



41P14NE0066 2.4021 MIDLOTHIAN

010

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MINING LANDS SECTION

Report On A
Helicopter Borne Magnetic Survey
Halliday Township Area
Larder Lake Mining Division
Northeastern Ontario

NTS: 41P/14,15
42A/2,3

NORCEN ENERGY RESOURCES LIMITED
Calgary, Alberta

Calgary, Alberta

June, 1981

Robert J. Laird,

Project Geologist -
Base Metals



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010C

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Summary

Scintrex Limited was contracted to complete a detailed helicopter-borne combined electromagnetic and magnetic survey over a selected portion of Sothman, Halliday and Midlothian townships. A total of 1545 line kilometres of surveying were completed at 125 metre and 250 metre line spacing. Numerous previously defined zones of conductivity were recorded as well as several new anomalous areas. The large area covered and the high resolution and detailed nature of the survey produced an excellent geophysical framework which, in conjunction with geological mapping, provides an important insight into the stratigraphy of the "Halliday Dome".

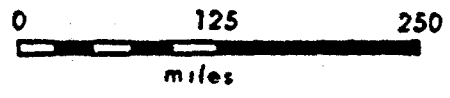
This report deals with selected portions of the geophysical surveys.



Norcen
Energy Resources Limited

LOCATION MAP

Figure 1.



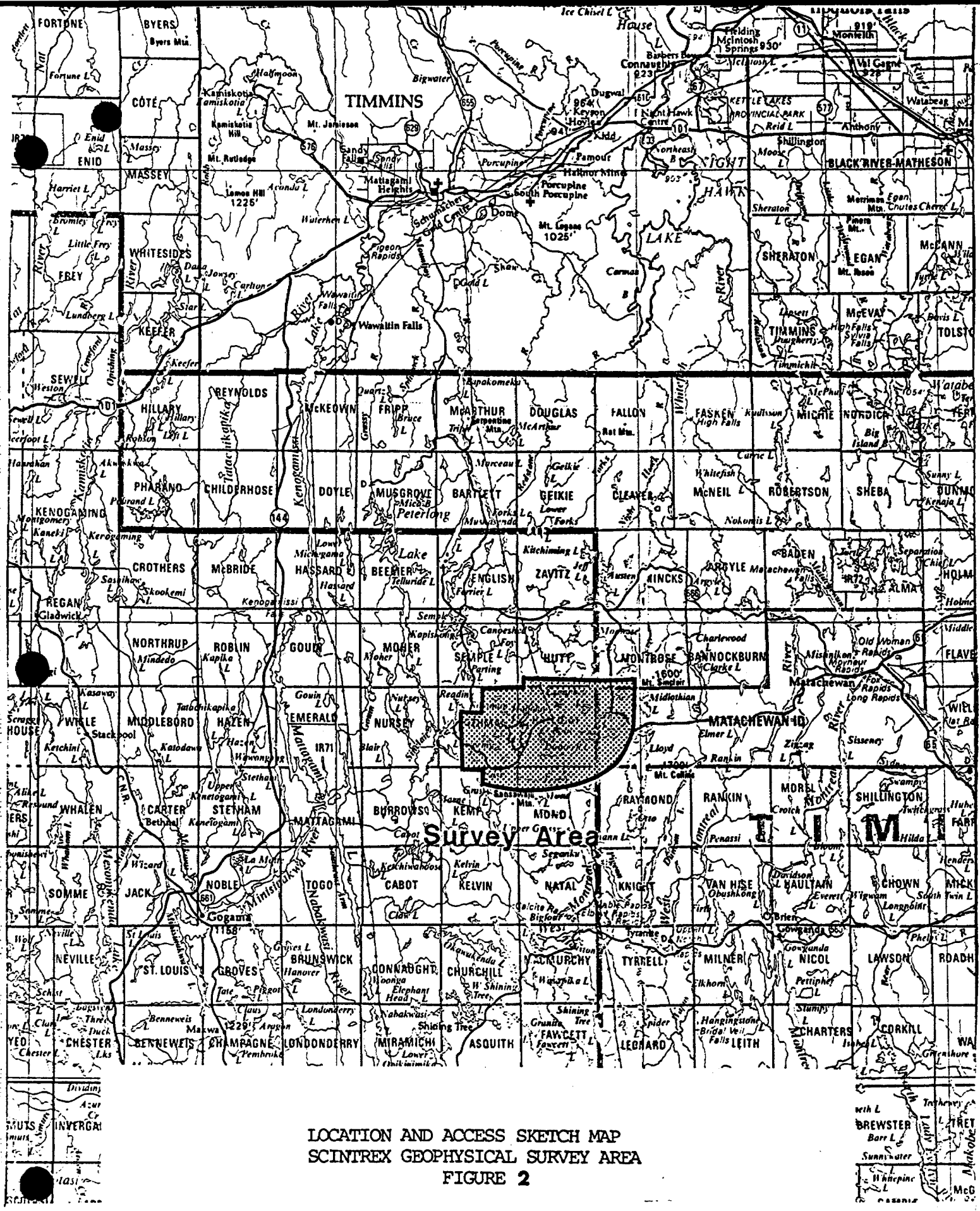
Introduction

This report deals with the results of a detailed helicopter-borne magnetic survey conducted by Scintrex Limited of Toronto. Installations for the survey began on January 16, 1981 and the survey was completed on February 3, 1981.

For the purpose of this report, a total of 206 unpatented mining claims owned by Norcen Energy Resources Limited were covered by a total of 243 line kilometres of surveying. The individual claims covered by the survey are listed and shown on the claims sketch enclosed as Appendix B. The final Scintrex Ltd. report is included as Appendix C.

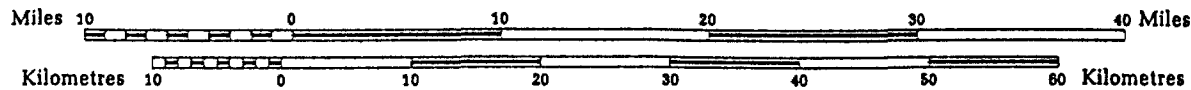
Location and Access

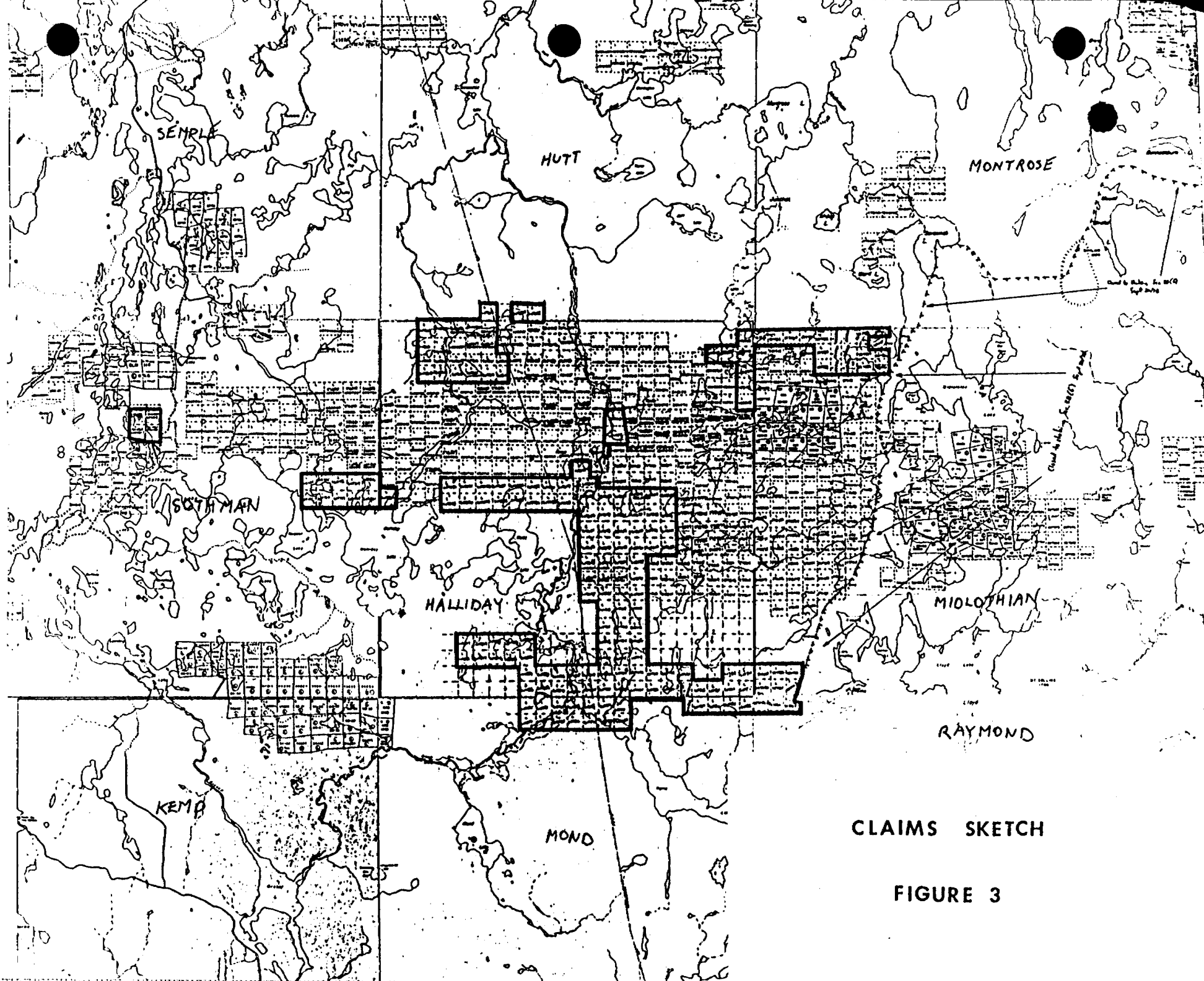
The centre of the survey area is located approximately 65 kilometres south of Timmins, Ontario. Numerous summer roads traverse the survey area and are accessible from Timmins and Shining Tree (Provincial highway #560). A powerline crosses the survey area and the adjacent service road provides access to parts of the area. The United Asbestos Inc. asbestos mine in Midlothian township is serviced by an all-weather road and Scintrex Ltd. used the available facilities as their logistical base throughout the survey.



LOCATION AND ACCESS SKETCH MAP
 SCINTREX GEOPHYSICAL SURVEY AREA
 FIGURE 2

Scale: 1:600 000





CLAIMS SKETCH

FIGURE 3

Topography and Resources

Most of the survey area is rolling hills and adjacent flat lying swamps. Pine, spruce and poplar are predominant in the higher ground with the black spruce and muskeg in the swampy areas. The western portion of the area has been extensively logged.

With the exception of one north-south trending esker in the vicinity of Radio Lake which is estimated to be 75 metres thick in places, most of the area is covered by only thin glacial overburden. Small eskers and parabolic sand dunes are common. Numerous outcrop ridges are exposed in the eastern part of the area.

General Geology

The geological setting of the survey area is based on the Ontario Department of Mines Geological Report 79 by E. G. Bright (1970) and numerous private company assessment reports. The area is underlain by the "Halliday Dome" of felsic flow and pyroclastic rocks intercalated with mafic pyroclastic and related sedimentary rocks of Archean age. The stratigraphy trends approximately east-west. Northeast trending shear zones and north-south trending faults interrupt the stratigraphy. At least one east-west trending graphitic and pyritic unit crosses the eastern half of the area. Several thick massive pyrite/pyrrhotite plus graphite zones have been reported in the western portion of the area.

Previous Work

No attempt will be made to summarize all of the previous exploration work which has been filed for assessment credit with the Resident Geologist in Kirkland Lake as it is beyond the purpose of this report. However, the following is a list of companies which have been active in the area in the past 15 years:

Falconbridge Copper, Amax, Newmont, Teck, Northgate, Granges, Texasgulf, Stairs Mining, Noranda, Essex, and Talisman Mines.

Many of the previous workers in the area have reported a favorable geological setting with, in some cases, appreciable amount of barren and/or base metal rich sulphide mineralization.

Survey Methods

The specifications for the electromagnetic, magnetic and navigational equipment are discussed in the Scintrex Ltd. report which is included here as Appendix C.

The magnetic data were measured by a Scintrex MAP-4 proton precession magnetometer with the sensor mounted in the HEM bird. The terrain clearance of approximately 30 metres and the "on line" accuracy of ± 5 metres was maintained by on-board navigational equipment which included a Bronzer MK-10 radar altimeter and a Del Norle Flying Flagman transponder-based navigation system.

Aeromagnetic Results and Discussion

The results of the aeromagnetic survey are presented as plates 1M, 2M, 3M in the back pocket of this report. The scale of the maps is 1:10,000. Each claim block has been given a letter designation (from A to G inclusive) for reference to the map and each block will be discussed separately.

Claim Block A

Claim Block A is located in the northwest corner of sheet 1M. In the area immediately south of the claim block magnetic anomalies were encountered which caused the magnetometer to go "off-lock" with a consequent loss of data. The claims are within an ultramafic complex.

Claim Block B

Claim Block B is located on sheets 1M and 2M, just south of Kelly Lake. The magnetic expression is weak having a maximum range of 100 gammas over the claim block.

Previous mapping and drilling in the immediate area indicate felsic breccias and felsic fragmentals as bedrock.

Claim Block C

Claim Block C is located in the northwest part of sheet 2M. The magnetic expression is weak over most of the claim block. The

stronger magnetic relief along the western part of the claim group is probably due to ultramafic bedrock. The majority of the claim block is underlain by felsic and intermediate metavolcanics.

Claim Block D

Claim Block D is located in Hutt Township in the northern part of sheet 2M. The magnetic relief has a maximum range of 70 gammas. Previous drilling has indicated rhyolite with a marcasite-graphite zone up to 150 feet (45 metres) thick.

Claim Block E

Claim Block E is located in the east-central part of sheet 2M. No magnetic anomalies occur in the claim block. Previous mapping indicates felsic volcanics as bedrock.

Claim Block F

Claim Block F is located in the southern part of sheet 2M and in the southwest part of sheet 3M. The dominant magnetic feature of this claim block is the linear zone striking at 135° . The magnetic character and intermittent ground exposure would indicate a diabase dyke. This is a major feature of the Halliday Dome. The indicated strike is at right angles to that shown on map 2187 of report 79.

The second feature of the magnetic data is a north-south

linear in the central part of the claim block. This may be a major fault through the area. The direction of movement is not clear on the basis of the magnetic data.

Previous mapping indicates felsic and intermediate metavolcanics. The southeast part of claim block F appears to be underlain by ultramafics as indicated by the stronger magnetic relief.

Claim Block G

Claim Block G is located in the northern part of sheet 3M. The magnetic relief is generally uniform with the eastern margin of the claim block possibly being a diabase dyke.

Previous mapping has indicated felsic and intermediate metavolcanics as well as Archean metasediments as bedrock.

Conclusions and Recommendations

The 206 mining claims as outlined in Appendix B were surveyed by a high resolution, detailed helicopter-borne magnetic survey with line spacings of 125 and 250 metres. The survey provided an improved understanding of the overall stratigraphic sequence in this part of the Halliday Dome.

Field examinations of the magnetic anomalies with emphasis on exposed geology is required to better define the stratigraphy of the dome as well as to isolate areas for detailed exploration.

Robert Lewis

Declaration

I, Robert J. Laird, of the City of Calgary, in the Province of Alberta, with a mailing address of 715 - 5th Ave. S.W., do hereby declare that:

1. I am employed as Project Geologist-Base Metals, by Norcen Energy Resources Limited, with offices at 715 - 5th Ave. S.W., Calgary, Alberta.
2. I completed a bachelor's degree in the co-op geology program at the University of Waterloo (1978), Waterloo, Ontario, and the M.Sc. (Applied) program in mineral exploration at McGill University (1980), Montreal, Quebec.
3. I have been involved in minerals exploration since 1975.
4. I am an applicant to the Association of Professional Engineers, Geologists and Geophysicists of Alberta.
5. I did personally set forth the facts as outlined in this report or made references to contractor work where appropriate, and did conduct, supervise, or review the work contained herein.
6. I do not have, nor do I expect to have, any interest in the properties held by Norcen Energy Resources Limited.

Date: June 29, 1981

Robert Laird
Robert Laird,
Project Geologist -
Base Metals.

APPENDIX A

TECHNICAL DATA STATEMENT



GEOPHYSICAL - GEOLOGICAL - GEOCHEMICAL
TECHNICAL DATA STATEMENT

TO BE ATTACHED AS AN APPENDIX TO TECHNICAL REPORT
FACTS SHOWN HERE NEED NOT BE REPEATED IN REPORT
TECHNICAL REPORT MUST CONTAIN INTERPRETATION, CONCLUSIONS ETC.

Type of Survey(s) Airborne Magnetic
Township or Area Halliday Township area
Claim Holder(s) Norcen Energy Resources Limited

Survey Company Scintrex Limited
Author of Report Robert Laird
Address of Author 715 - 5th Ave. S.W. Calgary, Alta.
Covering Dates of Survey January 16 - February 3, 1981
(linecutting to office)
Total Miles of Line Cut _____

MINING CLAIMS TRAVERSED
List numerically

<u>SPECIAL PROVISIONS CREDITS REQUESTED</u>	Geophysical	DAYS per claim
ENTER 40 days (includes line cutting) for first survey.	-Electromagnetic _____	
	-Magnetometer _____	
	-Radiometric _____	
ENTER 20 days for each additional survey using same grid.	-Other _____	
	Geological _____	
	Geochemical _____	

AIRBORNE CREDITS (Special provision credits do not apply to airborne surveys)

Magnetometer _____ Electromagnetic _____ Radiometric _____
(enter days per claim)

Airborne Geophysical Certificate

DATE: June 23, 1981 SIGNATURE: Robert Laird
Author of Report or Agent

Res. Geol. _____ Qualifications 2.3564

Previous Surveys

File No.	Type	Date	Claim Holder
			<u>L.D.</u>

TOTAL CLAIMS 206

If space insufficient, attach list

OFFICE USE ONLY

GEOPHYSICAL TECHNICAL DATA

GROUND SURVEYS – If more than one survey, specify data for each type of survey

Number of Stations _____ Number of Readings _____

Station interval _____ Line spacing _____

Profile scale _____

Contour interval _____

MAGNETIC

Instrument _____

Accuracy – Scale constant _____

Diurnal correction method _____

Base Station check-in interval (hours) _____

Base Station location and value _____

ELECTROMAGNETIC

Instrument _____

Coil configuration _____

Coil separation _____

Accuracy _____

Method: Fixed transmitter Shoot back In line Parallel line

Frequency _____
(specify V.L.F. station)

Parameters measured _____

GRAVITY

Instrument _____

Scale constant _____

Corrections made _____

Base station value and location _____

Elevation accuracy _____

INDUCED POLARIZATION
RESISTIVITY

Instrument _____

Method Time Domain Frequency Domain

Parameters – On time _____ Frequency _____

– Off time _____ Range _____

– Delay time _____

– Integration time _____

Power _____

Electrode array _____

Electrode spacing _____

Type of electrode _____

SELF POTENTIAL

Instrument _____ Range _____

Survey Method _____

Corrections made _____

RADIOMETRIC

Instrument _____

Values measured _____

Energy windows (levels) _____

Height of instrument _____ Background Count _____

Size of detector _____

Overburden _____
(type, depth - include outcrop map)

OTHERS (SEISMIC, DRILL WELL LOGGING ETC.)

Type of survey _____

Instrument _____

Accuracy _____

Parameters measured _____

Additional information (for understanding results) _____

AIRBORNE SURVEYS

Type of survey(s) Airborne Magnetic

Instrument(s) Scintrex MAP-4 proton precession magnetometer
(specify for each type of survey)

Accuracy ± 1 gamma
(specify for each type of survey)

Aircraft used Bell 206B helicopter (C-GGUB) owned by Huisson Aviation of Timmins

Sensor altitude 30 metres to 35 metres

Navigation and flight path recovery method Del Norle Flying Flagman fixed transponder radar navigational system; 16 mm Vinten camera and airphoto mosaic

Aircraft altitude 60 metres to 70 metres Line Spacing 125 metres and 250 m

Miles flown over total area 1545 kilometres Over claims only 243 kilometres

GEOCHEMICAL SURVEY - PROCEDURE RECORD

Numbers of claims from which samples taken _____

Total Number of Samples _____

Type of Sample _____
(Nature of Material)

Average Sample Weight _____

Method of Collection _____

Soil Horizon Sampled _____

Horizon Development _____

Sample Depth _____

Terrain _____

Drainage Development _____

Estimated Range of Overburden Thickness _____

SAMPLE PREPARATION

(Includes drying, screening, crushing, ashing)

Mesh size of fraction used for analysis _____

General _____

ANALYTICAL METHODS

Values expressed in: per cent
p. p. m.
p. p. b.

Cu, Pb, Zn, Ni, Co, Ag, Mo, As, -(circle)

Others _____

Field Analysis (_____ tests)

Extraction Method _____

Analytical Method _____

Reagents Used _____

Field Laboratory Analysis

No. (_____ tests)

Extraction Method _____

Analytical Method _____

Reagents Used _____

Commercial Laboratory (_____ tests)

Name of Laboratory _____

Extraction Method _____

Analytical Method _____

Reagents Used _____

General _____

APPENDIX B
CLAIMS SCHEDULE
and
CLAIMS SKETCH

Halliday Project
AIRBORNE MAGNETIC ASSESSMENT REPORT

by Robert J. Laird

June, 1981

Claims Schedule

Halliday Township - total 140 claims

<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>
609802	597453	609639	609676
	597454	609640	609677
609601	597455	609641	609678
609602	597456	609642	609679
609603		609643	609680
609604	597450	609644	609681
609605	597451	609645	609682
609606		609646	609683
609607	597472	609647	609684
609608	597473	609648	609685
609609	597474	609649	609686
609610	597475	609650	609687
609611		609651	609688
609612	609626	609652	609689
609613	609627	609653	609690
609614	609628	609654	609691
	609629	609655	609692
618952	609630		609693
618953	609631	609668	
618954	609632	609669	609908
	609633	609670	609909
609617	609634	609671	609910
609618	609635	609672	609911
609619	609636	609673	609912
609620	609637	609674	609913
609621	609638	609675	609914

Halliday Township (Continued)

<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>
609915	609927	609812	609888
609916	609928	609813	609889
609917	609929	609814	609890
609918	609930	609815	609891
609919			609892
609920	609935	609868	609893
609921		609869	609894
609922	609805		609895
609923		609874	609896
609924	609808	609875	609897
609925	609809	609876	
609926		609877	

Mollothian Township - total 25 claims

<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>
597482	597489	597496	597461
597483	597490	597497	597462
597484	597491	597498	597463
597485	597492	597499	597464
597486	597493	597500	
597487	597494		
597488	597495	597457	
		597458	

Raymond Township - total 3 claims

<u>Claim No.</u>	<u>Claim No.</u>
597459	597465
597460	

Mond Township - total 19 claims

<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>	<u>Claim No.</u>
609806	609816	609870	609878
609807		609871	609879
	609931	609872	609880
609810	609932	609873	609881
609811	609933		
	609934		609884
			609885

Hutt Township - total 3 claims

<u>Claim No.</u>	<u>Claim No.</u>
609622	609616
609623	

Schuman Township - total 16 claims

Claim No.

Claim No.

Claim No.

609803
609804

609792
609793
609794
609795
609796
609797
609798

609799
609800
609801

597466
597467
597468
597469

APPENDIX C
FINAL SCINTREX LTD.
GEOPHYSICAL REPORT

REPORT ON
AIRBORNE GEOPHYSICAL SURVEY
HALLIDAY TOWNSHIP AREA
MATACHEWAN, ONTARIO

On Behalf Of

Norcen Energy Resources Limited
715 - 5th Avenue S.W.
Calgary, Alberta
T2P 2X7

By

Scintrex Limited
222 Snidercroft Road
Concord, Ontario
L4K 1B5

I. Johnson
IJ/cc
April, 1981
T-2082

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MAPS

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Plate 1E Electromagnetic Anomaly Plots, Scale 1:10,000 (Western Plate)
Plate 1M Contoured Magnetic Data, Scale 1:10,000 (Western Plate)
Plate 2 Photomosaic Base Map, Scale 1:10,000 (Central Plate)
Plate 2E Electromagnetic Anomaly Plots, Scale 1:10,000 (Central Plate)
Plate 2M Contoured Magnetic Data, Scale 1:10,000 (Central Plate)
Plate 3 Photomosaic Base Map, Scale 1:10,000 (Eastern Plate)
Plate 3E Electromagnetic Anomaly Plots, Scale 1:10,000 (Eastern Plate)
Plate 3M Contoured Magnetic Data, Scale 1:10,000 (Eastern Plate)

REPORT ON
HELICOPTER-BORNE GEOPHYSICAL SURVEY
HALLIDAY TOWNSHIP AREA
MATACHEWAN, ONTARIO

On Behalf Of
Norcen Energy Resources Limited

1. INTRODUCTION

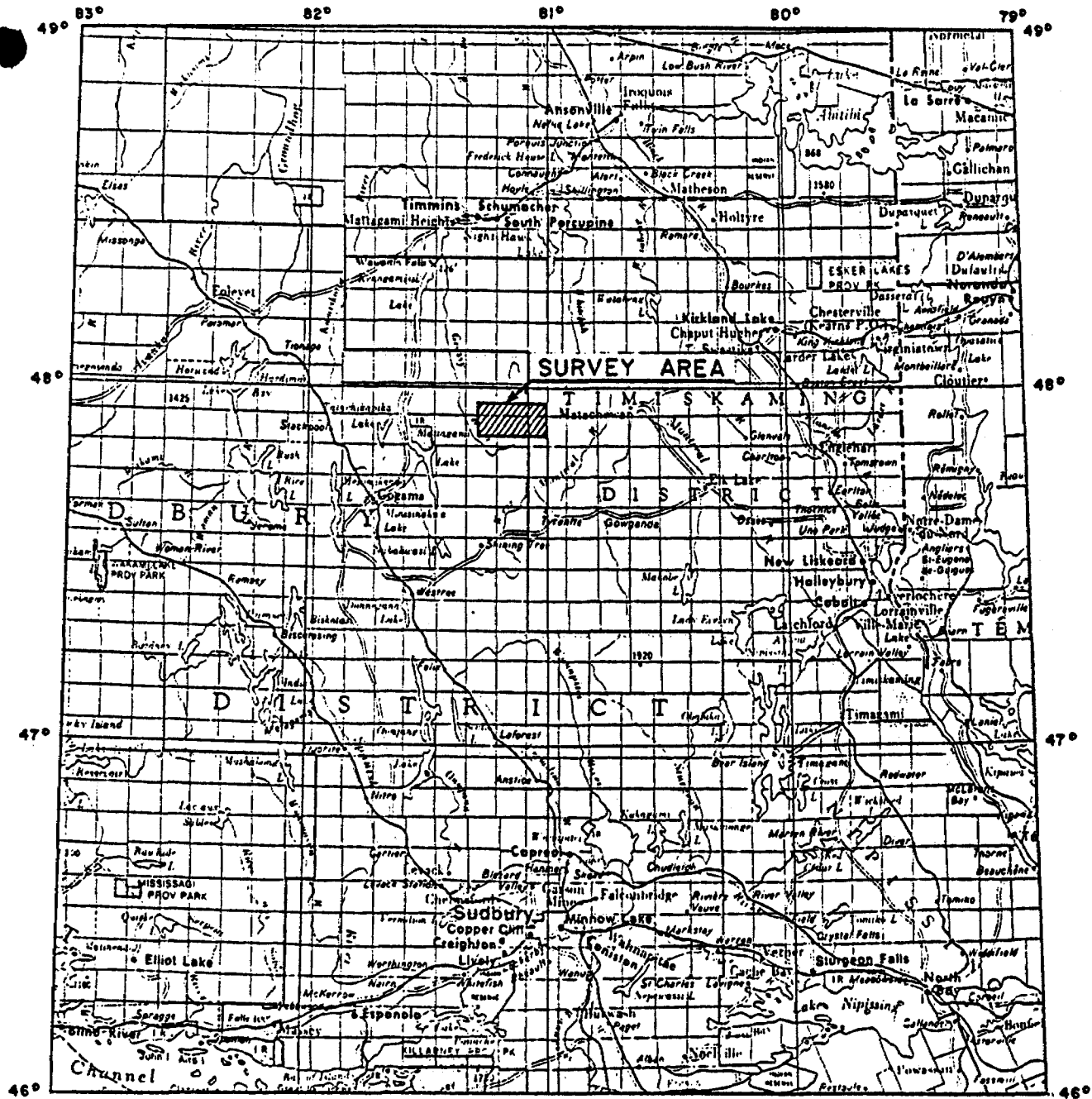
A helicopter-borne geophysical survey was carried out by Scintrex Limited on behalf of Norcen Energy Resources Limited in the Matachewan area of Ontario. The field portion of the work was begun on January 16, 1981 and completed by February 3.

The survey covered an area in and around Halliday Township, Ontario (see Figures 1 and 2). Total coverage, including two magnetic tie lines was 1545 line km (or 1451 line km when measuring from survey boundary to survey boundary only). Principal geophysical sensors were an electromagnetic system (Scintrex HEM-802) measuring in-phase and quadrature secondary field components at 735 and 3220 Hz and a proton precession magnetometer (Scintrex MAP-4). Navigation was controlled by a 'Flying Flagman' radar ranging navigational system.

Results were compiled in Toronto with contoured magnetics and drafted EM anomaly centers at a scale of 1:10,000 being the principal presentation styles.

This report describes the survey procedures, instrumentation and production, in-field compilation and final compilation. Maps showing the results of the work are included both within (plates 1E, 1M, 2E, 2M, 3E, 3M) and outside of (plates 1, 2, 3) this report.

This report was prepared by Scintrex Limited, Concord, Ontario, Canada.



LOCATION MAP

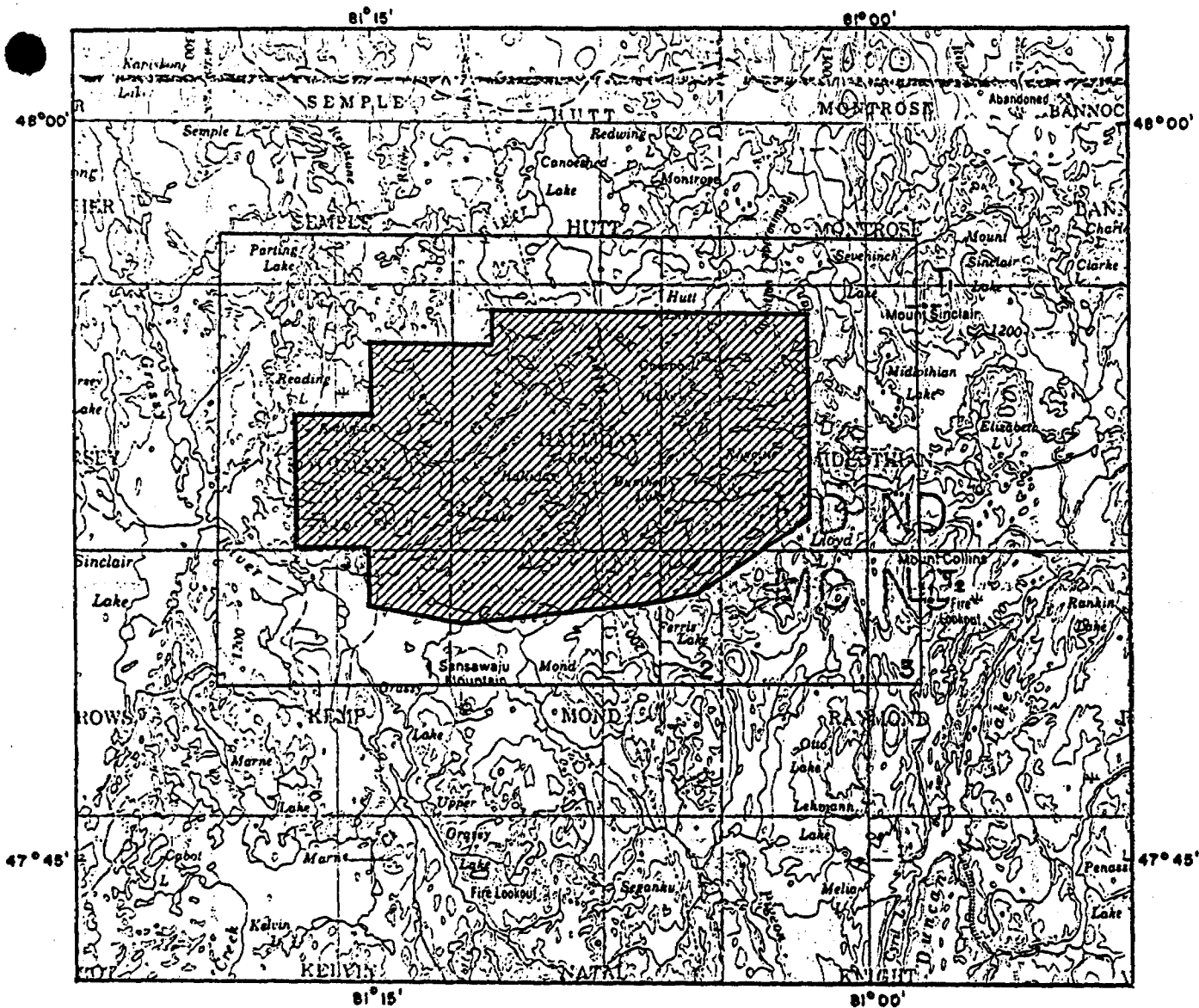
NORCEN ENERGY RESOURCES LIMITED
 HALLIDAY TOWNSHIP AREA
 ONTARIO

AIRBORNE GEOPHYSICAL SURVEY

SCALE : 1 : 2,000,000



FIGURE 1



SURVEY AREA MAP

NORCEN ENERGY RESOURCES LIMITED

HALLIDAY TOWNSHIP AREA

ONTARIO

AIRBORNE GEOPHYSICAL SURVEY

⊕ TRANSPANDERS T_1 & T_2

KILOMETERS 0 5 10 15 KILOMETERS

Scale : 1 : 250,000



80-T2082

FIGURE 2

SURVEY AREA

The survey area is located approximately 60 miles south of Timmins (or 25 miles west of Matachewan - see Figures 1 and 2). The operations base for the survey was the United Asbestos mine site located on Lloyd Lake, approximately 20 miles west, by road, from Matachewan and immediately to the east of the survey area.

3. SURVEY EQUIPMENT

The survey equipment consisted of the following:

- a) A Scintrex HEM-802 electromagnetic system measuring in-phase and quadrature (out-of-phase) secondary field components at frequencies of 735 and 3220 Hz. (See Appendix 1 for details). The analog output of the EM system was pre-filtered with a low pass filter. The rise time on said filter (rise time = the time required for an impulse response to go from 10% to 90% of the impulse value) was 0.50 seconds. The digital recording rate of all HEM data was 0.5 seconds.
- b) A Scintrex MAP-4 proton precession magnetometer with the sensor mounted in the HEM bird (see Appendix 2 for details).
- c) A Scintrex RCM-8 eight channel analog recorder (hot pen type).
- d) A Sonotek SDS-1200 digital data acquisition system.
- e) A Bonzer MK-10 radar altimeter.
- f) A 60 Hz monitor.
- g) A Scintrex IITC-2 intervalometer.
- h) A Vinten 16 mm camera.
- i) A Del Norte Flying Flagman transponder-based navigational system (see Appendix 3 for details).
- j) Instrument mounting rack, base station magnetometer, test equipment, tools and spare parts.

SURVEY SPECIFICATIONS AND SURVEY CREW

The survey specifications were as follows:

Line Spacing - 125 m (410 ft) and 250 m (820 ft).

Sensor terrain clearance - 100 to 150 ft.

Aircraft speed - 70 mph.

The survey crew consisted of:

Geophysicists - Ian Johnson/Vince Tanzini

Operator 1 - John Glover

Operator 2 - Evan Veroni

Dataman - Paul Conroy

Pilot - John Hall/John Ahlstrom

Michael Lewis, Operations Manager of Scintrex, maintained overall supervision from the Scintrex office in Concord (Toronto). John Gillan of Norcen Energy Resources was on site at the start and end of the project.

The helicopter, C-GGUB, a Bell 206B, was owned and operated by Huisson Aviation Limited, Timmins, Ontario.

5. FIELD PROCEDURES AND PRODUCTION SUMMARY

If all were to proceed without failures or interruptions, the field work would advance according to:

- a) Install equipment in helicopter, assemble HEM 'bird', set up base station magnetometer, install the two fixed transponders.
- b) Ground test and HEM warm up.
- c) Fly survey.
- d) Check and edit all analog traces, develop flight path film and plot back the flight path (as a check against the Flying Flagman operation).

The acceptable data was produced on 18 survey flights (see Table 1 for details).

Any given flight would normally proceed as follows:

- a) Ground system and magnetometer check.
- b) Take off.
- c) Airborne systems check (including Flying Flagman) and pre-flight analog/digital calibration sequence.
- d) Fly lines.
- e) Post-flight analog/digital calibration sequence.
- f) Land.

The one technical procedure requiring special attention was the installation and operation of the Flying Flagman navigational system. This system operates with two ground (remote or slave) transponders and one airborne (master) transponder. The master communicates with both remotes in order to establish the distances from master to both slaves. (The communication signal is transmitted at approximately 9 Gigahertz and then only during short 'on' periods separated by approximately 1 millisecond).

The two distances, master to remote (T_1) and master to remote (T_2), are internally compared with the base line distance (T_1 to T_2) which was entered earlier by flying across the base line, the Flying Flagman system automatically recognizing the minimum distance point. Triangulation gives the x-y coordinate at a given point in time. The pre-programmed grid is compared with actual position to provide direction to the pilot. X and Y coordinates are recorded on the digital data acquisition system with updates every 0.5 seconds.

TABLE 1
SURVEY PRODUCTION SUMMARY

<u>Flight</u>	<u>Date</u>	<u>Lines Surveyed & Accepted</u>
1	January 23	--
2	January 24	1-6
3	January 25	7-11
4	January 27	12-17
5	January 28	18-29
6	January 28	32-42
7	January 28	42-55
8	January 29	56-67
9	January 29	68-70
10	January 30	--
11	January 31	--
12	January 31	71-82
13	January 31	83-91
14	January 31	94-105
15	February 1	108-115
16	February 3	116-127
17	February 3	129-155, MTL1
18	February 3	30,31,92,93,106,107,MTL2

N.B: Lines 1 to 123 inclusive were flown with a 125 m line spacing.

Lines 123 to 155 inclusive were flown for odd numbered lines only (giving an effective line spacing of 250 m).

Positional information is recorded to the nearest 0.1 m; actual accuracy is probably ± 5 m.

The two fixed transponders were set up - a) in the fire tower on Mount Collins, and b) on Mount Sinclair (see Figure 2). These locations permitted line of site coverage for the entire survey area. Having fixed these ground stations, the system was initialized by setting the start and end points of line zero (just outside, to the east of and parallel to the north-south boundary line of the survey area (Eastern edge). As the system programs the flight plan as a rectangular grid, all line stop-starts, except those in the northeast corner, were controlled manually using the photomosaic.

The survey work proceeded in most parts without incident. A few points should however be mentioned.

- a) Flight No. 2 was aborted due to dropping the HEM bird. The sensor was repaired and used to complete the survey. A noticeable and yet acceptable increase in EM noise levels ensued.
- b) A power line running approximately north-south through the center of the area rendered the EM data useless for approximately one line spacing (125 m) on either side.

6. DATA RECORDING

6.1 Analog Records

The analog records display the following:

<u>Channel</u>	<u>Content</u>	<u>Approximate Full Scale Gain</u>
1	60 Hz monitor	--
2	735 Hz in-phase	150 ppm
3	735 Hz quadrature	150 ppm
4	3220 Hz in-phase	150 ppm
5	3220 Hz quadrature	150 ppm
6	Magnetometer	100 gammas
7	Magnetometer	1000 gammas
8	Altimeter	500 ft

Fiducial (one per second) counters are shown above channel 1 and below channel 8. Chart speed is 2 mm/second. Lines and fiducial numbers are manually labelled. Where the fiducial trace is seen the system is on line and all recording systems on.

The analog records for the survey have been fan-folded and stored in envelopes, one per flight.

At the start and end of each flight are calibration sequences. The four EM channels are calibrated by activating pre-set 100 ppm (parts per million) calibration pulses. The magnetometer channels are calibrated on analog only as the digital records read directly in gamma. The same holds true of the radar altimeter record.

The base station magnetometer recorder was run with 100 gamma full scale and at a chart speed of 10 cm/hr. Throughout the production survey work, the base station magnetometer showed no anomalous external field magnetic activity.

Flight logs, maintained by the operator, show all lines surveyed, start and end fiducial points, initializing information and any non-standard events.

6.2 Digital Records

All airborne survey data were recorded on the digital data acquisition system. Fiducials and magnetometer readings were updated every 1 second. All time EM, altimeter and positioned x-y data were sampled every 0.5 seconds. All EM data were digitally sampled after electronic filters of rise times 0.5, 1.1 and 2.2 seconds.

Recording was on 9-track magnetic tape, 800 bpi format.

7. IN-FIELD COMPILATION

The analog records were studied for quality and consistency. All lines were labelled and fiducials marked. The flight path film was developed and edited. The flight path was recovered on photomosaics (scale 1" = $\frac{1}{4}$ mile) to ensure area coverage at agreed line spacings. Prominent electromagnetic anomalies were identified and plotted on an overlay ('red-ball') map at the scale of the photomosaics. These maps were presented to Norcen at the end of the field work.

8. PRESENTATION

8.1 Base Map

The flight path was machine plotted at a scale of 1:10,000. The flight path film was used to outline all significant topographic features on the photomosaic base (photo-enlarged to a scale of approximately 1:10,000). Such topographic features were then transferred in outline to the flight path map by comparing fiducials. Such a scheme was adopted as the photomosaics were of uncertain quality; a gross scaling error of approximately 2%, and possibly more severe local offsets were apparent.

The resultant planimetric maps were used as base maps for the presentation of the geophysical results. The photo-enlarged photomosaics which show no survey information are included as complimentary maps to the planimetric maps used.

8.2 Electromagnetic Anomaly Selection and Plotting

The analog records were studied for anomalous responses, all of which were analyzed and plotted. Those responses which were considered as due to "lake bottom" sediments (typified by a broad, low amplitude response primarily in the 3220 Hz quadrature channel) were most often omitted from consideration. All anomalies selected for presentation showed some response in the 735 Hz quadrature channel (even if none in the 735 Hz in-phase channel).

All selected anomalies were analyzed by computer and the interpreted conductance and depth to source estimates listed (assuming a vertical half plane model). For plotting purposes, the average conductance and depth to source (average for the two sensing frequencies) are shown under the anomaly centers. If no inversion calculation has been undertaken for the low frequency anomaly (due for example to no observed response in the in-phase component), the conductance and depth to source estimates for the high frequency response calculation are plotted.

The anomaly centers have been plotted as one of four possible categories. These are described in the map legend as follows:

CATEGORY 3	(735 Hz In-phase amplitude > 10 ppm)	_____●
CATEGORY 2	(0 ppm < 735 Hz In-phase amplitude ≤ 10 ppm)	_____●
CATEGORY 1	(0 ppm = 735 Hz In-phase amplitude)	_____○
CATEGORY 0	(either 735 or 3220 Hz In-phase amplitude < 0 ppm)	_____□

Where the listing shows a negative depth to source, this is set to zero for plotting purposes.

8.3 Magnetic Contour Map

All magnetic data was machine contoured at the scale of 1:10,000. The minimum contour interval is 10 gammas. Magnetic contouring was done by Dataplotting Services Limited, Toronto.

Lines 1 to 29 inclusive showed a digital magnetic record of uncertain quality. As a result, magnetic data for these lines was manually digitized from the analog records before entering the machine contouring process.

In the northwest corner of the survey area, magnetic anomalies were encountered which caused, for certain line segments, the magnetometer to go 'off-lock' with a consequent loss of data.

In general, given the navigational quality of the data set, the contoured magnetic data may be treated with confidence. Apart from loss of data in the northwest corner of the survey area, the data set is complete with no apparent compilation problems. The power line does not noticeably affect the contoured magnetics.

Throughout most of the survey area, the magnetic field is characterized by extensive regions of low magnetic gradients. Such regions produce the most rigorous tests for airborne magnetic data sets and the processing algorithms used. Given the navigational accuracy available and the absence of marked external field magnetic activity, the results should be of good quality. The only distraction from the ideal is a small levelling residue which is somewhat apparent as north-south stripping. This is not felt to be a major problem and could be improved upon with a higher density of control lines and a more sophisticated levelling algorithm.

CONCLUSIONS

A helicopter-borne electromagnetic and magnetic survey of approximately 1500 line km has been completed on behalf of Norcen Energy Resources Limited in the Halliday Township area of Ontario. Results, including the radar ranging flight path have been plotted at a scale of 1:10,000. Numerous high conductance EM targets are indicated. Comparison with the contoured magnetics would guide the assignment of conductor axes and priorities thereof. The interpreted results should be of high quality, as the survey flown was of the "high resolution" type.

Respectfully submitted,

SCINTREX LIMITED



Ian Johnson, Ph.D., P.Eng.
Geophysicist



Michael Lewis, M.Sc., P.Eng.
Manager, Geophysical Surveys Division.

APPENDIX I

HEM-802 SPECIFICATIONS

and

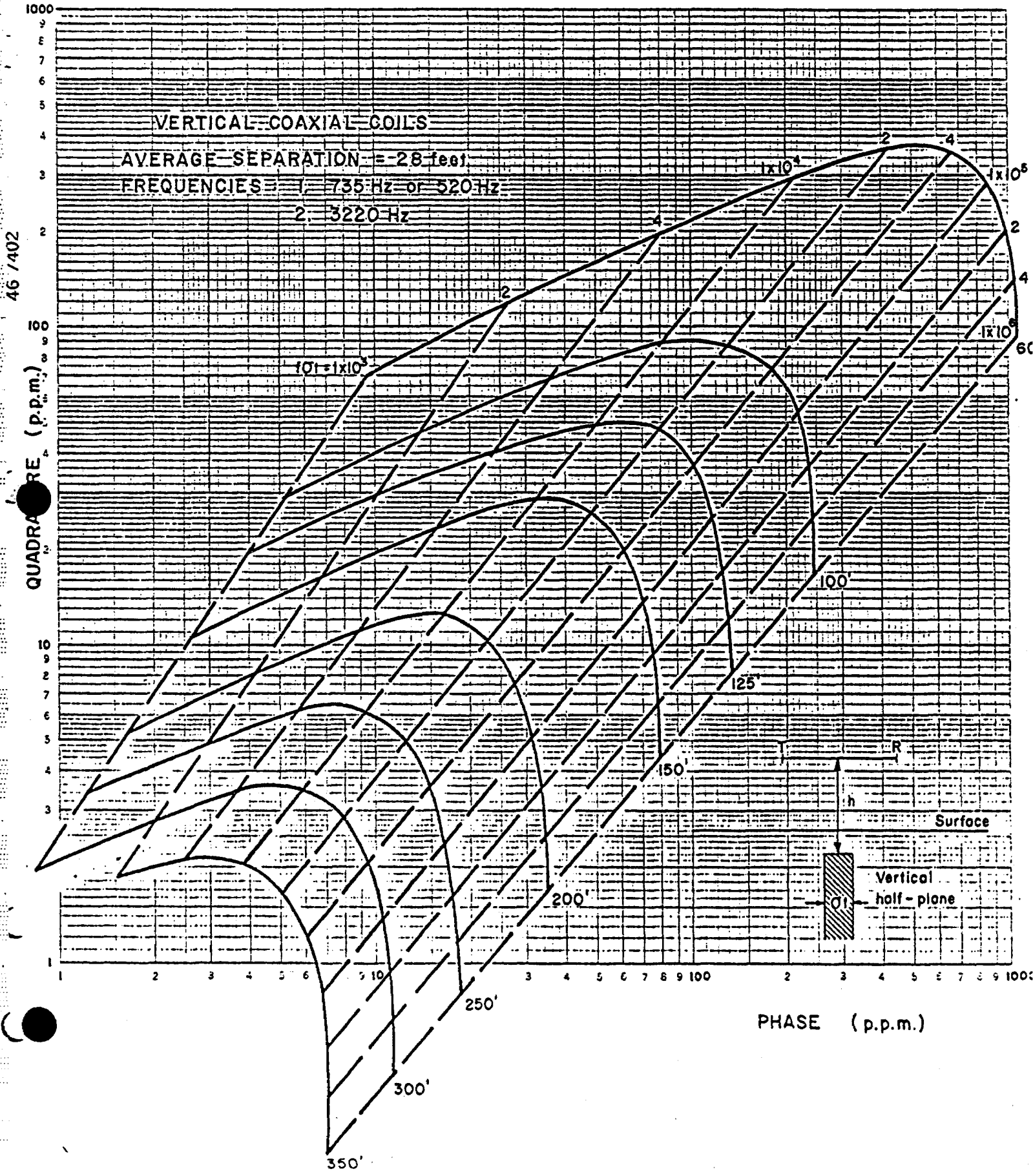
PHASOR DIAGRAMS

APPENDIX

HEM-802 SPECIFICATIONS AND PHASOR DIAGRAMS

Parameters Measured	In-phase and out-of-phase components of secondary field in parts per million of the normal, undisturbed primary field at two frequencies simultaneously
Frequencies	Low Frequency: 500 Hz or 735 Hz High Frequency: 3220 Hz
Sensitivity	1 part per million
Noise Level	Dependent on atmospheric noise and air turbulence, but generally better than 1 ppm out-of-phase and 3 ppm in-phase at 1 sec time constant
Time Constants	0.2, 0.5, or 1.0 seconds
Coil Orientation	Vertical coaxial
Coil Separation	8.55 meters average 8.84 meters low frequency 8.26 meters high frequency
Bird Construction	Three 3 m sections, plus nose and tail cones and drag skirt
Power Requirements	28 V DC, 35 watts (not including recorder)
Recommended Aircraft	Alouette Lama, Bell 206 Long Ranger or equivalent depending on altitude, temperature and humidity conditions
Altitude of Bird	30 m below the helicopter and approximately 30 m above the ground
Weight	Total approximately 155 kg for EM unit including bird, cable, recorder, console and racks
Compatibility	Compatible with all radiometric systems and proton and fluxgate magnetometers

SCINTREX HEM - 802 FOR VERTICAL THIN SHEETS



SCINTREX HEM - 802

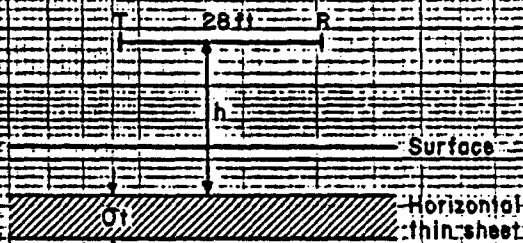
FOR HORIZONTAL THIN SHEETS

VERTICAL COAXIAL COILS

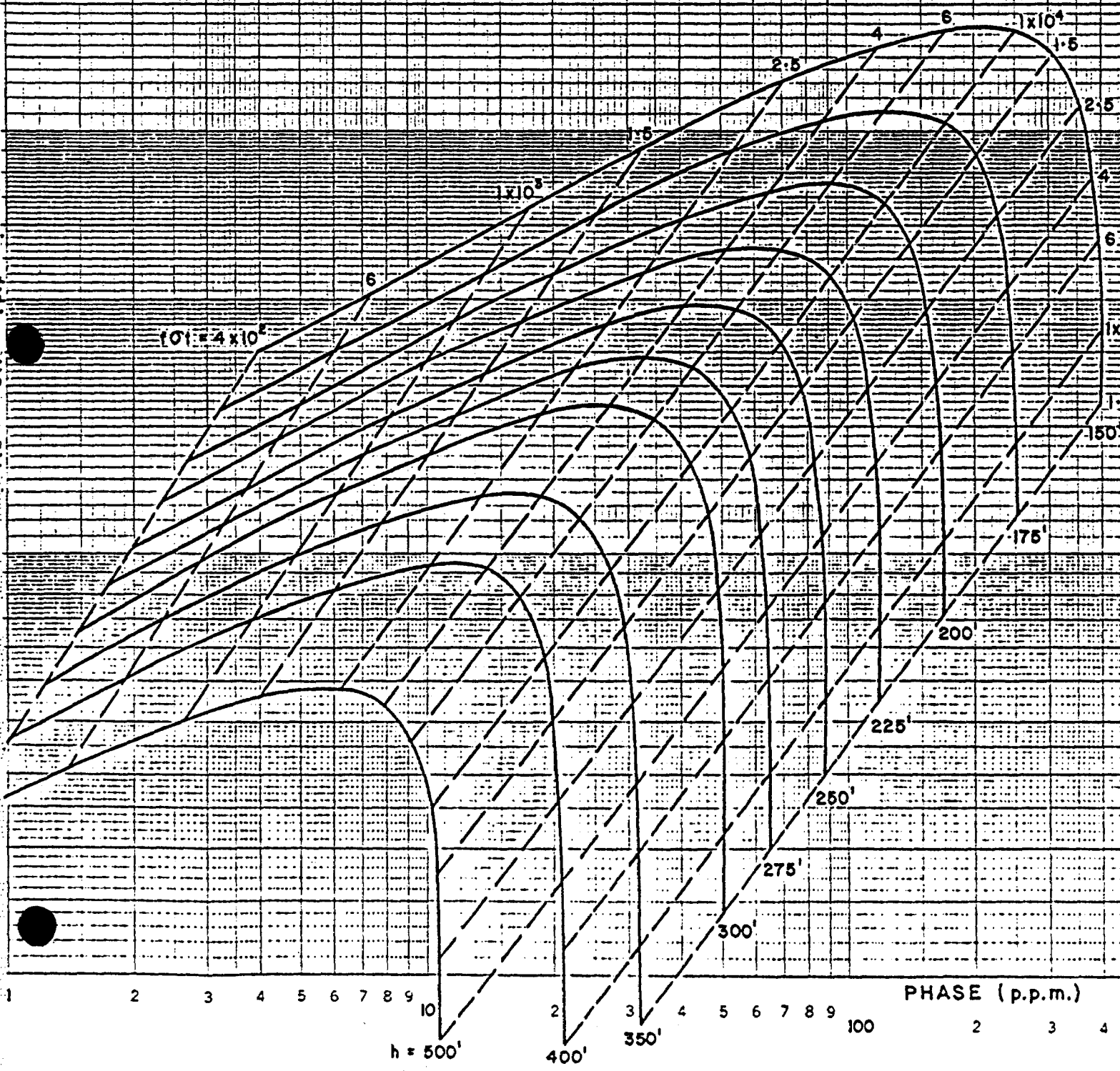
AVERAGE SEPARATION = 28 feet

FREQUENCIES = 1. 735 Hz or 520 Hz

2. 3220 Hz



A.E.U.S.P.



APPENDIX II

MAP-4 MAGNETOMETER SPECIFICATIONS

APPENDIX

MAP-4 SPECIFICATIONS

Range	20,000 - 100,000 gammas (worldwide) continuous range fully automatic
Sensitivity	± 1 gamma
Accuracy	± 1 gamma
Sampling Rate	Standard 1 sec, with provision for synchronization to other equipment
Readout-Visual	Digital display by 5 incandescent, 7 bar display lights
Digital Data Output	RDC 1-2-4-8 DTL, TTL compatible
Analog Data Output	5 V full scale for 1000 gammas or 100 gammas, 1 gamma resolution
External Trigger	Requirements: +4 V to 0 transition (as slave) Output: +4 V to 0 transition at start of cycle (as master)
Power Requirements	24-30 V DC, 3.2 A max.
Temperature Range	-30 to +50° C
Dimensions and Weights	Console 8½ x 5½ x 13" (half-rack); 12 lbs Sensing head 7 x 24X"; 18 lbs

APPENDIX III

FLYING FLAGMAN SPECIFICATIONS

APPENDIX

FLYING FLAGMAN SPECIFICATIONS

Working Principle	Ranges from the moving vehicle to two or more ground transponders are measured many times per second and processed continuously by a microprocessor to give position, track and track error steering information
Equipment	The two or more ground stations each have a transponder and antenna and use an AC power supply or a battery for power. The airborne equipment consists of a master transponder, digital distance measuring unit, DDMU control panel, pilot's L-R control panel, steering indicator, power supply, and antenna
Operating Range	Up to 80 km (50 miles) line of sight from the ground transponders
Range Accuracy	It is within 3 meters at 80 km
Weight	Approximately 40 lb (18.1 kg) depending upon the aircraft
Flight Patterns Available	Long straight tracks (74 km, plus), multiple parallel tracks, oval patterns, circular patterns
Line Spacings	Selectable between 013 meters and 3045 meters
Remote Transponders	A remote transponder is approximately the size of a briefcase and weighs 15 lb. The antenna weighs 1 lb. They draw a maximum of 0.7 amp at 24 V and can operate for several days with automobile batteries or permanently with a small power supply using 115 V AC input. They are weatherproof and can be installed permanently, if desired A time sharing adapter allows up to four different aircraft to use the same two ground transponders.
Options	A race track option allows a pilot to program a race track pattern. An X-Y preflight option allows a pilot to pre-program his initial flight path and check points prior to takeoff.

put

The standard output is in a Serial ASCII format compatible with RS232 or Del Norte 12 V communication line

Information Retention

At least one month with all external power turned off unless the set button is pressed with the L-R mode switch in station reference or X-Y, or unless P₁ and P₂ are pressed again in the designate position

APPENDIX IV

ELECTROMAGNETIC ANOMALY LISTINGS

The following listings are largely self-explanatory. Some explanation, however, follows.

I. 735, IP, PPM, etc.

Anomaly amplitudes in ppm (parts per million) at the selected frequency (735 or 3220 Hz) for the selected component (IP = in-phase, Q = quadrature). Original amplitude assignments were in small divisions of analog. These values were converted to ppm using the average conversion factors of 3 ppm/small division for the 735 IP, 735 Q, 3220 IP and 3220 Q channels.

II. ALT.

Helicopter terrain clearance at the peak location. Bird terrain clearance is arrived at by assuming a 110 foot cable.

III. ST., DEP.

Sigma t (conductivity-thickness product or conductance) in mhos of the vertical half plane model (VHP) and depth to top of VHP model (appears as negative where model is above ground surface, i.e. bad fit).

IV. AVERAGE, ST., DEP.

Average conductance (ST) and depths (DEP) from low and high frequency

V.

COND. RANGE

Conductance range figure based on average conductance estimate (see Item IV above). Conductance range figures vary from one to nine (higher numbers for higher apparent conductance values). Conductance range figure delimiters are as follows:

CONDUCTANCE RANGE FIGURES

1	0	<	01	<	2.0 mhos
2	2.0	<	01	<	3.0 mhos
3	3.0	<	01	<	5.0 mhos
4	5.0	<	01	<	8.0 mhos
5	8.0	<	01	<	12.0 mhos
6	12.0	<	01	<	17.0 mhos
7	17.0	<	01	<	30.0 mhos
8	30.0	<	01	<	75.0 mhos
9	75.0	<	01	<	∞ mhos

VI.

CAT.

Category based on 735 Hz in-phase amplitude with delimiters as follows;

ELECTROMAGNETIC ANOMALIES _____

D - Anomaly label 3.1 - Conductance (in mhos) 52 - Depth to source (feet) D
3.1 52

CATEGORY 3 (735 Hz in-phase amplitude > 10 ppm) _____ ●

CATEGORY 2 (0 ppm < 735 Hz in-phase amplitude ≤ 10 ppm) _____ ●

CATEGORY 1 (0 ppm = 735 Hz in-phase amplitude) _____ ○

CATEGORY 0 (either 735 or 3220 Hz in-phase amplitude < 0 ppm) _____ □

ANOMALOUS ZONE AND PEAK LOCATION _____ ◯

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHF		AVERAGE		COND. RANGE	CAT.		
										(735 ST.	(3220 ST.	(735 HZ) DEP.	(3220 HZ) DEP.			ST.	DEP.
1S	A		205		0	5	3	15	250	*****	****	0.3	-6	0.3	-6	1	1
1S	B		297		0	5	3	12	260	*****	****	0.4	1	0.4	1	1	1
1S	C		331		8	11	28	27	250	5.0	44	2.7	10	3.9	27	3	2
1S	D		345		0	5	3	9	280	*****	****	0.5	10	0.5	10	1	1
1S	E		383		0	5	3	18	250	*****	****	0.3	-14	0.3	-14	1	1
1S	F		391		13	11	28	31	260	12.2	56	2.4	-16	7.3	20	4	3
1S	G		398		0	5	3	21	300	*****	****	0.3	-86	0.3	-86	1	1
1S	H		403		0	5	3	18	310	*****	****	0.3	-74	0.3	-74	1	1
2N	A		541		0	3	7	9	380	*****	****	1.1	-63	1.1	-63	1	1
2N	B		552		3	5	17	24	210	2.4	129	1.4	41	1.9	85	1	2
2N	C		607		8	18	31	52	230	3.0	23	1.4	-12	2.2	6	2	2
2N	D		637		0	0	3	18	240	*****	****	0.3	-4	0.3	-4	1	1
2N	E		646		0	3	3	9	240	*****	****	0.5	50	0.5	50	1	1
2N	F		653		0	3	3	3	210	*****	****	1.6	207	1.6	207	1	1
2N	G		693		0	3	3	9	200	*****	****	0.5	90	0.5	90	1	1
2N	H		773		0	8	3	34	220	*****	****	0.2	-42	0.2	-42	1	1
2N	I		819		0	3	3	12	230	*****	****	0.4	31	0.4	31	1	1
2N	J		829		0	11	7	49	200	*****	****	0.3	-17	0.3	-17	1	1
3S	A		830		0	5	3	31	230	*****	****	0.2	-48	0.2	-48	1	1
3S	B		835		0	5	3	27	230	*****	****	0.2	-45	0.2	-45	1	1
3S	C		842		0	5	3	12	220	*****	****	0.4	41	0.4	41	1	1
3S	D		848		3	3	7	6	230	5.0	194	2.0	130	3.5	162	3	2
3S	E		897		0	3	3	12	250	*****	****	0.4	11	0.4	11	1	1
3S	F		933		0	0	3	9	220	*****	****	0.5	70	0.5	70	1	1
3S	G		969		0	5	3	12	230	*****	****	0.4	31	0.4	31	1	1
3S	H	1018	1023	1029	0	8	3	24	240	*****	****	0.3	-52	0.3	-52	1	1
3S	I		1040		0	5	3	24	220	*****	****	0.3	-32	0.3	-32	1	1
3S	J		1050		13	26	59	82	180	4.2	62	2.3	15	3.3	39	3	3
4N	A		1260		0	8	3	27	220	*****	****	0.2	-35	0.2	-35	1	1
4N	B	1295	1301	1306	3	8	17	40	250	1.8	38	0.9	-22	1.4	8	1	2
4N	C		1327		0	8	7	46	200	*****	****	0.3	-14	0.3	-14	1	1
4N	D		1366		0	0	3	6	190	*****	****	0.6	149	0.6	149	1	1
4N	E		1400		0	0	3	6	220	*****	****	0.6	119	0.6	119	1	1
4N	F		1439		0	3	3	12	220	*****	****	0.4	41	0.4	41	1	1
4N	G		1452		0	8	3	40	230	*****	****	0.2	-59	0.2	-59	1	1
4N	H		1473		0	3	3	12	190	*****	****	0.4	71	0.4	71	1	1
4N	I		1514		0	5	3	27	220	*****	****	0.2	-35	0.2	-35	1	1
5S	A		1520		0	5	3	21	230	*****	****	0.3	-16	0.3	-16	1	1
5S	B		1586		0	3	3	12	230	*****	****	0.4	31	0.4	31	1	1
5S	C	1597	1603	1611	0	3	3	21	220	*****	****	0.3	-6	0.3	-6	1	1
5S	D		1693		0	0	3	12	250	*****	****	0.4	11	0.4	11	1	1
5S	E		1747		0	8	7	46	230	*****	****	0.3	-44	0.3	-44	1	1

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	-----VHP-----		AVERAGE		COND. RANGE	CAT.		
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.	ST. DEP.	ST. DEP.				
5S	F		1773		0	5	3	18	250	*****	****	0.3	-14	0.3	-14	1	1
5S	G	1824	1829	1829	0	5	3	12	220	*****	****	0.4	41	0.4	41	1	1
6N	A		1900		0	5	3	18	230	*****	****	0.3	6	0.3	6	1	1
6N	B	1918	1923	1931	3	11	21	55	240	1.4	25	0.9	-39	1.2	-6	1	2
6N	C		1995		0	0	3	15	180	*****	****	0.3	64	0.3	64	1	1
6N	D		2027		0	0	3	15	190	*****	****	0.3	54	0.3	54	1	1
6N	E		2034		0	0	3	31	190	*****	****	0.2	-8	0.2	-8	1	1
6N	F		2039		0	0	3	37	190	*****	****	0.2	-15	0.2	-15	1	1
7S	A		228		0	3	3	9	260	*****	****	0.5	30	0.5	30	1	1
7S	B		283		0	0	3	6	250	*****	****	0.6	89	0.6	89	1	1
7S	C	414	433	453	3	5	10	24	330	2.4	9	0.8	-86	1.6	-38	1	2
8N	A		602		0	5	17	15	270	*****	****	2.7	11	2.7	11	2	1
8N	B		616		0	8	14	34	280	*****	****	0.9	-49	0.9	-49	1	1
8N	C		626		0	8	21	49	260	*****	****	1.0	-42	1.0	-42	1	1
8N	D		636		0	5	7	18	290	*****	****	0.6	-37	0.6	-37	1	1
8N	E		770		3	5	3	6	280	2.4	59	0.6	59	1.5	59	1	2
9S	A		1130		0	5	17	31	280	*****	****	1.1	-40	1.1	-40	1	1
9S	B		1152		0	5	7	15	300	*****	****	0.7	-33	0.7	-33	1	1
9S	C		1168		0	5	14	15	240	*****	****	1.9	41	1.9	41	1	1
9S	D		1185		0	5	3	9	260	*****	****	0.5	30	0.5	30	1	1
10N	A		1294		0	5	3	12	270	*****	****	0.4	-9	0.4	-9	1	1
10N	B		1308		0	5	14	15	260	*****	****	1.9	21	1.9	21	1	1
10N	C		1317		0	5	3	9	300	*****	****	0.5	-10	0.5	-10	1	1
10N	D	1331	1338	1342	0	8	7	31	260	*****	****	0.4	-46	0.4	-46	1	1
10N	E		1380		0	3	3	9	250	*****	****	0.5	40	0.5	40	1	1
11S	A		1781		0	3	3	9	230	*****	****	0.5	60	0.5	60	1	1
11S	B		1890		3	5	7	34	250	2.4	89	0.4	-54	1.4	18	1	2
11S	C		1933		3	5	21	15	250	2.4	89	3.6	35	3.0	62	2	2
12S	A		219		0	0	3	6	280	*****	****	0.6	59	0.6	59	1	1
12S	B	297	305	313	3	3	7	24	300	5.0	124	0.5	-62	2.7	31	2	2
12S	C		340		11	8	28	21	250	12.2	78	3.7	21	8.0	50	4	3
13N	A		448		16	11	35	15	280	16.3	36	7.5	-2	11.9	17	5	3
13N	B		457		3	5	14	18	270	2.4	69	1.4	2	1.9	36	1	2
13N	C		480		3	8	17	37	270	1.8	18	1.0	-39	1.4	-10	1	2

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHP		AVERAGE		COND. RANGE	CAT.		
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.	ST. DEP.	ST. DEP.				
21N	D		1465		0	3	3	9	210	*****	****	0.5	80	0.5	80	1	1
22S	A		1731		0	3	10	15	260	*****	****	1.1	17	1.1	17	1	1
22S	B		1738		0	5	14	18	260	*****	****	1.4	12	1.4	12	1	1
22S	C		1894		8	13	31	21	260	4.1	23	4.5	10	4.3	17	3	2
23N	A		2106		5	11	21	15	260	3.0	35	3.6	25	3.3	30	3	2
23N	B		2117		3	8	17	34	210	1.8	78	1.1	27	1.4	53	1	2
23N	C		2122		3	5	7	34	210	2.4	129	0.4	-14	1.4	58	1	2
23N	D		2247		0	3	3	12	280	*****	****	0.4	-19	0.4	-19	1	1
24S	A		2505		3	5	10	15	250	2.4	89	1.1	27	1.8	58	1	2
24S	B		2513		0	5	10	21	250	*****	****	0.9	-2	0.9	-2	1	1
24S	C		2667		3	3	7	9	220	5.0	204	1.1	97	3.0	151	3	2
24S	D		2754		3	5	14	15	250	2.4	89	1.9	31	2.1	60	2	2
25N	A		2831		3	3	7	18	220	5.0	204	0.6	33	2.8	119	2	2
25N	B		2869		3	3	3	15	230	5.0	194	0.3	14	2.8	104	2	2
25N	C		2976		3	5	10	15	230	2.4	109	1.1	47	1.8	78	1	2
26S	A		3250		0	0	7	9	260	*****	****	1.1	57	1.1	57	1	1
26S	B		3264		0	3	10	12	260	*****	****	1.5	31	1.5	31	1	1
26S	C		3386		3	3	7	15	260	5.0	164	0.7	7	2.8	86	2	2
26S	D		3484		3	3	7	12	270	2.4	69	0.9	17	1.6	43	1	2
26S	E		3495		3	8	21	21	250	1.8	38	2.4	19	2.1	29	2	2
27N	A		3497		8	18	42	21	270	3.0	-17	6.3	-2	4.7	-9	3	2
27N	B		3510		3	3	7	6	280	5.0	144	2.0	80	3.5	112	3	2
27N	C		3740		3	3	7	9	290	5.0	134	1.1	27	3.0	81	3	2
28S	A		4005		0	3	3	9	310	*****	****	0.5	-20	0.5	-20	1	1
28S	B		4130		0	3	7	18	260	*****	****	0.6	-7	0.6	-7	1	1
28S	C		4229		0	3	10	12	270	*****	****	1.5	21	1.5	21	1	1
28S	D		4242		8	11	35	21	270	5.0	24	5.1	-2	5.1	11	4	2
29N	A		4247		5	3	10	6	320	16.9	103	3.8	19	10.4	61	5	2
29N	B	4353	4360	4372	3	5	10	31	250	2.4	89	0.6	-26	1.5	32	1	2
29N	C		4488		0	5	10	12	260	*****	****	1.5	31	1.5	31	1	1
30S	A	3047	3053	3059	0	5	7	21	290	*****	****	0.6	-44	0.6	-44	1	1
30S	B	3073	3082	3090	0	8	14	34	250	*****	****	0.9	-19	0.9	-19	1	1

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	-----VHP-----				AVERAGE		COND. RANGE	CAT.
										(735 ST.	HZ) DEF.	(3220 ST.	HZ) DEF.	ST.	DEF.		
39N	B		3699		13	13	35	21	230	9.4	56	5.1	38	7.3	47	4	3
39N	C		3779		3	5	7	12	270	2.4	69	0.9	17	1.6	43	1	2
39N	D	3811	3816	3822	5	11	24	24	250	3.0	45	2.6	14	2.8	30	2	2
39N	E		3923		5	11	24	15	240	3.0	55	4.5	42	3.8	49	3	2
39N	F		3928		0	8	17	24	240	*****	****	1.4	11	1.4	11	1	1
39N	G		3966		3	5	10	24	220	2.4	119	0.8	24	1.6	72	1	2
40S	A		4195		5	8	21	21	240	4.0	82	2.4	29	3.2	56	3	2
40S	B		4200		8	8	24	15	240	7.6	90	4.5	42	6.0	66	4	2
40S	C	4287	4299	4307	0	13	21	49	220	*****	****	1.0	-2	1.0	-2	1	1
40S	D		4342		3	5	10	15	270	2.4	69	1.1	7	1.8	38	1	2
40S	E		4424		5	3	7	6	260	16.9	163	2.0	100	9.4	132	5	2
41N	A		4482		3	3	7	9	330	5.0	94	1.1	-13	3.0	41	3	2
41N	B		4622		3	8	10	34	220	1.8	68	0.6	3	1.2	36	1	2
41N	C		4710		3	8	14	9	280	1.8	8	3.6	43	2.7	26	2	2
41N	D		4716		0	5	10	12	290	*****	****	1.5	1	1.5	1	1	1
41N	E		4772		3	5	14	21	210	2.4	129	1.2	51	1.8	90	1	2
42S	A		153		0	5	10	12	260	*****	****	1.5	31	1.5	31	1	1
42S	B		161		0	8	17	18	240	*****	****	2.2	34	2.2	34	2	1
42S	C		227		11	11	24	15	250	8.6	65	4.5	32	6.6	49	4	3
42S	D		324		0	5	3	21	230	*****	****	0.3	-16	0.3	-16	1	1
43N	A	511	518	525	0	8	10	43	200	*****	****	0.5	4	0.5	4	1	1
43N	B		717		5	5	24	12	280	6.4	91	5.6	5	6.0	48	4	2
43N	C		790		5	5	10	15	260	6.4	111	1.1	17	3.8	64	3	2
44S	A		941		3	5	7	6	310	2.4	29	2.0	50	2.2	40	2	2
44S	B		1014		3	3	10	9	260	5.0	164	2.3	62	3.6	113	3	2
44S	C		1130		3	3	3	9	280	5.0	144	0.5	10	2.7	77	2	2
44S	D		1150		3	5	10	12	270	2.4	69	1.5	21	1.9	45	1	2
45N	A		1283		0	3	3	6	270	*****	****	0.6	69	0.6	69	1	1
45N	B	1448	1453	1458	3	5	10	9	250	2.4	89	2.3	72	2.3	81	2	2
45N	C		1504		3	5	10	9	250	2.4	89	2.3	72	2.3	81	2	2
45N	D		1578		3	8	28	15	280	4.0	42	5.4	-1	4.7	21	3	2
46S	A		1730		3	8	14	12	290	1.8	-2	2.5	-2	2.2	-1	2	2
46S	B		1749		3	5	10	21	240	2.4	99	0.9	8	1.6	54	1	2
46S	C		1808		3	5	10	9	270	2.4	69	2.3	52	2.3	61	2	2
46S	D		1880		0	3	10	21	230	*****	****	0.9	18	0.9	18	1	1

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHF				AVERAGE ST. DEF.	COND. RANGE	CAT.	
										(735 HZ)		(3220 HZ)					
										ST.	DEF.	ST.	DEF.				
58S	A		1054		3	8	24	24	280	1.8	8	2.6	-16	2.2	-3	2	2
58S	B		1061		11	13	28	24	250	5.8	38	3.1	16	4.5	27	3	2
58S	C		1067		8	13	28	24	250	4.1	33	3.1	16	3.6	25	3	2
58S	D		1365		5	8	17	15	240	4.0	82	2.7	41	3.4	62	1	2
59N	A	1443	1445	1447	8	11	28	21	230	5.0	64	3.7	41	4.4	53	3	2
59N	B		1795		5	8	24	18	220	4.0	102	3.6	58	3.8	80	3	2
59N	C	1798	1803	1814	19	24	80	37	220	7.4	41	9.1	18	8.3	30	3	2
59N	D		1820		3	11	28	31	190	1.4	75	2.4	54	1.9	65	1	2
59N	E		1825		0	5	10	24	200	*****	****	0.8	44	0.8	44	1	1
60S	A		1949		3	8	17	27	180	1.8	108	1.2	62	1.5	85	1	2
60S	B		1968		40	34	101	49	200	15.4	46	9.0	20	12.2	33	6	2
60S	C		1978		11	13	31	31	220	5.8	68	2.8	24	4.3	46	3	3
60S	D		2261		0	0	24	21	230	*****	****	3.0	40	3.0	40	2	1
60S	E		2266		19	8	31	15	280	26.9	40	6.1	-2	16.5	19	6	3
61N	A	2669	2680	2682	0	5	14	18	180	*****	****	1.4	92	1.4	92	1	1
61N	B		2722		16	13	38	21	240	12.4	45	5.7	27	9.0	36	5	2
61N	C		2732		8	8	21	24	240	7.6	90	2.0	22	4.8	56	3	2
62S	A		2905		5	5	14	18	240	6.4	131	1.4	32	3.9	82	3	2
62S	B		2942		5	8	17	15	230	4.0	92	2.7	51	3.4	72	3	2
62S	C	2946	2954	2958	21	16	42	18	230	15.4	54	8.1	40	11.7	47	5	2
63N	A		3299		3	5	14	31	180	2.4	159	0.9	58	1.6	109	1	2
63N	B		3585		11	13	35	21	240	5.8	48	5.1	28	5.5	38	4	2
63N	C		3593		34	26	76	40	210	17.7	53	7.6	28	12.7	41	6	3
63N	D		3602		13	13	45	31	200	9.4	86	4.9	46	7.2	66	4	2
64S	A		3876		3	5	14	18	220	2.4	119	1.4	52	1.9	86	1	2
64S	B		3884		5	5	10	12	260	6.4	111	1.5	31	4.0	71	3	2
64S	C		3905		3	5	10	12	250	2.4	89	1.5	41	1.9	65	1	2
64S	D		3910		3	5	10	12	250	2.4	89	1.5	41	1.9	65	1	2
64S	E		4120		3	5	14	15	240	2.4	99	1.9	41	2.1	70	2	2
65N	A		4213		3	5	14	18	220	2.4	119	1.4	52	1.9	86	1	2
65N	B		4505		5	5	14	9	220	6.4	151	3.6	103	5.0	127	3	2
65N	C		4534		5	11	21	21	230	3.0	65	2.4	39	2.7	52	2	2
65N	D		4538		5	11	17	18	210	3.0	85	2.2	64	2.6	75	2	2
66S	A		4716		0	5	3	21	200	*****	****	0.3	14	0.3	14	1	1

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	-----VHF-----		AVERAGE		COND. RANGE	CAT.		
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.	ST. DEP.	ST. DEP.				
73S	D	1094			13	8	21	6	240	17.6	88	10.9	82	14.2	85	6	3
73S	C	1256			0	8	14	15	260	*****	****	1.9	21	1.9	21	1	1
73S	D	1455			0	5	3	31	220	*****	****	0.2	-38	0.2	-38	1	1
73S	E	1520			3	5	10	15	210	2.4	129	1.1	67	1.8	98	1	2
74N	A	1571			3	3	3	18	250	5.0	174	0.3	-14	2.6	80	2	2
74N	B	1822			0	5	7	12	240	*****	****	0.9	47	0.9	47	1	1
74N	C	1922			11	5	21	9	290	20.7	72	6.1	24	13.4	48	6	3
75S	A	1987			5	5	10	6	280	6.4	91	3.8	59	5.1	75	4	2
75S	B	2113			0	3	3	6	250	*****	****	0.6	89	0.6	89	1	1
76N	A	2526			3	3	3	12	240	5.0	184	0.4	21	2.7	103	2	2
76N	B	2775			5	5	10	12	210	6.4	161	1.5	81	4.0	121	3	2
76N	C	2783			11	5	17	9	280	20.7	82	5.0	38	12.8	60	6	3
77S	A	2849			8	5	17	6	280	12.8	87	8.2	49	10.5	68	5	2
77S	B	2986			3	8	14	18	260	1.8	28	1.4	12	1.6	20	1	2
77S	C	3198			0	3	3	27	180	*****	****	0.2	5	0.2	5	1	1
78N	A	3284			3	5	3	9	240	2.4	99	0.5	50	1.4	75	1	2
78N	B	3538			11	5	17	9	280	20.7	82	5.0	38	12.8	60	6	3
78N	C	3544			5	3	10	6	250	16.9	173	3.8	89	10.4	131	5	2
78N	D	3650			5	5	17	15	280	6.4	91	2.7	1	4.6	46	3	2
79S	A	3733			5	5	14	27	230	6.4	141	1.0	11	3.7	76	3	2
79S	B	3877			13	5	24	12	250	27.5	91	5.6	35	16.6	63	6	3
79S	C	4081			0	3	3	12	300	*****	****	0.4	-39	0.4	-39	1	1
80N	A	4279			0	3	3	21	250	*****	****	0.3	-36	0.3	-36	1	1
80N	B	4456			16	8	28	12	240	22.7	83	6.7	48	14.7	66	6	3
81S	A	4780			19	11	42	18	230	20.4	83	8.1	40	14.2	62	6	3
82N	A	5342			8	8	21	12	240	7.6	90	4.6	48	6.1	69	4	2
82N	B	5351			8	8	17	15	250	7.6	80	2.7	31	5.1	56	4	2
83S	A	294			8	11	28	18	230	5.0	64	4.5	45	4.7	55	3	2
83S	B	300			3	8	17	21	240	1.8	48	1.7	26	1.8	37	1	2

NORCEN LING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHP		AVERAGE		COND. RANGE	CAT.		
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.	ST. DEP.	ST. DEP.				
96N	A		1236		34	16	52	18	230	30.7	48	11.2	35	20.9	42	7	3
96N	B		1242		37	16	52	18	220	35.5	56	11.2	45	23.4	51	7	3
96N	C		1247		21	8	31	18	230	35.1	88	5.2	44	20.2	66	7	3
96N	D		1252		16	11	17	21	240	16.3	76	1.7	26	9.0	51	5	3
96N	E		1308		0	3	7	9	240	*****	****	1.1	77	1.1	77	1	1
97S	A		1432		0	5	7	15	240	*****	****	0.7	27	0.7	27	1	1
97S	B		1502		5	8	17	18	260	4.0	62	2.2	14	3.1	38	7	3
97S	C		1515		24	8	35	12	240	42.9	73	10.2	41	26.6	57	7	3
97S	D		1528		16	8	24	15	250	22.7	73	4.5	32	13.6	53	6	3
98N	A		1978		0	5	3	15	220	*****	****	0.3	24	0.3	24	1	1
98N	B		2077		5	8	14	18	250	4.0	72	1.4	22	2.7	47	2	3
98N	C		2100		13	11	21	12	250	12.2	66	4.6	38	8.4	52	5	3
98N	D		2112		24	11	38	12	260	27.1	28	11.6	19	19.3	24	7	3
98N	E		2123		3	8	14	15	250	1.8	38	1.9	31	1.8	35	1	2
99S	A		2283		3	5	10	15	200	2.4	139	1.1	77	1.8	108	1	2
99S	B		2300		48	13	62	18	200	73.2	73	16.6	60	44.9	67	8	3
99S	C		2302		48	13	62	18	200	73.2	73	16.6	60	44.9	67	8	3
99S	D		2318		16	8	28	18	230	22.7	93	4.5	45	13.6	69	6	3
99S	E		2337		13	11	28	18	220	12.2	96	4.5	55	8.3	76	5	3
100N	A		2866		24	16	49	21	220	18.6	61	8.5	44	13.6	53	6	3
100N	B		2873		21	8	38	12	240	35.1	78	11.6	39	23.3	59	7	3
100N	C		2892		27	11	45	15	250	34.3	40	11.3	21	22.8	31	7	3
100N	D		2894		27	18	45	9	250	18.2	26	26.9	28	22.6	27	7	3
101S	A		3066		21	11	35	15	230	23.9	80	7.5	48	15.7	64	6	3
101S	B		3082		3	5	10	21	190	2.4	149	0.9	58	1.6	104	1	3
101S	C		3093		69	26	107	34	180	48.0	64	17.7	45	32.8	55	8	3
101S	D		3099		48	24	83	37	180	31.3	82	9.7	58	20.5	70	7	3
101S	E		3103		21	18	42	27	180	12.7	95	5.0	68	8.9	82	5	3
101S	F		3291		5	3	7	15	170	16.9	253	0.7	97	8.8	175	5	3
102N	A		3666		45	24	80	31	220	27.7	43	11.3	20	19.5	32	7	3
102N	B		3669		48	21	80	27	220	37.0	44	12.6	23	24.8	34	7	3
102N	C		3671		42	21	69	31	210	29.6	57	9.3	32	19.5	45	7	3
102N	D		3690		3	5	10	18	190	2.4	149	1.0	74	1.7	112	1	3
102N	E		3695		13	11	31	15	190	12.2	126	6.1	88	9.2	107	5	3
103S	A		3863		8	5	14	9	290	12.8	77	3.6	33	8.2	55	5	3
103S	B		3883		19	11	38	15	290	20.4	23	8.9	-14	14.7	5	6	3

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	-----VHF-----				AVERAGE ST. DEP.	COND. RANGE	CAT.	
										(735 HZ) ST. DEP.	(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.	(3220 HZ) ST. DEP.				
103S	C		3887		21	13	38	18	260	19.3	27	6.8	13	13.0	20	6	3
104N	A		4390		21	16	42	24	270	15.4	14	5.6	-7	10.5	4	5	3
104N	B		4394		16	16	45	21	270	10.0	10	7.5	-4	8.8	3	5	3
104N	C		4412		11	8	24	12	260	12.2	68	5.6	25	8.9	47.	5	3
105S	A		4564		11	16	42	24	210	4.9	65	5.6	53	5.2	59	4	3
105S	B		4580		13	11	31	15	210	12.2	106	6.1	68	9.2	87	5	3
105S	C		4601		27	21	66	27	220	15.3	53	9.9	24	12.6	39	6	3
105S	D		4604		45	26	83	31	230	25.2	30	11.8	10	18.5	20	7	3
105S	E		4610		40	29	87	37	200	19.5	48	10.3	37	14.9	43	6	3
105S	F		4672		0	5	7	31	210	*****	****	0.4	4	0.4	4	1	1
105S	G		4678		0	5	7	43	200	*****	****	0.3	-11	0.3	-11	1	1
105S	H		4699		3	11	24	64	180	1.4	85	0.9	17	1.2	51	1	3
106S	A		1347		11	8	17	12	280	12.2	48	3.5	12	7.9	30	4	3
106S	B		1360		27	16	45	21	240	21.5	39	7.5	26	14.5	33	6	3
106S	C		1363		29	18	49	24	240	20.8	34	7.1	21	13.9	28	6	3
106S	D		1371		8	8	17	21	220	7.6	110	1.7	46	4.7	78	3	3
106S	E		1382		27	13	38	18	260	25.3	23	6.8	13	16.1	18	6	3
106S	F		1390		16	11	28	15	250	16.3	66	5.4	29	10.8	48	5	3
106S	G		1449		0	5	7	34	250	*****	****	0.4	-54	0.4	-54	1	1
106S	H		1454		0	8	3	40	240	*****	****	0.2	-49	0.2	-49	1	1
106S	I		1475		0	21	28	82	210	*****	****	0.9	-21	0.9	-21	1	1
106S	J		1526		0	16	17	70	230	*****	****	0.6	-40	0.6	-40	1	1
107N	A		1031		0	5	10	49	250	*****	****	0.5	-52	0.5	-52	1	1
107N	B		1034		0	5	7	40	250	*****	****	0.3	-58	0.3	-58	1	1
107N	C		1072		0	13	14	55	220	*****	****	0.6	-20	0.6	-20	1	1
107N	D		1082		0	8	3	31	210	*****	****	0.2	-28	0.2	-28	1	1
107N	E		1157		11	13	31	31	250	5.8	38	2.8	-6	4.3	16	3	3
107N	F		1175		29	11	45	12	280	40.8	8	17.0	-4	28.9	2	7	
107N	G		1178		27	11	42	12	260	34.3	30	13.6	18	24.0	24	7	
107N	H		1189		11	11	28	15	240	8.6	75	5.4	39	7.0	57	4	3
108N	A		1215		5	8	14	15	270	4.0	52	1.9	11	3.0	32	2	3
108N	B		1235		19	11	31	12	270	20.4	43	8.6	14	14.5	28	6	3
108N	C		1239		16	8	24	9	270	22.7	53	8.2	24	15.5	39	6	3
108N	D		1248		8	5	14	9	270	12.8	97	3.6	53	8.2	75	5	3
109S	A		1464		5	5	17	9	220	6.4	151	5.0	98	5.7	125	4	3
109S	B		1478		21	11	35	6	220	23.9	90	29.7	69	24.8	80	7	3
109S	C		1483		16	8	31	9	240	22.7	83	12.1	47	17.4	65	7	3
109S	D		1509		13	16	45	21	230	7.1	50	7.5	36	7.3	43	4	3

NORCEN LISBING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHP		AVERAGE ST. DEP.	COND. RANGE	CAT.			
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.						
109S	E		1600		0	8	10	40	210	*****	****	0.5	1	1	1		
109S	F		1621		3	8	10	31	220	1.8	68	0.6	4	1	2		
110N	A		2011		0	5	7	24	230	*****	****	0.5	8	1	1		
110N	B		2098		8	11	21	15	270	5.0	24	3.6	15	4.3	20	2	
110N	C		2105		3	5	10	12	250	2.4	89	1.5	41	1.9	65	1	
110N	D		2117		11	8	24	9	240	12.2	88	8.2	54	10.2	71	5	
110N	E		2126		5	5	14	12	240	6.4	131	2.5	48	4.5	90	3	
111S	A		2346		5	5	17	6	480	6.4	-109	8.2	-151	7.3	-129	4	2
111S	B		2360		5	8	17	12	230	4.0	92	3.5	62	3.8	77	3	2
111S	C		2365		3	5	14	15	190	2.4	149	1.9	91	2.1	120	3	2
111S	D		2369		5	5	14	18	180	6.4	191	1.4	92	3.9	142	3	2
111S	E		2378		11	11	31	18	230	8.6	85	5.2	44	6.9	65	4	2
111S	F		2419		0	3	7	12	230	*****	****	0.9	57	0.9	57	1	1
111S	G		2441		0	3	3	21	240	*****	****	0.3	-26	0.3	-26	1	1
112N	A		2712		0	3	7	6	210	*****	****	2.0	150	2.0	150	1	1
112N	B		2756		0	8	17	9	250	*****	****	5.0	68	5.0	68	3	1
112N	C		2934		13	16	42	21	230	7.1	50	6.3	38	6.7	44	4	3
112N	D		2941		3	8	21	21	210	1.8	78	2.4	59	2.1	69	2	2
112N	E		2944		3	11	21	24	200	1.4	65	2.0	62	1.7	64	1	2
112N	F		2949		5	11	24	18	240	3.0	55	3.6	38	3.3	47	3	2
113S	A		3153		3	8	14	12	220	1.8	68	2.5	68	2.2	68	2	2
113S	B		3164		5	8	17	15	170	4.0	152	2.7	111	3.4	132	3	2
113S	C		3167		5	11	17	15	180	3.0	115	2.7	101	2.9	108	2	2
113S	D		3174		24	24	62	31	210	11.4	55	7.9	34	9.7	45	5	2
113S	E		3180		3	5	10	21	210	2.4	129	0.9	38	1.6	84	1	2
113S	F	3414	3418	3426	3	11	17	21	170	1.4	95	1.7	96	1.6	96	1	2
114N	A		3561		3	8	10	15	260	1.8	28	1.1	17	1.4	23	1	2
114N	B		3746		19	18	52	31	220	10.6	54	5.8	25	8.2	40	5	2
114N	C		3752		8	11	28	24	260	5.0	34	3.1	6	4.0	20	3	2
114N	D		3758		3	8	14	21	190	1.8	98	1.2	71	1.5	65	1	2
114N	E		3762		3	8	14	18	250	1.8	38	1.4	22	1.6	30	1	2
115S	A		3922		3	5	14	21	170	2.4	169	1.2	91	1.8	130	1	2
115S	B		3928		3	11	24	34	170	1.4	95	1.7	72	1.6	84	1	2
115S	C		3931		3	11	24	37	180	1.4	85	1.5	59	1.5	72	1	2
115S	D		3934		3	11	24	31	210	1.4	55	1.9	34	1.7	45	1	2
115S	E		3938		8	13	28	37	210	4.1	73	1.9	29	3.0	51	3	2
115S	F		3944		16	18	42	27	210	8.1	63	5.0	38	6.6	51	4	2
115S	G		3948		16	18	45	31	220	8.1	53	4.9	26	6.5	40	4	3

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHP		AVERAGE		COND. RANGE	CAT.
										(735 ST.)	(HZ) DEP.	(3220 ST.)	(HZ) DEP.		
115S	H		4020		0	3	3	24	180	*****	****	0.3	8	1	1
115S	I	4208	4214	4220	0	5	10	15	190	*****	****	1.1	87	1	1
116N	A		285		0	8	14	18	260	*****	****	1.4	12	1	1
116N	B		289		0	8	14	18	260	*****	****	1.4	12	1	1
116N	C		302		3	5	3	27	210	2.4	129	0.2	-25	1	2
116N	D		311		0	8	3	24	200	*****	****	0.3	-12	1	1
116N	E		503		3	8	24	24	250	1.8	38	2.6	14	2	2
116N	F		508		0	8	21	21	240	*****	****	2.4	29	2	1
116N	G		572		0	3	7	21	260	*****	****	0.6	-14	1	1
117S	A		706		0	11	24	37	230	*****	****	1.5	9	1	1
117S	B		713		3	13	35	43	230	1.3	12	2.2	6	1	2
117S	C		718		0	8	17	31	240	*****	****	1.1	0	1	1
117S	D		794		0	5	7	18	270	*****	****	0.6	-17	1	1
117S	E		959		0	8	17	18	240	*****	****	2.2	34	2	1
117S	F		963		0	5	17	18	230	*****	****	2.2	44	2	1
118N	A		1087		0	8	14	21	240	*****	****	1.2	21	1	1
118N	B		1090		0	11	17	21	250	*****	****	1.7	16	1	1
118N	C		1237		0	3	3	15	300	*****	****	0.3	-56	1	1
118N	D		1303		0	8	14	31	270	*****	****	0.9	-32	1	1
118N	E		1309		0	5	10	18	280	*****	****	1.0	-16	1	1
119S	A		1481		0	3	7	6	280	*****	****	2.0	80	1	1
119S	B		1556		0	3	7	21	270	*****	****	0.6	-24	1	1
119S	C		1593		0	5	7	34	230	*****	****	0.4	-34	1	1
119S	D		1732		3	8	14	24	240	1.8	48	1.1	4	1	2
119S	E		1737		0	11	17	24	230	*****	****	1.4	21	1	1
120N	A		104		0	11	17	27	220	*****	****	1.2	22	1	1
120N	B		219		0	5	3	31	260	*****	****	0.2	-78	1	1
120N	C		260		0	3	7	15	320	*****	****	0.7	-53	1	1
120N	D		326		0	3	7	18	230	*****	****	0.6	23	1	1
121S	A		583		0	5	10	31	260	*****	****	0.6	-36	1	1
121S	B		636		0	8	7	49	210	*****	****	0.3	-27	1	1
121S	C		771		-2	11	17	27	240	*****	****	1.2	2	1	0
121S	D		778		-2	13	24	40	200	*****	****	1.3	35	1	0
122N	A		927		-2	13	17	34	210	*****	****	1.1	27	1	0
122N	B		932		-2	13	14	34	230	*****	****	0.9	1	1	0
122N	C		1041		0	3	3	18	260	*****	****	0.3	-24	1	1

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHP		AVERAGE ST. DEP.	COND. RANGE	CAT.	
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.				
122N	D		1059		0	11	17	76	200	*****	****	0.6	-14	1	1
122N	E		1063		0	13	17	79	190	*****	****	0.6	-7	1	1
122N	F		1084		3	5	7	24	230	2.4	109	0.5	8	1	2
123S	A		1360		0	3	7	18	270	*****	****	0.6	-17	1	1
123S	B		1553		-2	16	28	43	220	*****	****	1.5	2	*	0
123S	C		1559		-2	18	35	49	210	*****	****	1.9	9	*	0
125N	A		1683		-2	11	17	18	280	*****	****	2.2	-6	*	0
125N	B		1688		-2	13	21	18	290	*****	****	2.9	-15	*	0
125N	C		1874		0	5	3	24	280	*****	****	0.3	-92	1	1
127S	A		1991		3	3	3	6	280	5.0	144	0.6	59	2	2
127S	B		2328		-2	11	14	27	230	*****	****	1.0	11	*	0
127S	C		2332		-2	8	7	18	240	*****	****	0.6	13	*	0
129N	A		219		3	5	10	15	300	2.4	39	1.1	-23	1	2
129N	B		418		0	5	10	18	260	*****	****	1.0	4	1	1
129N	C		421		0	3	10	15	260	*****	****	1.1	17	1	1
129N	D		440		0	5	10	18	260	*****	****	1.0	4	1	1
129N	E		456		3	5	10	12	270	2.4	69	1.5	21	1	2
131S	A		729		0	5	7	24	260	*****	****	0.5	-22	1	1
131S	B		733		0	5	7	24	260	*****	****	0.5	-22	1	1
131S	C		859		3	8	21	24	250	1.8	38	2.0	12	1	2
131S	D		889		0	3	3	9	220	*****	****	0.5	70	1	1
133N	A		1001		0	3	7	18	260	*****	****	0.6	-7	1	1
133N	B		1207		0	3	3	21	240	*****	****	0.3	-26	1	1
135S	A		1321		3	8	7	31	270	1.8	18	0.4	-56	1	2
137N	A		1687		0	3	7	12	320	*****	****	0.9	-33	1	1
139S	A		1714		0	5	7	9	250	*****	****	1.1	67	1	1
139S	B		1769		0	5	10	9	270	*****	****	2.3	52	2	1
139S	C		1789		0	5	7	21	290	*****	****	0.6	-44	1	1
139S	D		1795		0	5	7	24	280	*****	****	0.5	-42	1	1
141N	A		2092		0	3	3	12	300	*****	****	0.4	-39	1	1
143S	A		2224		0	3	7	27	260	*****	****	0.5	-42	1	1

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

145N	A	2584	0	3	3	9	250	*****	****	0.5	40	0.5	40	1	1		
147S	A	2654	0	8	10	31	250	*****	****	0.6	-26	0.6	-26	1	1		
147S	B	2661	0	5	7	24	250	*****	****	0.5	-12	0.5	-12	1	1		
149N	A	2953	2963	2970	0	3	7	18	240	*****	****	0.6	13	0.6	13	1	1
149N	B	3014	3025	3029	0	8	10	15	260	*****	****	1.1	17	1.1	17	1	1
151N	A	3410	3416	3426	0	8	7	34	260	*****	****	0.4	-64	0.4	-64	1	1
151N	B	3447			0	8	10	24	270	*****	****	0.8	-26	0.8	-26	1	1
153S	A	3470			0	8	7	12	270	*****	****	0.9	17	0.9	17	1	1
153S	B	3520			3	8	10	27	250	1.8	38	0.7	-11	1.2	14	1	2
155N	A	3827			3	5	7	9	290	2.4	49	1.1	27	1.7	38	1	2
155N	B	3856			3	3	3	12	290	5.0	134	0.4	-29	2.7	53	2	2
MTLE	A	3890			3	5	7	18	270	2.4	69	0.6	-17	1.5	26	1	2
MTLE	B	3937			0	5	7	18	300	*****	****	0.6	-47	0.6	-47	1	1
MTLE	C	3964			0	5	7	24	300	*****	****	0.5	-62	0.5	-62	1	1
MTLE	D	3971			0	5	3	18	300	*****	****	0.3	-64	0.3	-64	1	1
MTLE	E	4063			3	5	7	12	310	2.4	29	0.9	-23	1.6	3	1	2
MTLE	F	4123			13	3	24	3	310	79.0	61	45.9	17	62.5	29	8	3
MTLE	G	4126			13	3	24	3	320	79.0	51	45.9	7	62.5	29	8	3
MTLE	H	4138			13	5	24	6	290	27.5	51	14.7	28	21.1	40	7	3
MTLE	I	4143			13	5	24	6	290	27.5	51	14.7	28	21.1	40	7	3
MTLE	J	4298			5	8	24	9	240	4.0	82	8.2	54	6.1	68	4	4
MTLE	K	4307			8	11	24	18	290	5.0	4	3.6	-12	4.3	-3	3	2
MTLE	L	4397			3	3	7	9	230	5.0	194	1.1	87	3.0	141	3	2
MTLW	A	203			3	3	7	18	240	5.0	184	0.6	13	2.8	99	2	2
MTLW	B	319			0	5	0	18	270	*****	****	*****	****	*****	****	*	1
MTLW	C	353	364	375	0	8	0	27	260	*****	****	*****	****	*****	****	*	1
MTLW	D	906			0	3	0	12	250	*****	****	*****	****	*****	****	*	1

APPENDIX 5

Archive Tape Description

The following is a summary of the archive tape format containing raw and processed magnetic, altimeter and HEM data.

 ARCHIVE. JOB T2082.
 NORCEN
 MATACH AREA
 JANUARY 1981

1 2400-FOOT TAPE VOLUME.
 4 TAPE FILES.
 3 SHEETS.

FILE	SHEET	BLOCKS	LINES
====	====	=====	=====
1	1	1696	1-46
2	2	2708	47-108
3	3	1049	109-155
4	TL	151	901-902

FILE FORMAT.

DENSITY - 1600 BPI
 RECFM=FB
 LRECL=240
 BLKSTZF=4800

DATA FORMAT.

40 FIELDS PER LOGICAL RECORD.
 EBCDIC
 FORMAT (40T6)

DATA SAMPLING.

GENERALLY, 0.5 SECOND.
 MAGNETICS, 1 SECOND.
 HEM TIME CONSTANT, 0.5 SECOND.

RECORD CONTENT.

WORD	DESCRIPTION	UNITS
====	=====	=====
1	LINE NUMBER	
2	FLIGHT NUMBER	
3	FIDUCIAL NUMBER	
4	X-COORDINATE	0.001 INCHES
5	Y-COORDINATE	0.001 INCHES
6	SPARE	
7	TIME	24 HOUR CLOCK
8	RAW MAGNETICS	GAMMAS
9-12	SPARE	
13	RAW ALTIMETER	FEET
14	RAW HEM LOW FREQ, INPHASE	MV
15	RAW HEM LOW FREQ, O.P.	MV
16	RAW HEM HIGH FREQ, I.P.	MV
17	RAW HEM HIGH FREQ, O.P.	MV

1A	MARINER EASTING	METERS
1B	MARINER NORTHING	METERS
20	FINAL MAGNETICS	0.1 GAMMAS
21-28	SPARE	
29-32	FINAL HFM	0.1 PPM
33-35	SPARE	
36	HFM QUAD MINIMUM FLAG	(0,1)
37-40	SPARE	

NOTE : DEFAULT CODE = 0
 FINAL MAG FIELD CONTAINS DFAULT UNTIL VALUE UPDATE.

ISSUED - MAY 6/81 M. CONRON, DATAPLOTTING SERVICES

NOTE: Processing of the raw HEM data involved the following steps:

- 1) First, as the HEM is recorded in mV, the raw data was converted into ppm. This was done by dividing all channels of HEM data by 3.38 ppm/mV. This constant is an average obtained from the calibration sequences.
- 2) Each flight line is then scanned for a weighted minimum point of the HEM channels. (Minimum point can sometimes be selected erroneously due to noise or slow drift on line.)
- 3) Each HEM channel is then D.C. shifted to such that this "minimum" point has the following values:
 - 1 ppm for the 735 IP channel
 - 2 ppm for the 735 Q channel
 - 2 ppm for the 3220 IP channel
 - 7 ppm for the 3220 Q channel

These values represent the geophysical response expected from a 4000 ohm-meter homogeneous earth.

LINE	FLIGHT	START-FID	END-FID	RECORDS	MIN. FID	PICKED	BLOCK
1	2	89	449	720	140	0	1
2	2	449	829	760	520	0	37
3	2	829	1165	672	909	0	75
4	2	1165	1515	700	1480	0	108
5	2	1515	1829	628	1545	0	143
6	2	1829	2161	664	1886	0	175
7	3	115	554	878	554	0	208
8	3	554	848	588	815	0	252
9	3	848	1246	796	1213	0	281
10	3	1246	1575	658	1537	0	321
11	3	1575	2018	886	1995	0	354
12	4	76	391	630	163	0	398
13	4	391	726	670	413	0	430
14	4	726	1041	630	784	0	463
15	4	1041	1387	692	1091	0	495
16	4	1387	1687	600	1408	0	529
17	4	1687	2030	686	1688	0	559
18	5	100	435	670	420	0	593
19	5	435	819	768	788	0	627
20	5	819	1191	744	1116	0	665
21	5	1191	1593	804	1562	0	703
22	5	1593	2012	838	1927	0	743
23	5	2012	2381	738	2361	0	785
24	5	2381	2762	762	2700	0	822
25	5	2762	3099	674	3085	0	860
26	5	3137	3496	719	3418	0	893
27	5	3496	3869	746	3860	0	929
28	5	3869	4242	746	4169	0	967
29	5	4242	4618	752	4562	0	1004
30	18	2829	3129	600	2914	0	1041
31	18	2489	2829	680	2489	0	1071
32	6	864	1238	748	864	0	1105
33	6	1238	1613	750	1247	0	1143
34	6	1642	2035	786	1642	0	1180
35	6	2035	2429	788	2035	0	1220
36	6	2429	2813	768	2470	0	1259
37	6	2850	3267	834	2857	0	1297
38	6	3267	3664	794	3298	0	1339
39	6	3664	4061	794	4031	0	1379
40	6	4061	4448	774	4117	0	1419
41	6	4448	4859	822	4495	0	1457
42	7	74	470	792	126	0	1498
43	7	470	873	806	500	0	1538
44	7	873	1247	748	918	0	1578
45	7	1247	1661	828	1254	0	1616
46	7	1661	2052	782	1714	0	1657

ARCHIVE, OUTPUT TAPE BLOCKS= 1696

PUT IS *ERCDIC*

LINE	FLIGHT	START-FID	END-FID	RECORDS	MIN. FID	PICKED	BLOCK
47	7	2052	2480	856	2461	0	1
48	7	2480	2880	800	2528	0	43
49	7	2880	3315	870	3297	0	83
50	7	3315	3702	774	3328	0	127
51	7	3702	4123	842	3736	0	166
52	7	4123	4524	802	4157	0	208
53	7	4524	4957	866	4948	0	248
54	7	4996	5383	775	5025	0	291
55	7	5383	5819	872	5624	0	330
56	8	139	521	764	179	0	373
57	8	521	985	928	945	0	412
58	8	985	1405	840	1008	0	458
59	8	1405	1892	974	1849	0	500
60	8	1892	2305	826	2304	0	549
61	8	2305	2826	1042	2377	0	590
62	8	2826	3244	836	3152	0	642
63	8	3244	3754	1020	3442	0	684
64	8	3754	4159	810	4014	0	735
65	8	4159	4687	1056	4393	0	775
66	8	4687	5106	838	4925	0	828
67	8	5106	5642	1072	5364	0	870
68	9	77	486	818	95	0	924
69	9	486	1008	1044	780	0	965
70	9	1008	1436	856	1196	0	1017
71	12	127	654	1054	322	0	1060
72	12	654	1047	786	903	0	1112
73	12	1047	1555	1016	1215	0	1152
74	12	1555	1950	790	1852	0	1202
75	12	1950	2423	946	2058	0	1242
76	12	2423	2812	778	2714	0	1289
77	12	2812	3274	924	2918	0	1328
78	12	3274	3692	836	3602	0	1374
79	12	3692	4180	976	3758	0	1416
80	12	4180	4599	838	4547	0	1465
81	12	4599	5092	986	4625	0	1507
82	12	5092	5492	800	5457	0	1556
83	13	105	644	1078	114	0	1596
84	13	644	1053	818	1050	0	1650
85	13	1053	1601	1096	1079	0	1691
86	13	1601	2009	816	2008	0	1746
87	13	2009	2549	1080	2499	0	1786
88	13	2549	2973	853	2956	0	1840
89	13	2973	3539	1132	3522	0	1883
90	13	3539	3919	760	3900	0	1940
91	13	3919	4456	1074	3925	0	1978
92	18	2061	2489	856	2086	0	2031
93	18	1669	2061	784	2060	0	2074
94	14	99	489	780	123	0	2113
95	14	489	986	994	504	0	2152
96	14	986	1360	748	1003	0	2202
97	14	1360	1835	950	1395	0	2240
98	14	1835	2192	714	1846	0	2287
99	14	2192	2623	862	2583	0	2323
100	14	2623	2964	682	2793	0	2366
101	14	2964	3399	870	2968	0	2400
102	14	3399	3765	732	3443	0	2443
103	14	3765	4169	808	3765	0	2480
104	14	4169	4478	618	4203	0	2520
105	14	4478	4914	872	4480	0	2551
106	18	1259	1669	820	1261	0	2595
107	18	909	1259	700	937	0	2636
108	18	959	1372	740	1181	0	2677

ARCHIVE BASE DB0093

24

(File 3)

LINE	FLIGHT	START-FID	END-FID	RECORDS	MIN. FID	PICKED	BLOCK
109	15	1332	1836	1008	1387	0	1
110	15	1836	2215	758	1873	0	51
111	15	2215	2683	936	2230	0	89
112	15	2686	3019	667	2778	0	136
113	15	3019	3493	948	3030	0	169
114	15	3493	3824	662	3604	0	216
115	15	3824	4305	962	4103	0	249
116	16	220	583	731	397	0	298
117	16	583	1023	880	605	0	334
118	16	1023	1382	718	1053	0	378
119	16	1382	1797	830	1383	0	414
120	16	1	399	797	248	0	456
121	16	399	849	900	801	0	495
122	16	849	1219	740	903	0	540
123	16	1219	1619	800	1512	0	577
125	16	1619	1990	742	1957	0	617
127	16	1990	2399	818	2151	0	654
129	17	109	509	800	201	0	695
131	17	509	938	858	514	0	735
133	17	938	1299	722	983	0	778
135	17	1299	1506	414	1481	0	814
137	17	1506	1703	394	1539	0	835
139	17	1703	1967	528	1937	0	855
141	17	1967	2156	378	2057	0	881
143	17	2156	2367	422	2324	0	900
145	17	2367	2604	474	2391	0	921
147	17	2604	2829	450	2765	0	945
149	17	2829	3029	400	2837	0	967
151	17	3250	3463	430	3279	0	987
153	17	3463	3685	444	3660	0	1009
155	17	3685	3869	368	3736	0	1031

ARCHIVE. OUTPUT TAPE BLOCKS= 1049

OUTPUT IS *ERCDIC*

ARCHIVE BASE DB0093

24

(File 4)

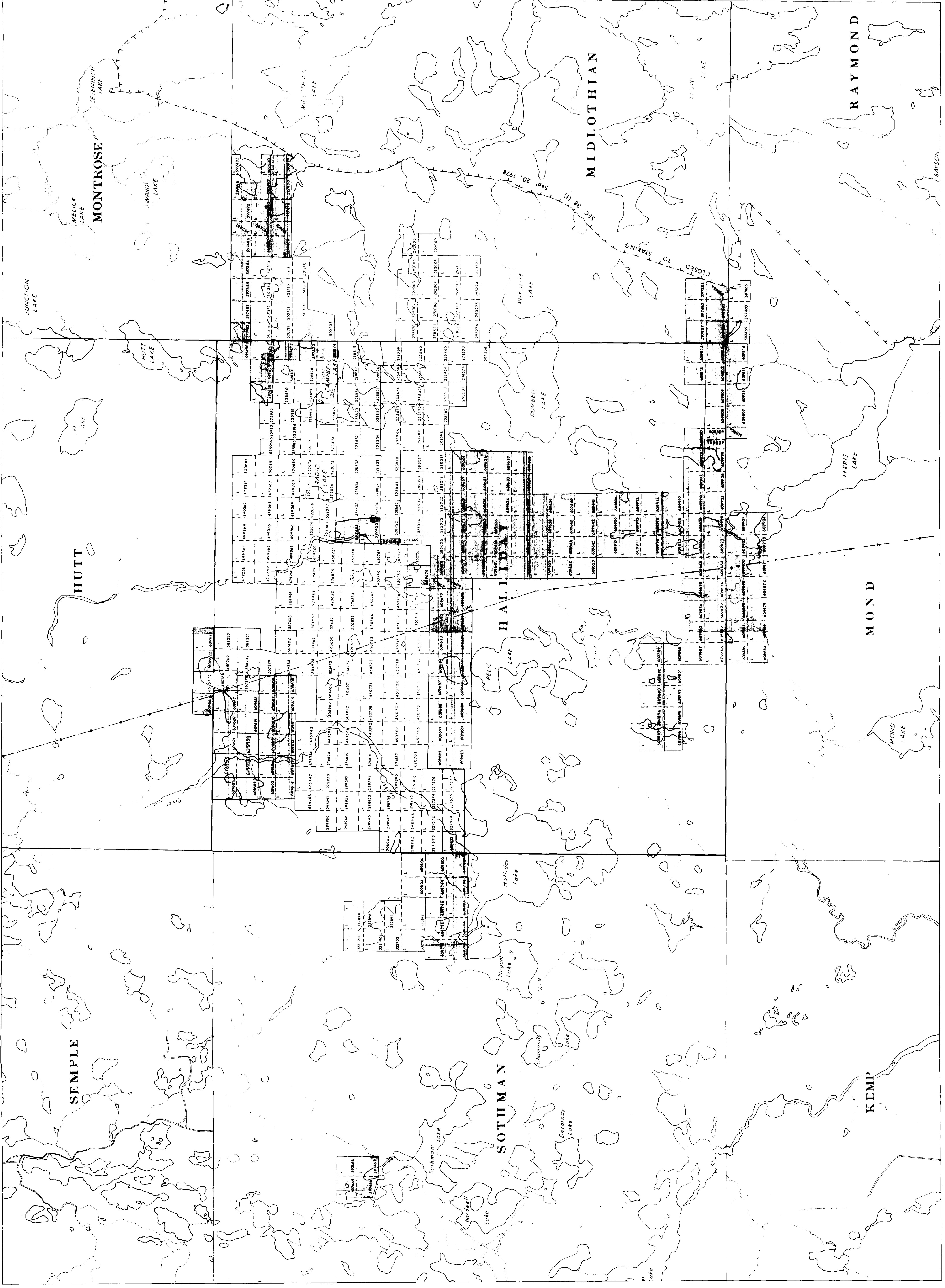
LINE	FLIGHT	START-FID	END-FID	RECORDS	MIN. FID	PICKED	BLOCK
901	17	3869	4569	1400	4227	0	1
902	18	100	909	1618	103	0	71

ARCHIVE. OUTPUT TAPE BLOCKS= 151

OUTPUT IS *ERCDIC*

NORCEN LISTING - HALLIDAY TOWNSHIP AREA -

LINE NO.	POS.	FROM FID.	PEAK LOC.	TO FID.	735 IP PPM	735 Q PPM	3220 IP PPM	3220 Q PPM	ALT. (FT)	VHF		AVERAGE		COND. RANGE	CAT.		
										(735 HZ) ST. DEP.	(3220 HZ) ST. DEP.	ST. DEP.	ST. DEP.				
73S	B	1094			13	8	21	6	240	17.6	88	10.9	82	14.2	85	6	3
73S	C	1256			0	8	14	15	260	*****	****	1.9	21	1.9	21	1	1
73S	D	1455			0	5	3	31	220	*****	****	0.2	-38	0.2	-38	1	1
73S	E	1520			3	5	10	15	210	2.4	129	1.1	67	1.8	98	1	2
74N	A	1571			3	3	3	18	250	5.0	174	0.3	-14	2.6	80	2	2
74N	B	1822			0	5	7	12	240	*****	****	0.9	47	0.9	47	1	1
74N	C	1922			11	5	21	9	290	20.7	72	6.1	24	13.4	48	6	3
75S	A	1987			5	5	10	6	280	6.4	91	3.8	59	5.1	75	4	2
75S	B	2113			0	3	13	6	250	*****	****	0.6	89	0.6	89	1	1
76N	A	2526			3	3	3	12	240	5.0	184	0.4	21	2.7	103	2	2
76N	B	2775			5	5	10	12	210	6.4	161	1.5	81	4.0	121	3	2
76N	C	2783			11	5	17	9	280	20.7	82	5.0	38	12.8	60	6	3
77S	A	2849			8	5	17	6	280	12.8	87	8.2	49	10.5	68	5	2
77S	B	2986			3	8	14	18	260	1.8	28	1.4	12	1.6	20	1	2
77S	C	3198			0	3	3	27	180	*****	****	0.2	5	0.2	5	1	1
78N	A	3284			3	5	3	9	240	2.4	99	0.5	50	1.4	75	1	2
78N	B	3538			11	5	17	9	280	20.7	82	5.0	38	12.8	60	6	3
78N	C	3544			5	3	10	6	250	16.9	173	3.8	89	10.4	131	5	2
78N	D	3650			5	5	17	15	280	6.4	91	2.7	1	4.6	46	3	2
79S	A	3733			5	5	14	27	230	6.4	141	1.0	11	3.7	76	3	2
79S	B	3877			13	5	24	12	250	27.5	91	5.6	35	16.6	63	6	3
79S	C	4081			0	3	3	12	300	*****	****	0.4	-39	0.4	-39	1	1
80N	A	4279			0	3	3	21	250	*****	****	0.3	-36	0.3	-36	1	1
80N	B	4456			16	8	28	12	240	22.7	83	6.7	48	14.7	66	6	3
81S	A	4780			19	11	42	18	230	20.4	83	8.1	40	14.2	62	6	3
82N	A	5342			8	8	21	12	240	7.6	90	4.6	48	6.1	69	4	2
82N	B	5351			8	8	17	15	250	7.6	80	2.7	31	5.1	56	4	2
83S	A	294			8	11	28	18	230	5.0	64	4.5	45	4.7	55	3	2
83S	B	300			3	8	17	21	240	1.8	48	1.7	26	1.8	37	1	2



SEMPLE TWP
SOTHMAN TWP

CORK
LAKE

READING

LAKE

BARDWELL

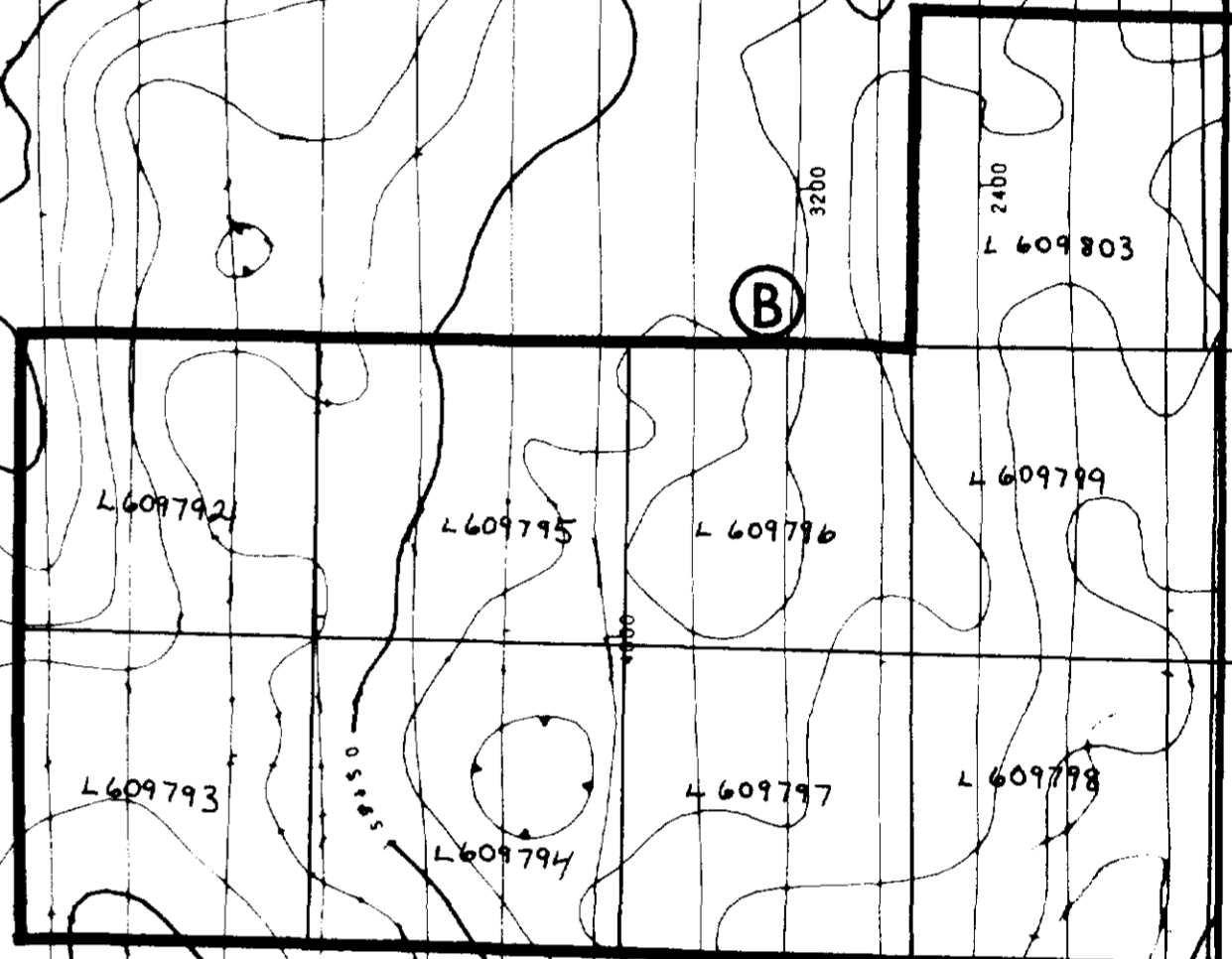
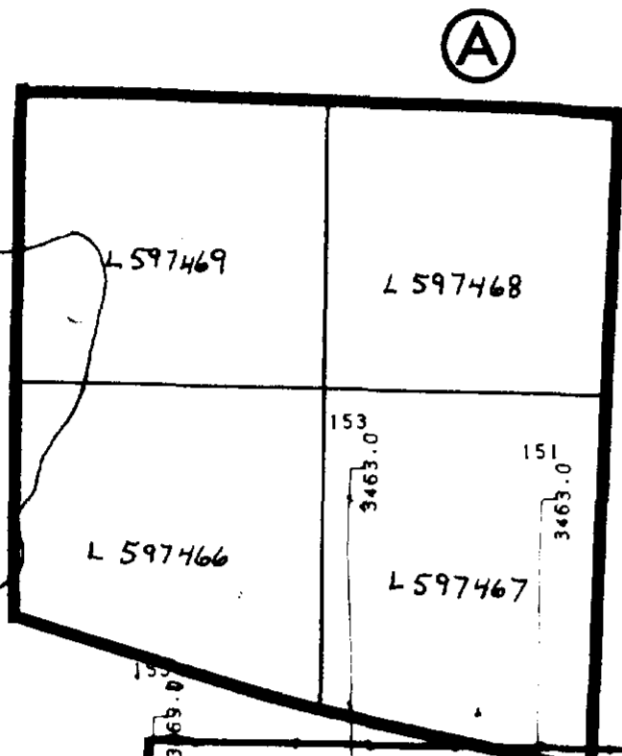
LAKE

LOONWING

LAKE

SOTHMAN TWP
KEMP TWP

GRASSY



- LEGEND**
- FLIGHT LINE
 - 25 - LINE NUMBER
 - FOCAL NUMBER
 - ROW FIDUCIAL POINT
 - ROAD OR TRACK
 - SURVEY BOUNDARY
 - NEAR FLIGHT LINE SPACING 25, 50 METERS
 - MEAN SENSOR ALTITUDE 50 METERS
 - MINIMUM CONTOUR INTERVAL 10 GAMMAS



PLATE 1 M

NORCEN ENERGY RESOURCES LIMITED
HALLIDAY TOWNSHIP AREA
ONTARIO

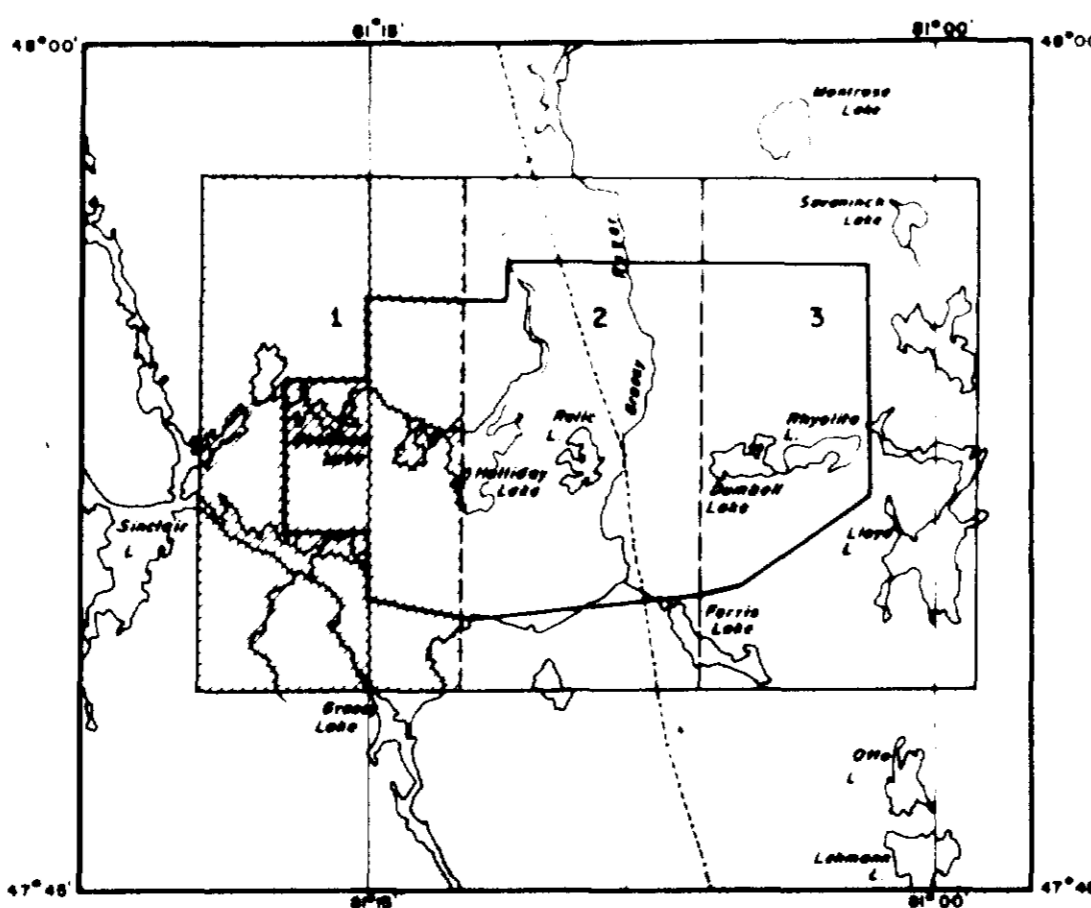
AIRBORNE GEOPHYSICAL SURVEY

SCINTREX HEM-802 ELECTROMAGNETIC SYSTEM
SCINTREX MAP-A MAGNETOMETER
RADAR RANGING NAVIGATION

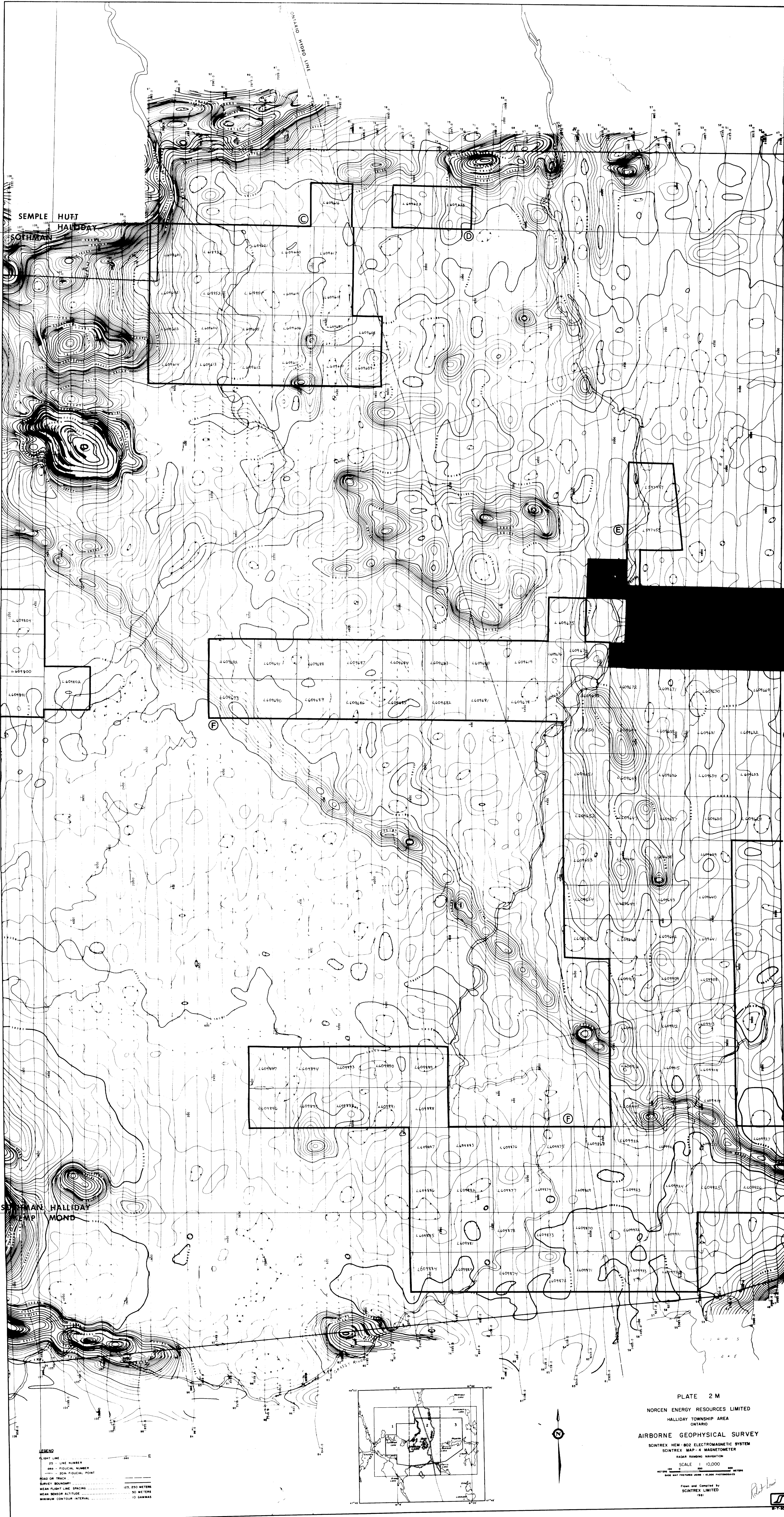
SCALE 1:10,000

METERS 0 100 200 METERS
BASE MAP PREPARED USING 1:50,000 PHOTOGRAPHS

Planned and Compiled by
SCINTREX LIMITED



Robert Lewis



SEMPLER HUTT
HALLIDAY
SOBHAMAN

HUTT TWP
HALLIDAY TWP

SEMPLER MOND
HALLIDAY

HALLIDAY
MOND

LEGEND
 LIGHT LINE 25 - LINE NUMBER
 400 - FIDUCIAL NUMBER
 20M FIDUCIAL POINT
 ROAD ON TRACK
 SURVEY BOUNDARY
 MEAN FLIGHT LINE SPACING 125 METERS
 MEAN MENSUR ALTITUDE 50 METERS
 MINIMUM CONTOUR INTERVAL 10 METERS

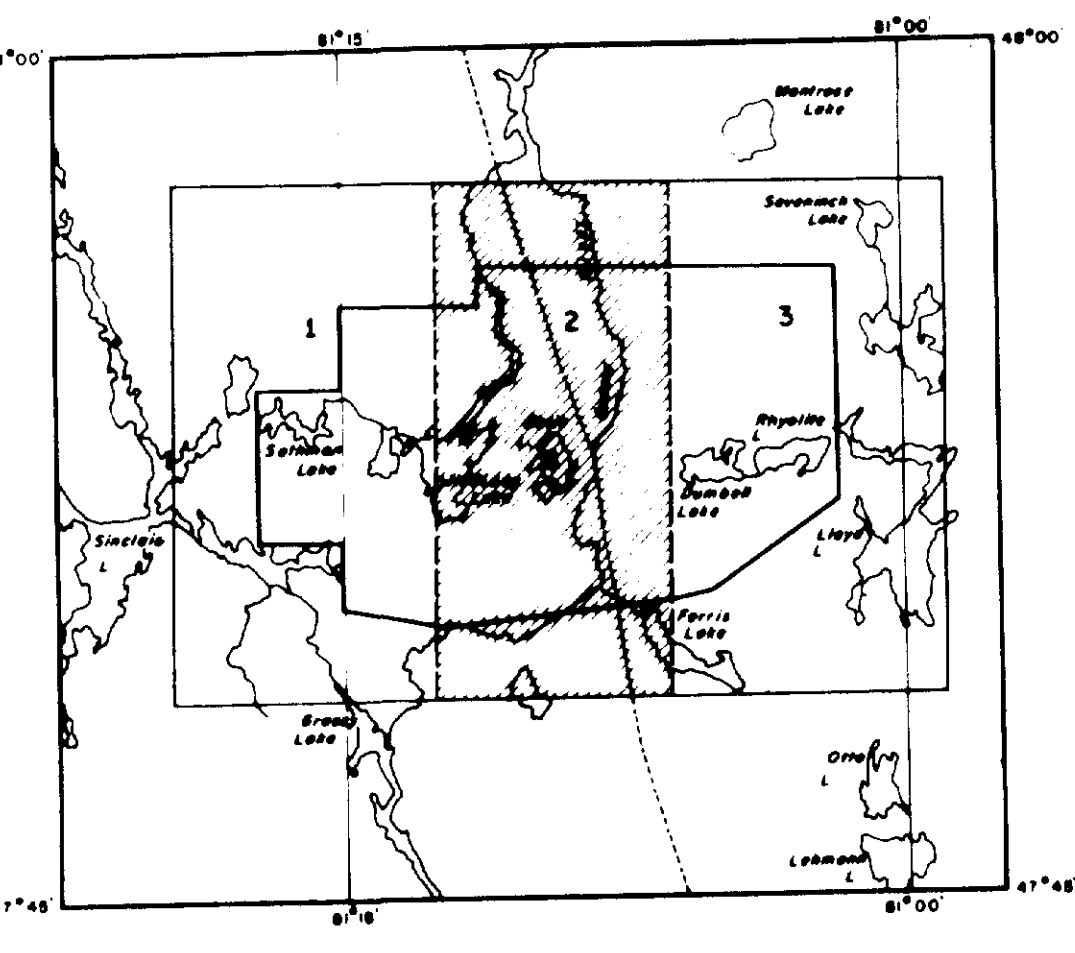


PLATE 2 M
 NORCEN ENERGY RESOURCES LIMITED
 HALLIDAY TOWNSHIP AREA
 ONTARIO
 AIRBORNE GEOPHYSICAL SURVEY
 SCINTREX HEM-802 ELECTROMAGNETIC SYSTEM
 SCINTREX MAP-4 MAGNETOMETER
 RADAR RANGING DEVIATION
 SCALE 10,000
 METERS
 HORIZONTAL METERS
 VERTICAL METERS
 DATE MAP PREPARED UNDER 10,000 PERFORMANCE
 Drawn and Compiled by
 SCINTREX LIMITED
 1981



HUTT
HALLIDAY
MONTROSE

MONTROSE
MIDLOTHIAN

MIDLOTHIAN

MOND RAYMOND

LEGEND
 FLIGHT LINE _____
 25 - LINE NUMBER
 200 - FOCAL NUMBER
 200 - 200 M. FOCAL POINT
 ROAD OR TRACK _____
 SURVEY BOUNDARY _____
 NEAR FLIGHT LINE SPACING _____ 125, 250 METERS
 NEAR SENSOR ALTITUDE _____ 50 METERS
 MINIMUM CONTOUR INTERVAL _____ 10 METERS

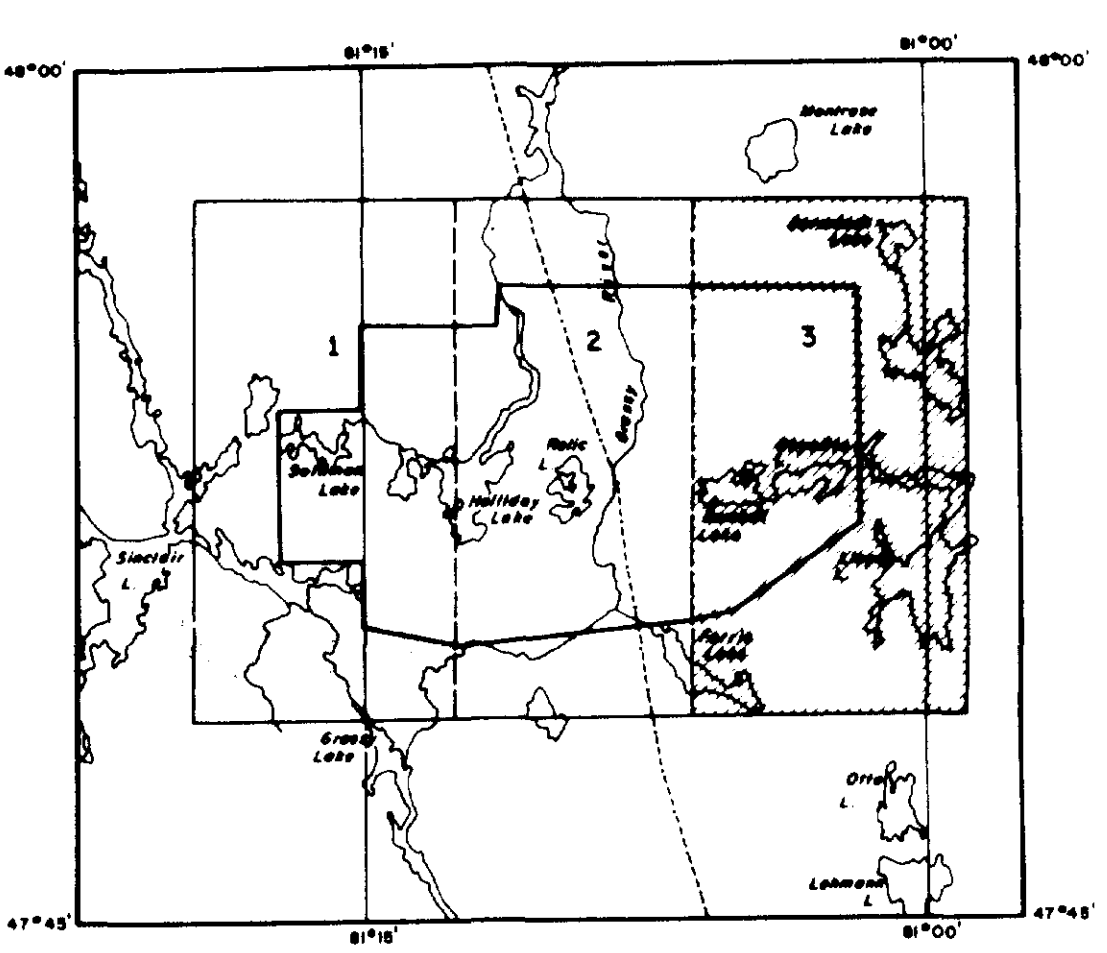


PLATE 3 M
 NORCEN ENERGY RESOURCES LIMITED
 HALLIDAY TOWNSHIP AREA
 ONTARIO
AIRBORNE GEOPHYSICAL SURVEY
 SCINTREX HEM-802 ELECTROMAGNETIC SYSTEM
 SCINTREX MAP-4 MAGNETOMETER
 RADAR RANGING NAVIGATION
 SCALE 1:10,000
 METERS TO FEET
 1:10,000
 1:10,000
 1:10,000
 FROM AND COMPILED BY
 SCINTREX LIMITED
 1981