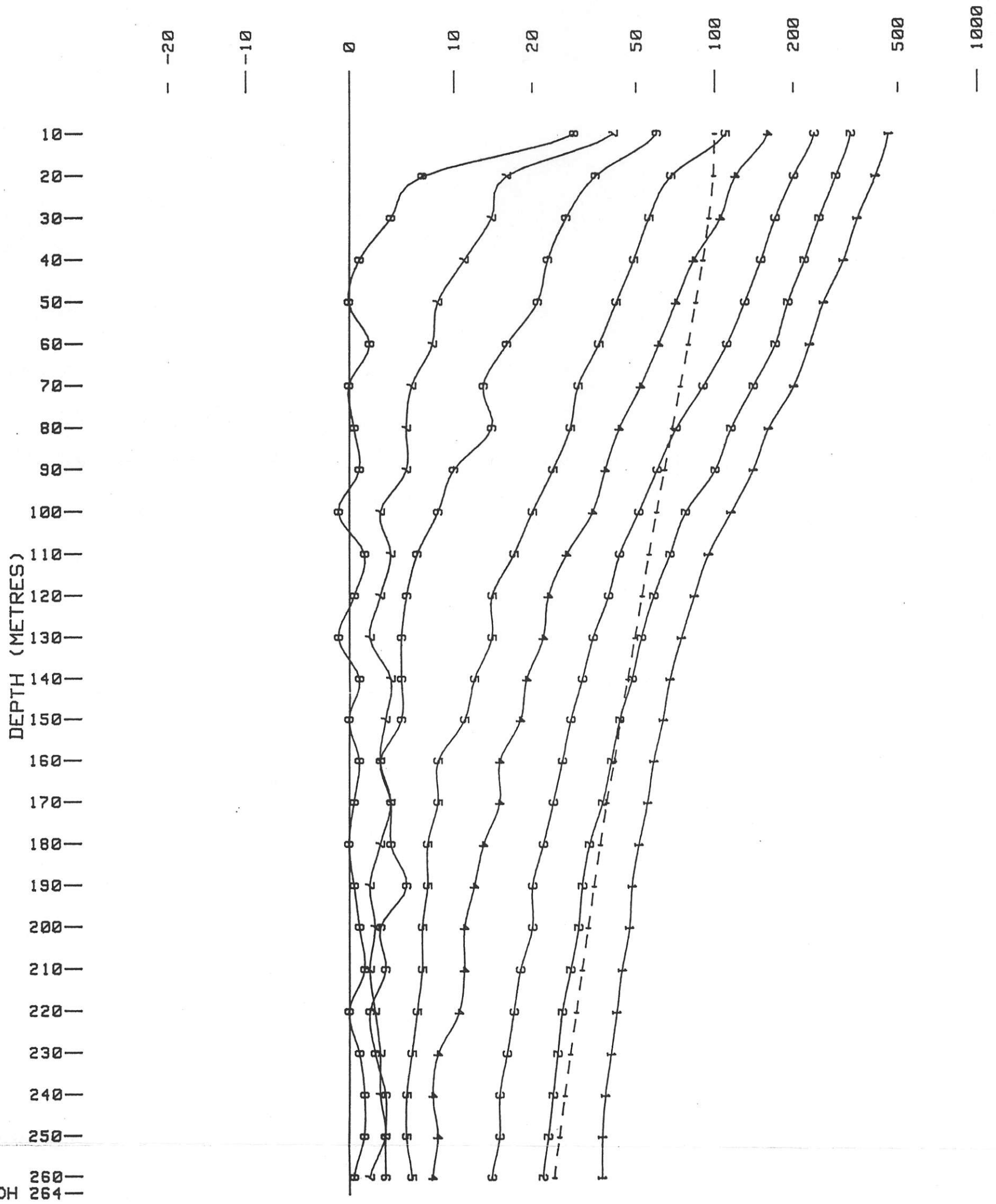
LOOP LOCATION SKETCH

50 0 50 100

FIGURE 1

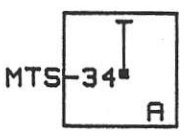
CRONE BOREHOLE PEM UNITS



INSTRUMENT: CRONE PEM

TIME BASE: 10 MSEC

CONSTANT GAIN 100%



MINNOVA INC.

MT. SICKER

BOREHOLE PULSE EM SURVEY

DDH MTS-34 LOOP A

WHITE GEOPHYSICAL INC.

DATE:25 JUNE 1987

FIG: 2