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INTRODUCTION

Between July 21st and July 23rd, 1964, a helicopter-borne electromagnetic survey was carried out over an area of approximately 24 square miles in Oke Township, Ontario. The area measured 6 miles in an east-west direction and 4 miles in a north-south direction, enclosing a group of claims previously staked by the participants in the survey.

Although Huntec Limited acted as prime contractor on this work and provided supervision and consulting services, the actual surveying was done by an associated company, Hunting Survey Corporation Limited. A Bell 47G-4B helicopter was provided by Kenting Aviation Limited, another associated company. Pilot and engineer were Messrs. Hort and Miller respectively. The geophysical operator was Mr. Harold Sandau. Consulting was done by Mr. J. Lloyd and the writer. Mr. Keith Benner represented Mid-North Engineering Services and Goldray Mines, and was present throughout the survey work.

The electromagnetic instrument used was the Hunting In-Phase, Out-Of-Phase equipment mounted in a 30-foot "bird" and operating at 4000 cycles per second. The helicopter was equipped with a radio-altimeter model APN-1, providing a continuous record of height above ground. The path of the aircraft was recorded by means of 35 millimeter photography exposed continuously during flight. The aircraft was navigated by the geophysical operator from an enlargement of existing aerial photographs of the area. An attempt was made to fly evenly spaced lines, 400 feet apart in a north-south direction across the area.

Unfortunately, the extremely featureless terrain made such regular traverses impossible and several gaps of up to 1600 feet were experienced locally. Nevertheless, 72 lines were flown in a north-south direction, with an average length of 4 miles. In addition, 8 east-west lines were flown in the west part of the area, with an average length of 3 miles. Mean aircraft height was maintained at 200 feet above ground. The "bird" was carried 100 feet below the helicopter, namely at a mean height of 100 feet above ground.

The data resulting from this survey are presented in the following form:

1. Helicopter-borne Electromagnetic Survey map "Electromagnetic Anomalies and Interpretation" at a scale of 1 inch to 800 feet. Prints in map pocket. Original provided to Mid-North Engineering Services.
2. Original electromagnetic profiles supplied to Mid-North Engineering Services.
3. Original radio-altimeter record supplied to Mid-North Engineering Services.
4. 35 millimeter positioning film supplied to Mid-North Engineering Services.

In addition to the above data, and at the request of the participants, a reproduction was made of the published aeromagnetic data of Oke Township. This was done at a scale of approximately 1 inch to 800 feet in order to fit as closely as possible to the E.M. map. Prints of this map are provided in the map pocket. Transparencies have been prepared for both participants.

SUMMARY

10 anomaly groups of interest have been detected by the E.M. survey. Of these, 4 lie outside the ground held by the participants, though it is understood that one of these has since been acquired. Anomaly A6 straddles the property boundary.

A large number of 1-line anomalies are scattered elsewhere through the area. None of these are considered sufficiently strong to be considered worthy of further investigation at the present time.

With the exception of anomaly groups A6 and A7, all of the main anomalies appear to be associated with basic or ultra-basic rocks, probably intrusives. Anomaly groups A1 to A5 inclusive, A8 and A9 are associated with a band of strong magnetic anomalies, most probably related to ultra-basic intrusives. Anomaly group A10 seems to be associated with a smaller band of intermediate to basic intrusive or volcanic rocks.

Not all of the conductors interpreted on this survey are expected to be related to metallic mineralization. In particular, those given an E.M. grade C could very well be caused by combinations of conductive overburden and local bedrock conditions. In this area the overburden is found to be more conductive in the vicinity of basic and ultra-basic rocks. A large number of out-of-phase anomalies were recorded in the survey area, and these have not been shown on the E.M. map. Those remaining are considered to have moderate to good prospects of association with metallic conductors.

The anomaly groups of interest are listed as follows in the order in which the writer places their importance as base metal prospects:

ANOMALY GROUP	PRIORITY
A9	1
A1	2
A2	3
A5	4
A4	5
A3	6
A10	7
A6	8
A8	9
A7	10

It is recommended that ground geophysical work be carried out on the above anomaly groups in order of priority, considering of course the property ownership. Ground geophysical work should consist of spot seismic depth determinations, followed by a suitable ground electromagnetic method, with ground magnetometer profiles or groups of profiles over the centers of conductivity. If encouraging results are obtained from this program, the conductors should be investigated by trenching or drilling.

REDUCTION OF DATA

The E.M. data are recorded in the form of profiles of in-phase and out-of-phase response on curvilinear Esterline Angus chart paper at a scale of 400 parts per million full scale. Each small division on the chart represents a secondary field strength of 8 parts per million referred to the primary field at the receiver. The amplitude of individual anomalies is measured from the local background and is shown in parts per million on the E.M. map.

The height above ground of the helicopter is shown on similar chart paper at a scale of approximately 10 feet per small division. The datum is shown at the end of each day's recording. The height of the "bird" can be obtained by subtracting 100 feet from the height of the helicopter.

The flight path shown on the E.M. map was obtained by comparing 35 millimeter photography exposed during flight with a preconstructed mosaic made by enlargement from existing aerial photography. Owing to the featureless nature of the terrain, the flight path recovery on this job was extremely difficult. On some lines as few as two recognizable points were obtained. In general, such points, called fiducials, were kept to a distance of 4000 feet or less apart. The positions of the anomalies were obtained by linear interpolation between the plotted fiducials. This assumes a straight flight path and constant flying speed. This approximation leads to some small error in the anomaly positions. This is expected to amount to as much as 200 to 400 feet of positioning error in some instances, though the average error will be less than 200 feet. Nearer to the better fiducials, the error may be as little as plus or minus 50 feet.

In addition to the anomaly amplitude, a letter A, B or C is assigned to note the grade of the anomaly. This is obtained by interpretation, based partly on the shape of the anomaly and partly on the ratio of the in-phase to the out-of-phase components of the anomaly.

INTERPRETATION

The Hunting helicopter-borne E.M. system was described by the writer in "Helicopter E.M. Test, Mobrun Ore Body, Noranda" in Canadian Mining Journal, November, 1961." The system measures the in-phase and out-of-phase components of the secondary electromagnetic field, in terms of the primary field at the receiver. Receiving and transmitting coils are held vertical and coaxial in a towed "bird", a distance of 30 feet apart and 100 feet below the helicopter. The sensitivity of the measuring system is such that the minimum recognizable in-phase anomaly is about 8 parts per million. Noise on the in-phase profile should be less than 5 parts per million and was maintained at this level in the present survey. The frequency of the alternating electromagnetic field is 4000 cycles per second.

The system so designed is sensitive to large bodies at a depth of up to 250 feet below the "bird". Anomalies in the range 8 to 100 parts per million are commonly obtained over sulphide bodies when this equipment is operated at a "bird" height of 100 feet. The anomaly amplitude decreases with increasing depth (and increasing height) at a roughly 3.8 power. Consequently an anomaly of 8 parts per million could be caused by a large body buried 150 feet below ground or a very small body at surface. This ambiguity is to some extent resolved by studying the shape of the anomaly.

Although the E.M. system is of such a geometry as to minimize the effects of flat-lying conductors such as conducted overburden, these effects are not completely eliminated. However, it is usually possible to reject such effects by interpretation on the basis of the shapes of the anomalies so produced and the in-phase to out-of-phase ratios. In the present survey, a large number of anomalies were produced as a result of conductive overburden. This is aggravated in the vicinity of the large ultra-basic intrusives by a local overburden conductivity increase. The presence of conductive overburden not only introduces spurious anomalies but also distorts the true shapes and amplitude ratios of anomalies produced by conductors in the bedrock. Consequently there are a number of anomalies in the present survey that one would not normally expect to be associated with metallic conductors, that have been shown on the E.M. map as having possible significance. Such anomalies are given a grade C. It is probable that they can be substantiated or eliminated on the basis of ground geophysical work.

A number of anomalies have been detected that can be said to be associated with metallic conductors (probably massive sulphides) with little or no doubt. These are assigned a grade A. Their amplitudes vary from 20 to 56 parts per million, indicating reasonable size and only moderate depth of burial.

In between the grade A and grade C anomalies there are a number that have been assigned a grade B. These anomalies are either too weak in amplitude to include in the A group with confidence or have characteristics intermediate to the A and C groups. Examples of the former are some of the anomalies in anomaly group A1: examples of the latter are to be found in anomaly groups A3, A5 and A6. These anomalies are almost certainly related to conducters within the bedrock, but their true nature is to some extent obscured by the effects of conductive overburden.

Of some 77 anomalies detected by the E.M. survey and considered to be possibly significant, all but 20 are arranged in anomaly groups and given further description below. The remaining 20 are of an isolated nature and with one exception only are of grade C. Only nine of the 20 fall within the property boundaries of the owners. The writer does not recommend that these anomalies be given further investigation at the present time.

ANOMALY GROUP A1

This anomaly group lies on the flank of a strong magnetic anomaly at the south-west end of a chain of magnetic anomalies believed to be related to ultra-basic intrusives. The anomaly group falls outside the property boundaries of the owners and within a small group of claims staked by another company. The anomalies in this group are of the A and B categories, and the writer considers that they are associated with massive sulphide bodies occurring over a strike length of at least 3000 feet. Depth of overburden is expected to be moderate, probably less than 50 feet.

ANOMALY GROUP A2

This group consists of 3 small anomalies which may actually constitute one conductor. The anomalies are sharp and have good ratios, but the amplitudes are very low. This suggests a near-surface conductor of very small size. The anomalies fall in a bend in South Creek, and should be well positioned. It is possible that their identity can be established by ground geophysical survey with either trenching or shallow drilling. The anomalies lie on the north flank of the main magnetic anomaly extending east-west through the north part of the owners property. Geologically, they are expected to lie within basic or ultra-basic rocks, close to the contact with surrounding volcanics.

ANOMALY GROUP A3

This anomaly group consists of 10 individual anomalies arranged in what are probably 4 or more near-parallel conductors. These conductors strike approximately north-west, which is one of the main directions of faulting in the area. The amplitudes of the anomalies vary from weak to strong but the ratios and shapes are such as to suggest electrolytic conduction, probably in a fault zone or a buried valley. For reasons mentioned above, however, the possibility of metallic conductiion should not be ruled out. This can most probably be established by ground electromagnetic survey.

The anomalies fall near a break in the main east-west magnetic anomaly, further support for their possible association with a fault zone.

ANOMALY GROUP A4

5 individual anomalies have been connected tentatively into three north-northwest trending conductors. This strike is by no means certain, but can be established by ground geophysical survey. The anomalies are more similar to those of Anomaly group A2 than those of anomaly group A3. They are of low amplitude and are mainly narrow with good ratios. The southern-most anomaly of the group is more similar to those in anomaly group A3, and may be related to it.

Anomaly group A4 falls on the north flank of the magnetic anomaly and the conductors are believed to lie within or close to ultra-basic rocks near their contacts with volcanics. A dyke swarm is interpreted to cross the main ultra-basic intrusion near this conductor.

ANOMALY GROUP A5

This is a group of 4 anomalies arranged in 1 or 2 conducting bands. The anomalies are broad but have good ratio and reasonably strong amplitude. Conductivity is expected to be good and definitely within the range normally associated with massive sulphides. However, the breadth of the anomalies, despite the relatively strong amplitudes, points to some interference by conductive overburden and offers an alternative association in terms of a locally highly conducting fault zone. This could be the same fault zone as mentioned previously in connection with Anomaly group A3. The anomalies lie south of the main magnetic anomaly and on the north flank of a minor anomaly that may be associated with a dyke swarm entering from the south.

The writer considers that the probabilities of anomaly group A5 relating to massive sulphides and to electrolytic conduction in a fault zone are about even. This can be weighted one way or the other by a ground electromagnetic survey.

ANOMALY GROUPS A6 AND A7

These two anomaly groups lie to the southeast of the ultra-basic intrusives, and only the north half of Anomaly group A6 is within the property boundaries. The latter anomaly lies along the extension of the possible fault zone mentioned previously. Amplitudes, shapes and ratios of most of the anomalies in these groups are such as to suggest electrolytic conduction in either fault zones or buried valleys. However, 1 grade B anomaly has been interpreted (in anomaly group A6), and the possibility of metallic conduction in the bedrock cannot be completely ruled out. These 2 anomalies are nevertheless given low priorities as exploration prospects.

ANOMALY GROUP A8

This is a group of 3 anomalies of appearance similar to those in groups A6 and A7. They have similar strike and are associated with the break in the main east-west magnetic anomaly that could be associated with a northwest trending fault. The anomalies are most probably associated with electrolytic conduction in a fault zone or locally conducting overburden in a buried topographic feature. However, the possibility of metallic conduction cannot be ruled out.

ANOMALY GROUP A9

This anomaly group consists of 2 strong anomalies which have shapes and ratios characteristic of massive sulphide bodies. The anomalies connect to form a conductor of west-northwest strike, lying along the south edge of an old beaver pond. The conductor is believed to be fairly shallow (probably less than 50 feet) and of reasonable width and strike extent. It lies within a magnetic anomaly believed to be part of the chain of ultra-basic intrusives previously described.

While the conductor has not been completely outlined as it lies in the extreme corner of the survey area, the 2 anomaly intersections are sufficient to show that it is most certainly related to conduction in the bedrock and is most probably caused by massive sulphides rather than graphite.

This conductor is given the highest priority for further investigation.

ANOMALY GROUP A10

This anomaly group lies well to the west of the property boundary. It consists of 6 widely scattered anomalies of assorted character. Nevertheless, they appear to have in common reasonably good E.M. ratios and a possible association with a band of intermediate to basic volcanic or intrusive rock. 2 of the anomalies are given a B grade on the basis of shape and ratio. Should any followup work be done on this anomaly group, the main emphasis should be placed on those 2 anomalies.

Follow up work on the above anomalies should take the form of spot seismic determinations to determine the best ground E.M. method, to assist in the interpretation and to provide information for a drilling program, ground E.M. survey to locate exactly the conductor axes and "box in" the region of strongest conductivity, ground magnetometer profiles over the regions of strongest conductivity, followed by trenching (if applicable) or drilling if the geophysical results are encouraging. The ground E.M. survey can be done on lines 400 feet apart but intermediate lines at 200-foot intervals may be needed in the region of strongest conductivity. Horizontal loop survey by the Ronka method or inductive loop Turam survey are the methods recommended for the ground E.M. Either of these techniques will be capable of pin-pointing the conductor for drilling and providing some assurance of the probable nature of the conductor. Of the 2 methods, the Ronka method is preferred if the depth of overburden permits.

HUNTEC LIMITED

Norman Paterson

Norman R. Paterson, Ph.D., P. Eng.,
Project Manager.

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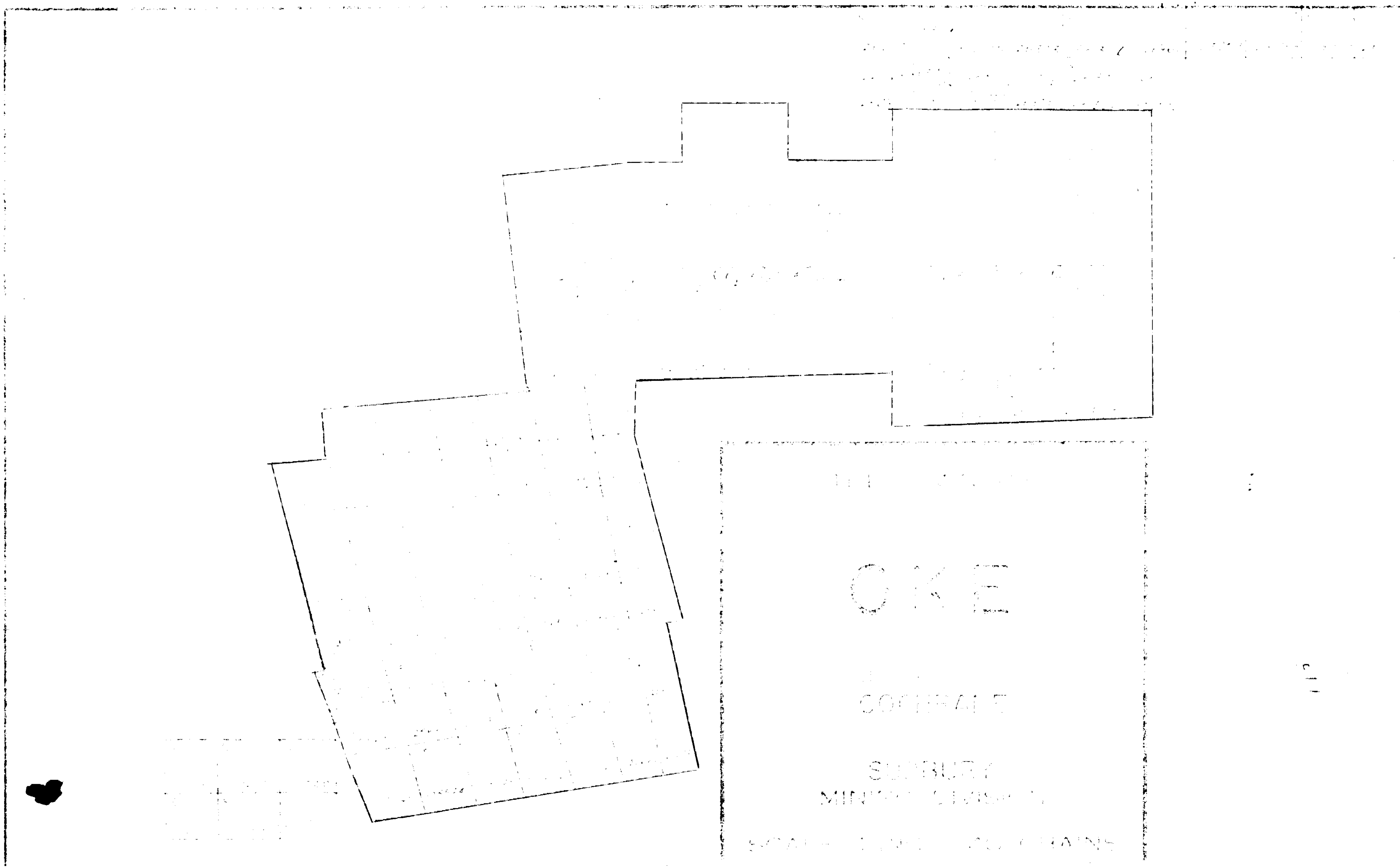
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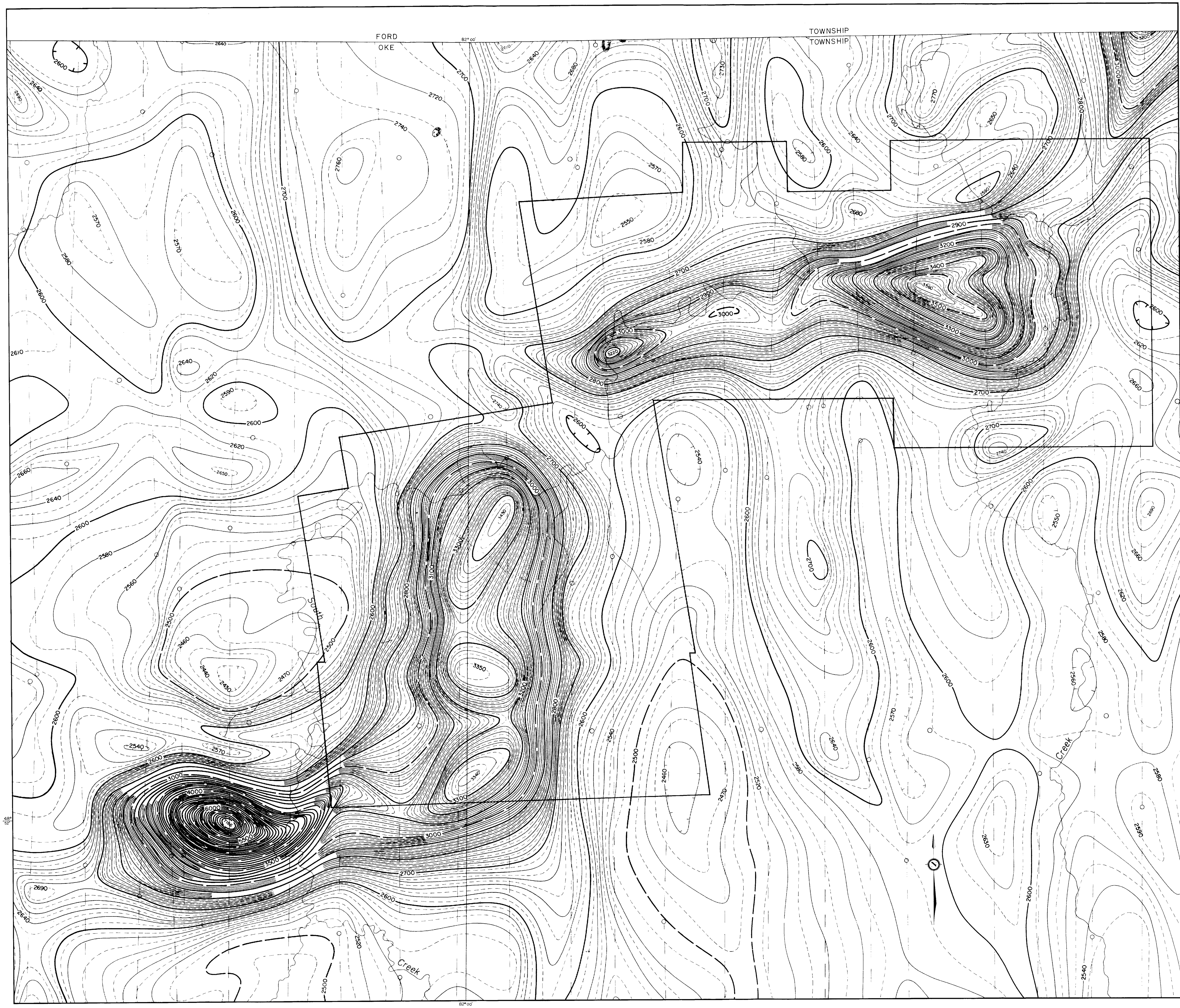

SCALE
1 Inch to 800 Feet
(Approx)

Reproduced from
Aeromagnetic Map, OKE TOWNSHIP
by
HUNTING SURVEY CORPORATION LIMITED
TORONTO, CANADA
1964

File 63-1624

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GOLDRAY MINES AND MID-NORTH ENGINEERING SERVICES LIMITED
HELICOPTER - BORNE ELECTROMAGNETIC SURVEY

MEAN TERRAIN CLEARANCE (BIRD)	100 FEET
MEAN FLIGHT LINE SPACING	400 FEET
E.M. ANOMALY NORTH-SOUTH LINES	●
E.M. ANOMALY EAST-WEST LINES	■
FIDUCIAL POINTS	3690
FLIGHT LINES	
CLAIM GROUP BOUNDARY	

16 B — Amplitude (Anomaly) Grade

Possible strike and continuity of anomaly

A2 — Anomaly group № 2

Outline of geological unit, interpreted from aeromagnetics

OKE TOWNSHIP, ONTARIO

SCALE

1 Inch to 800 Feet

ELECTROMAGNETIC ANOMALIES AND INTERPRETATION

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N.R. Paterson, Ph.D., P.Eng., Geophysicist

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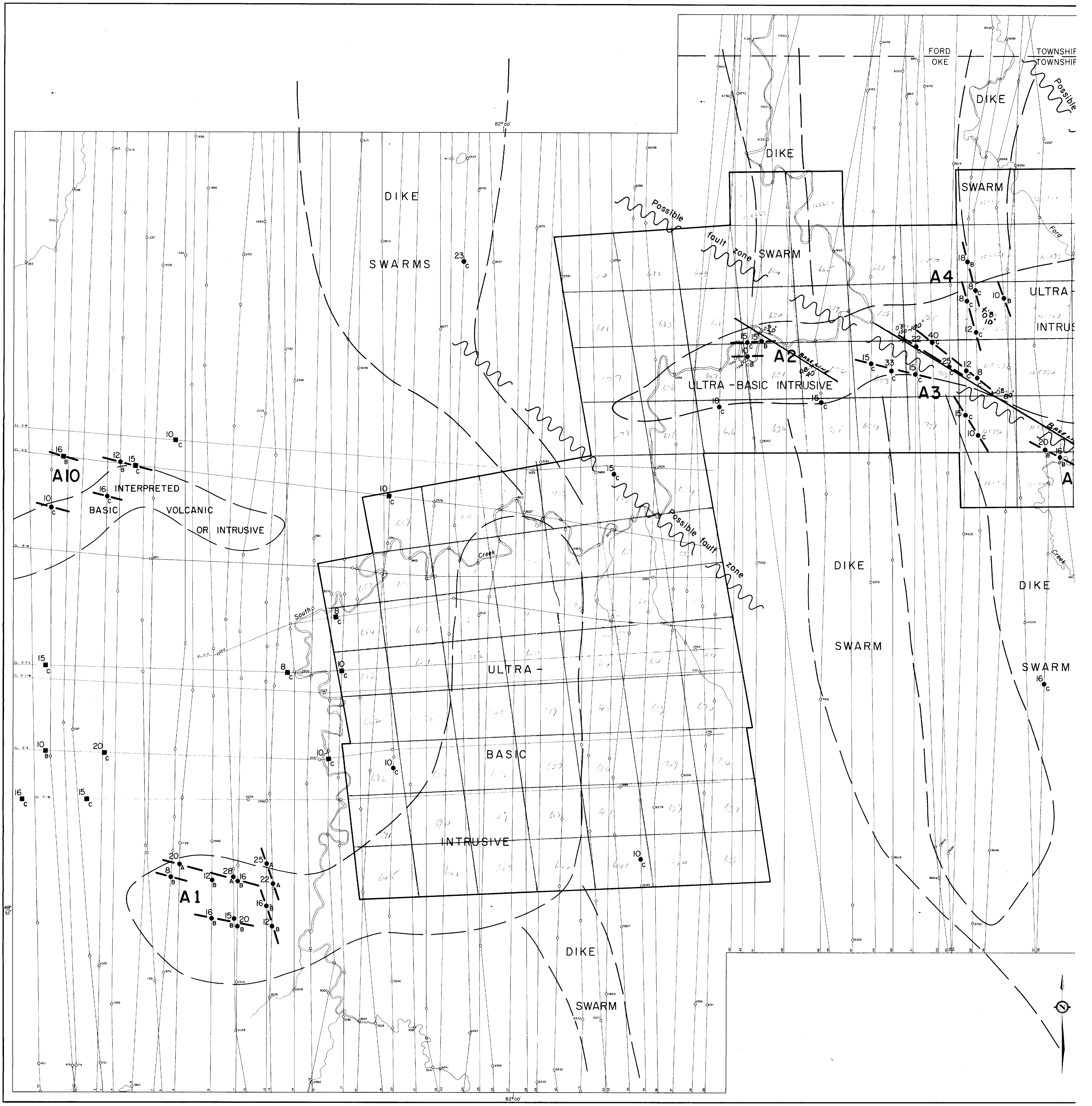
GOLDRAY MINES AND MID-NORTH ENGINEERING SERVICES LIMITED
HELICOPTER - BORNE ELECTROMAGNETIC SURVEY



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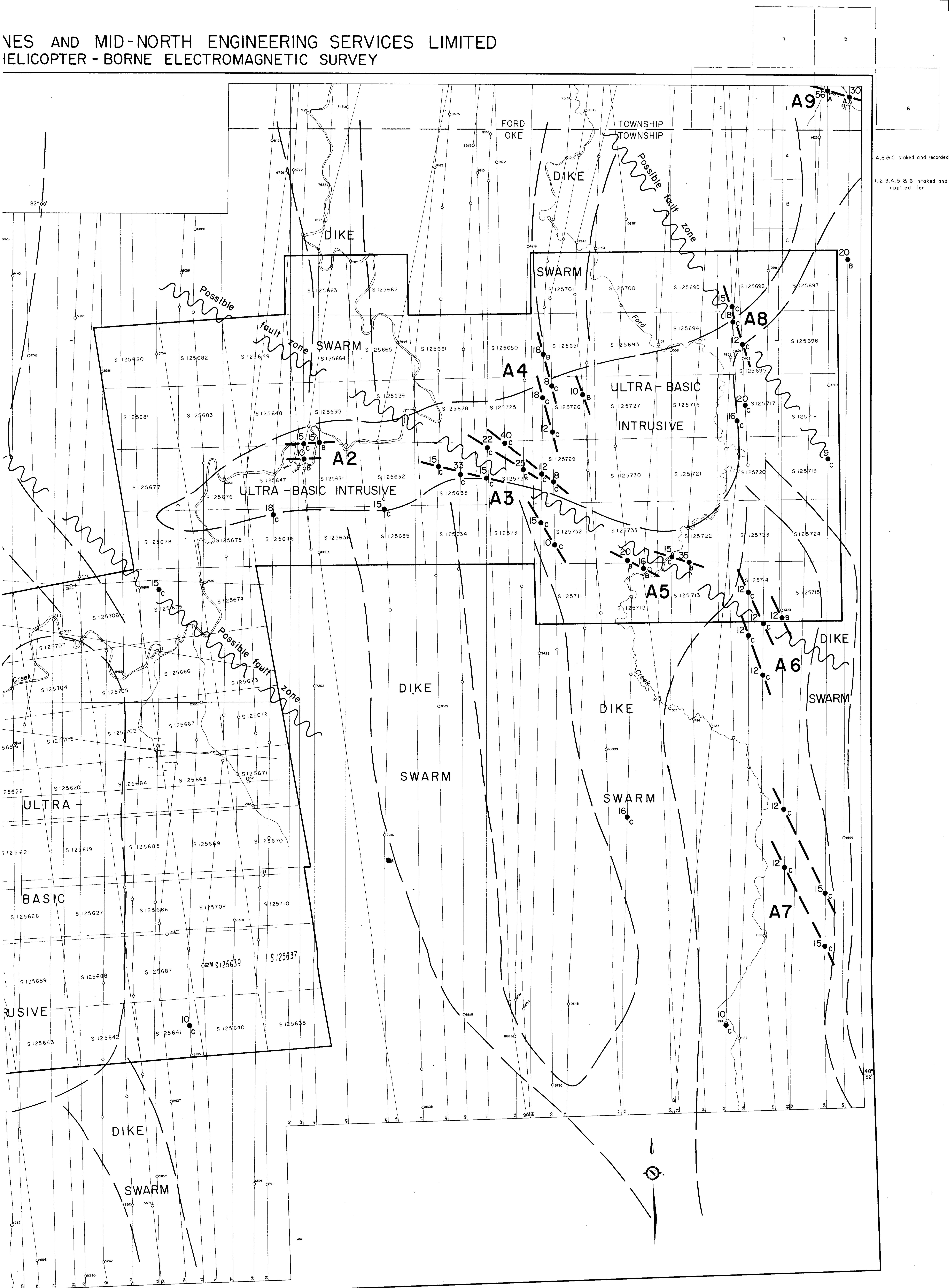

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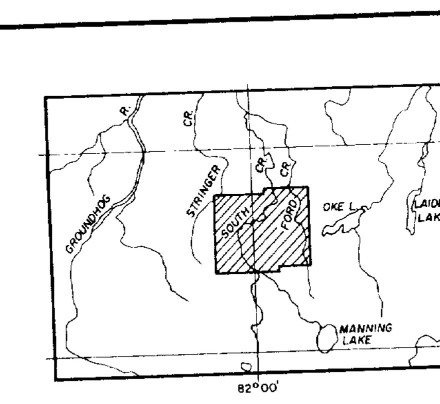

ELECTROMAGNETIC ANOMALIES
AND
INTERPRETATION

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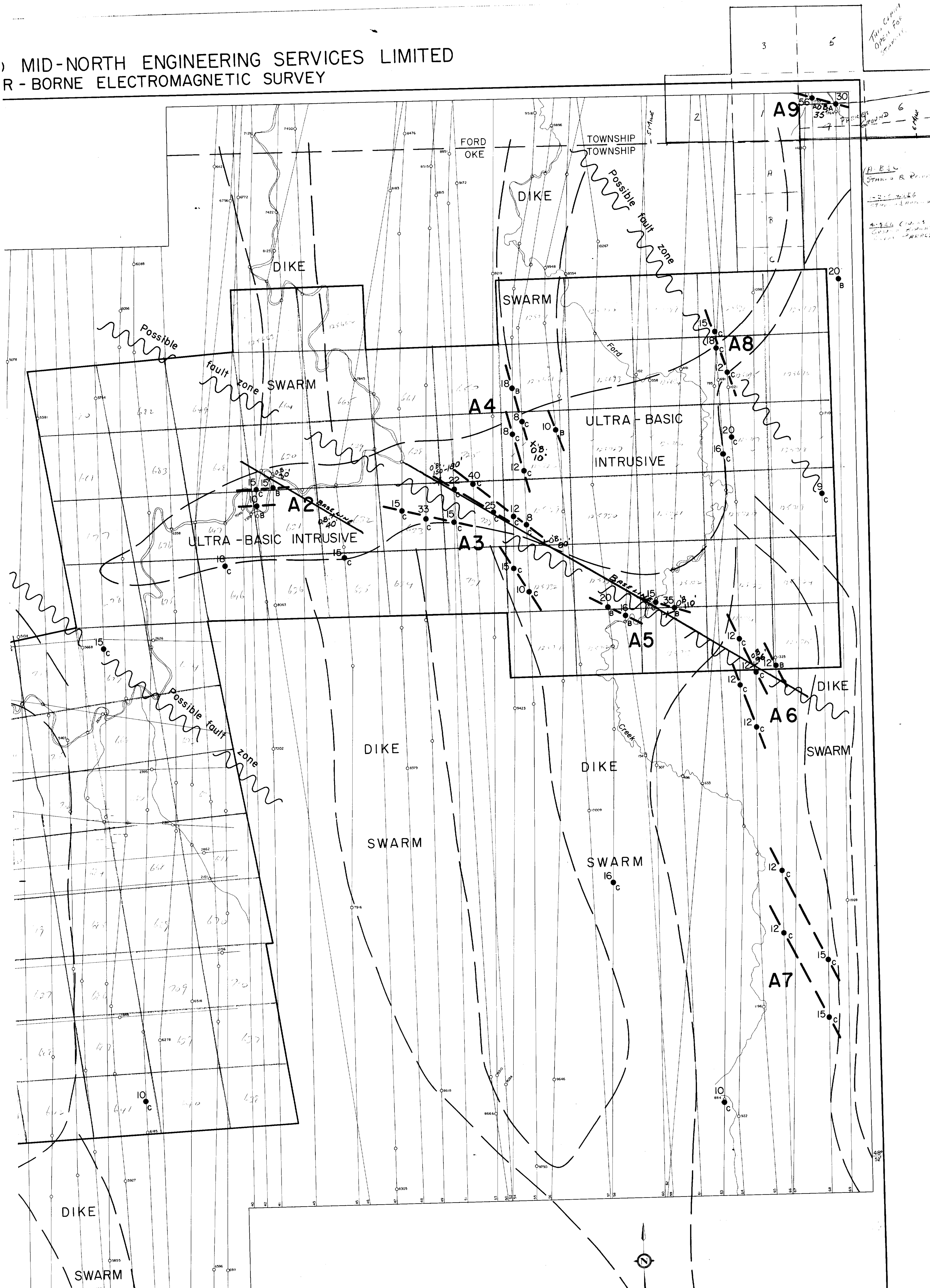

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ELECTROMAGNETIC ANOMALIES
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INTERPRETATION

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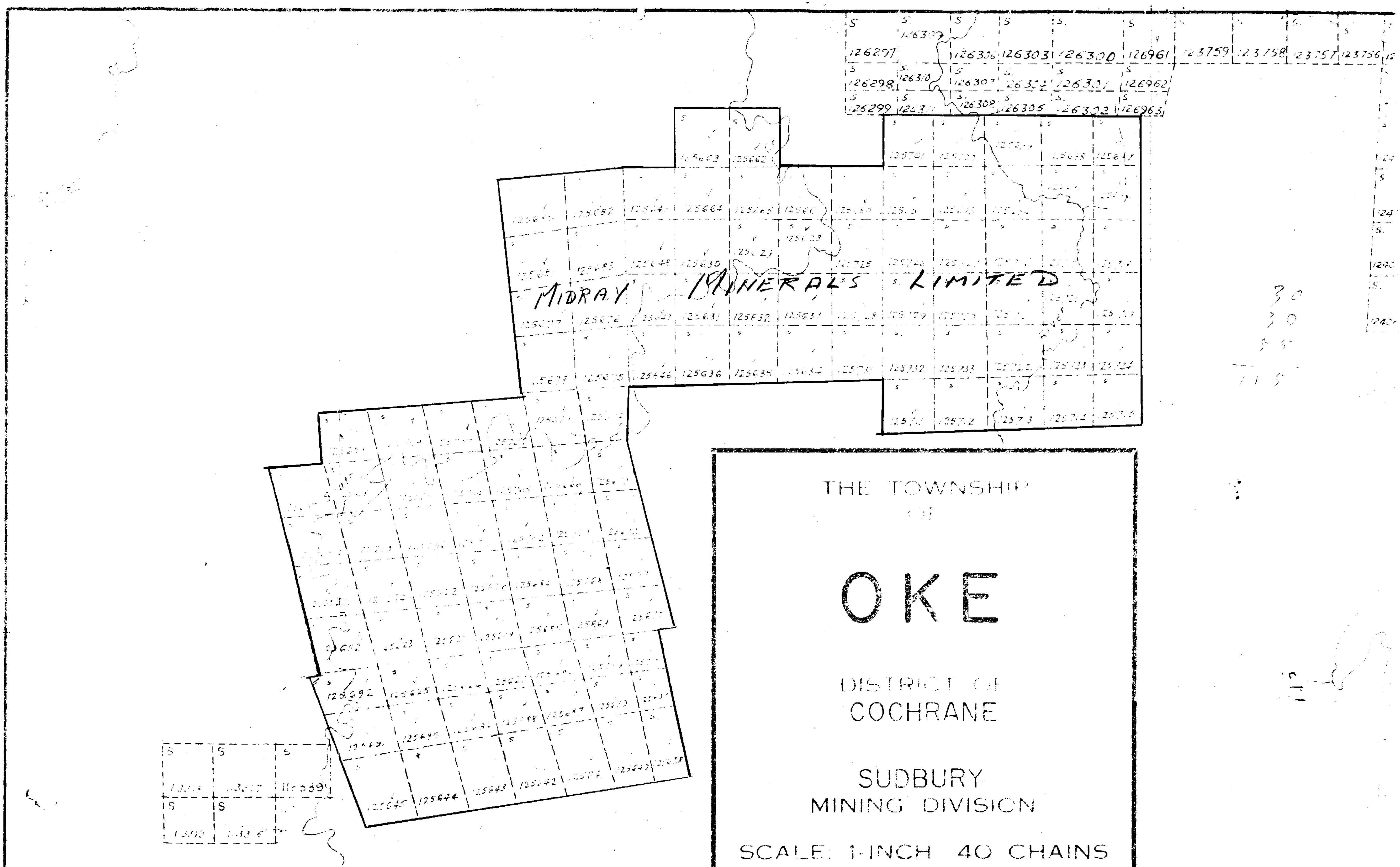
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THE TOWNSHIP
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COCHRANE
SUDBURY
MINING DIVISION
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