A REPORT ON GEOPHYSICAL SURVEYS ON THE RAYLLOYD-RAM PETROLEUMS PROPERTY, SAVANT LAKE AREA, ONTARIO

August 6, 1982.

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TABLE OF CONTENTS

Figures and Plans

Appendices

ABSTRACT

During the period February 1, 1982, to June 15, 1982, Mr. R.G. Ramsay of Raylloyd Mines & Explorations Ltd. completed magnetic and VLF-EM surveying over the Raylloyd-Ram Petroleums property in the Savant Lake area of northwestern Ontario. The property consists of twenty-nine unpatented mining claims, located on Highway 599, approximately fourteen miles north of the town of Savant Lake.

Geophysical surveying, consisting of 2130 magnetic stations and 1932 VLF-EM stations , was completed over 35.1 line miles of base line and cross lines within the property area. A Scintrex MF-2 proton magnetometer, and a Geonics EM-16 VLF-EM unit were utilized in this work.

Approximately thirty-six moderate to strongly conductive zones were defined within the property, seventeen of these closely associated with magnetite iron formation. These magnetically-associated conductors are believed caused by pyritic and/or graphitic zones within or at the contacts of the iron formation bands.

The small Wiggle Creek gold prospect in the northern part of the property is located in a pyritic facies of the iron formation. The prospect itself is too limited in size to yeild a definite geophysical response. However, it is believed a stratabound type of occurrence, which could well be repeated in more extensive proportions in iron formation depositional areas, and defined by VLF-EM conductivity.

Initial evaluation of the geophysical results by thorough prospecting and trenching is suggested.

INTRODUCTION

During the period February 1, 1982, to June 15, 1982, magnetic and VLF-Electromagnetic surveys were completed on the Wiggle Creek gold property of Raylloyd Mines & Explorations Ltd., and Ram Petroleums Ltd. This property, consisting of 29 unsurveyed and unpatented mining claims, and containing 1,160 acres, more or less, is situated in the central part of McCubbin Township, within the Administrative District of Thunder Bay, Ontario.

The property lies between Savant Lake and Kashaweogama Lake, at the intersection of latitude 50° 26' N, and longitude 90° 37' W. It is easily accessible via Highway 599 from the town of Savant Lake, as shown in Figure 1 to this report.

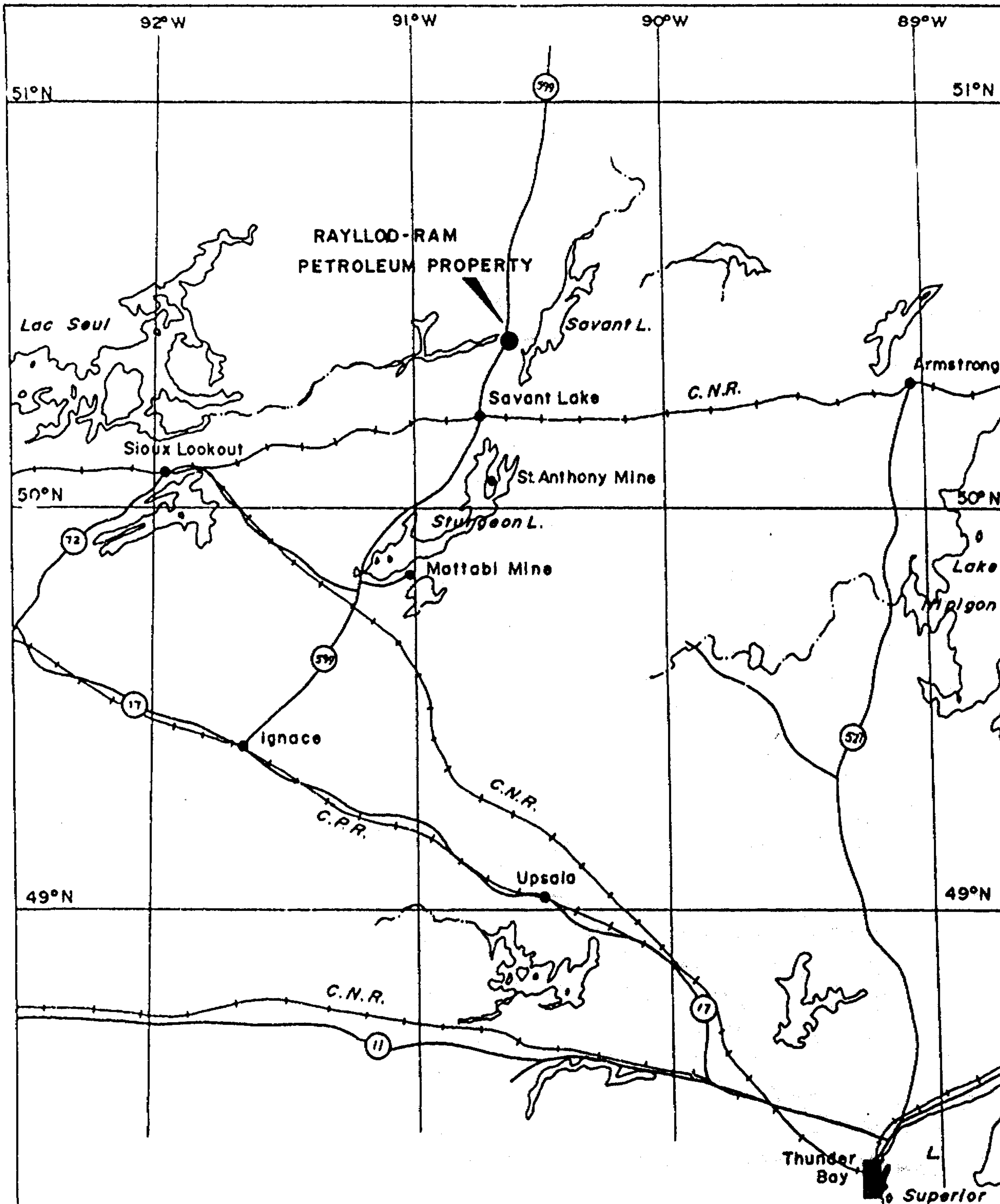
The northern part of the property contains the Wiggle Creek gold prospect. This consists of a small zone of near-massive arsenopyrite carrying up to 0.30 oz. Au/ton, lying within a pyritic and carbonate-rich facies of iron formation. Banded magnetite iron formation is present in the immediate vicinity of the prospect. To the south other poorly explored pyritic zones associated with iron formation are known to exist.

The geophysical program was undertaken as the initial phase of exploration of the property by Raylloyd Mines and Ram Petroleums. The surveys were completed by Mr. R.G. Ramsay, operator, and the interpretation undertaken by G.M. Hogg, P.Eng., at the request of Mr. Ramsay.

LAND TENURE, OWNERSHIP

The included claims are registered in the name of Ram Petroleums Ltd. Interest in the lands, specified under separate agreement, is 50 percent Raylloyd Mines & Explorations Ltd., and 50 percent Ram Petroleums Ltd.

The claims are warranted in good standing, and ownership is secure and as represented.



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GENERAL LOCATION PLAN

RAYLLOYD-RAM PETROLEUM PROPERTY, N.W. ONTARIO

Figure 1 25 MILES

SCALE: 1 inch = 25 miles

The claims included in the property are shown in Figure 2 to this report, and may be listed as follows:

Claim No.	Township	Registered Owner	Recorded
Pa 437120	McCubbin	Ram Petroleums Ltd.	Sept. 1979
Pa 437121	"	"	"
Pa 437122	"	"	"
Pa 437123	"	"	"
Pa 437124	"	"	"
Pa 437125	"	"	"
Pa 486083	"	"	April, 1980
Pa 486084	"	"	"
Pa 486085	"	"	"
Pa 486086	"	"	"
Pa 486358	"	"	April, 1980
Pa 486359	"	"	"
Pa 486360	"	"	"
Pa 486361	"	"	"
Pa 486362	"	"	"
Pa 486363	"	"	"
Pa 486364	"	"	"
Pa 486365	"	"	"
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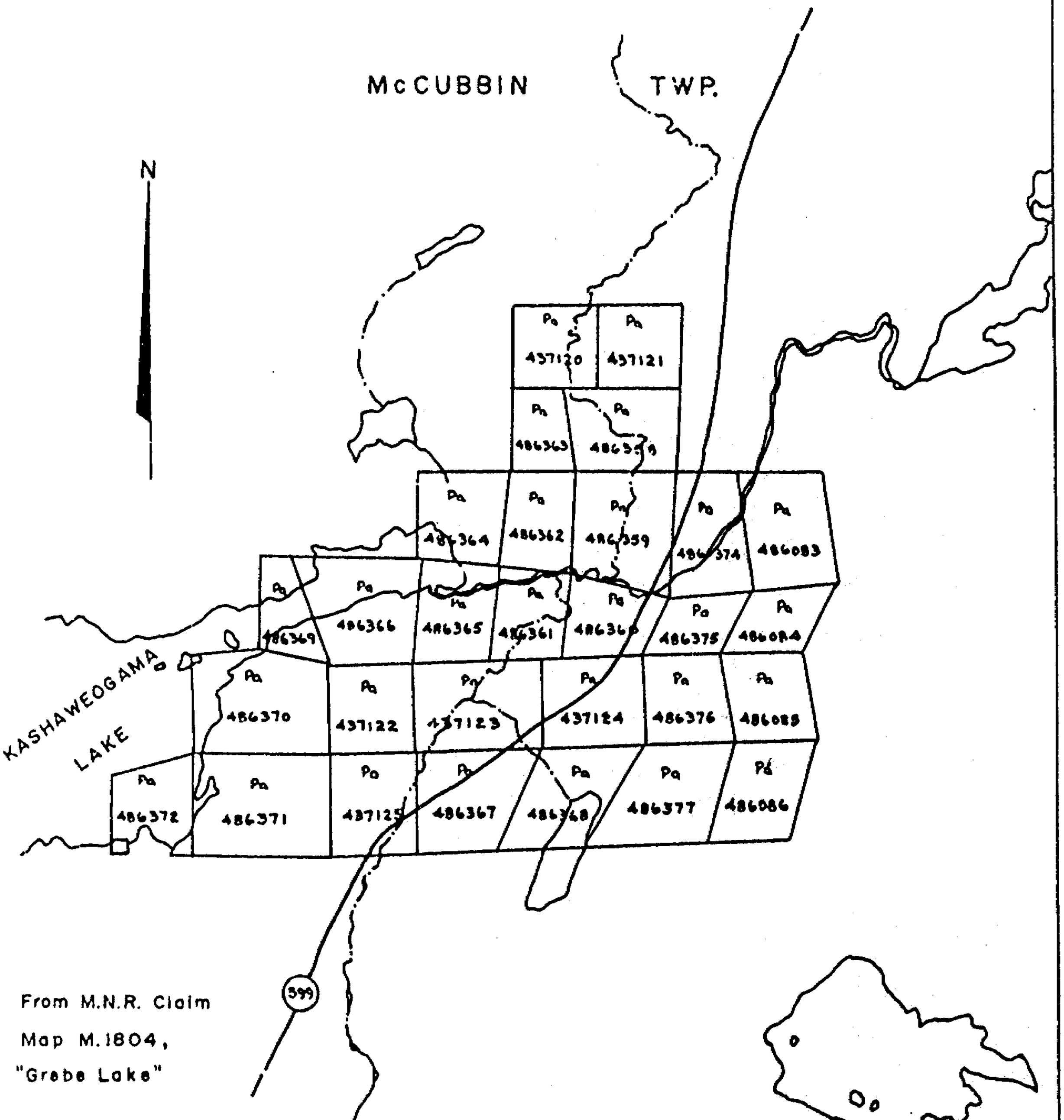
Pa 486376	"	"	"
Pa 486377	"	"	"



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CLAIM LOCATION PLAN
RAYLLOYD-RAM PETROLEUM PROPERTY, N.W. ONTARIO

Figure 2

SCALE: 1 inch = 1/2 mile ½ MILE

GENERAL GEOLOGY

The Savant Lake area is underlain by a metasedimentary/metavolcanic complex of Archean age. The metasedimentary units, including cherty magnetic iron formation, are mainly restricted to a large basinal structure which lies between Savant and Kashaweogama Lakes. The containing rocks are chiefly metavolcanics, but include some intrusive rocks near the west end of the basin. The configuration of the basin structure , and the position of the Raylloyd-Ram Petroleums property, are indicated in Figure 3 to this report (Aeromagnetic Plan, from G.S.C. Geophysical Map No. 1119G).

The rocks of the area are strongly folded, attendant to the formation of the major basinal structure. Faulting of various orientations is present throughout the area.

The Raylloyd-Ram Petroleums property is located in the western extremity of the basin area. The east arm of Kashaweogama Lake appears to lie along the axis of the major basinal syncline, defined by a distinct magnetic "low" which extends across the property in an easterly direction.

Rocks in the property area include banded magnetite iron formation with associated pyritic carbonate iron formation and andesitic tuff; argillitic to sericitic arenites (locally termed "graywackes"); and minor dioritic to granitic intrusives. Some graphitic interbeds occur within the metasedimentary sequence, and appear common in the southwestern property area.

The Wiggle Creek gold prospect, exposed in a single trench in the north property area (claim Pa. 437120), consists of a small zone of near-massive auriferous arsenopyrite lying within a pyritic carbonate-rich facies of iron formation. Magnetite iron formation is proximal, but contains no sulphide mineralization or gold. Quartz veining occurs within the carbonate-rich strata. As noted, values as high as 0.30 oz.Au/ton have been reported from the prospect.

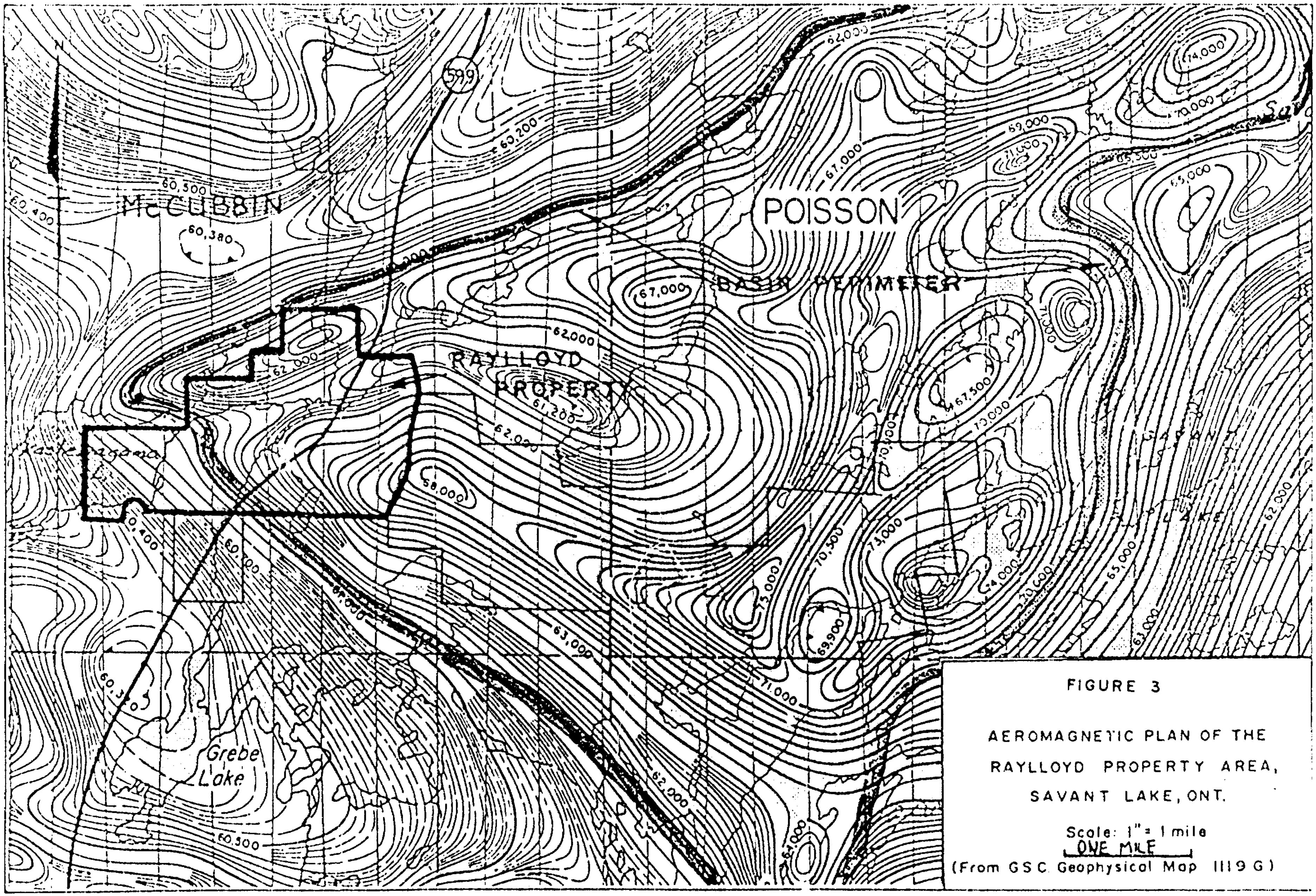


FIGURE 3

AEROMAGNETIC PLAN OF THE RAYLLOYD PROPERTY AREA, SAVANT LAKE, ONT.

Scale: 1" = 1 mile

ONE MILE

(From GSC Geophysical Map 1119 G)

The geology of the area, and the property, are described in M.N.R. Geoscience Report No. 160 (Geology of McCubbin, Poisson and McGillis Townships, Savant Lake Area; W.D. Bond, 1977), and in a private report prepared for Raylloyd Mines and Explorations Ltd. in November, 1981, by the writer. In this latter report geophysical surveying of the property was recommended. These and other sources of information on the property area are listed in Appendix I here appended.

GROUND GEOPHYSICAL SURVEYS

GENERAL INFORMATION.

During the period February 1, 1982, to June 15, 1982, a field party under the supervision of Mr. R.G. Ramsay of Raylloyd Mines completed 35.1 miles of line cutting on the property. This included two grid areas; the North Grid with north-south cross lines at 200 foot spacing; and the South Grid with north-south cross lines at 400 foot spacing. The location of the grid areas may be seen on Map No. 1 (in pocket), and actual distribution of footage may be listed as follows:

North Grid:	E-W Base Line-	2,400 ft.
	N-S Cross Lines (200' sp.)-	37,050 ft.
South Grid:	E-W Base Line-	10,400 ft.
	N-S Cross Lines (400' sp.)-	135,600 ft.

During the period these grid areas were surveyed by magnetic and VLF-Electromagnetic methods by Mr. Ramsay. Readings were taken at 100 foot intervals along the lines in both surveys, closing to 50 foot intervals in anomalous areas. Numbers of stations read in each of the grid areas are as follows:

North Grid:	Magnetic Readings-	369
	VLF-EM Readings-	480
South Grid:	Magnetic Readings-	1,761
	VLF-EM Readings -	1,452

A Scintrex MF-2 proton magnetometer was utilized in the magnetic survey process. This instrument is capable of 1 gamma resolution with a total field 100,000 gamma range. Because of the presence of magnetite iron formation a 50 gamma sensitivity was used in the survey, and diurnal corrections were not applied.

A Geonics EM-16 instrument was utilized in the VLF-EM surveying. This unit has a sensitivity of ± 1%, and yields in-phase and out-of phase values on conductive zones activated by an external very low frequency radio signal. In this survey the 17.8 kHz frequency signal of Cutler, Maine, was used throughout.

The general specifications of these instruments are shown in Appendix II to this report.

VLF-EM data has been processed by the Fraser Filter method (see Appendix III) to allow contouring of results, and better resolution of anomaly configuration and strength.

MAGNETIC SURVEY RESULTS:

In the North Grid area (Map No. 1 and Map No. 3, in pocket) the presence of two distinct bands of cherty magnetite iron formation is indicated. The southernmost band terminates at Line 8E, but extends on a S 80° W bearing beyond the western limit of the survey area. Although folding may have caused repetition of a single iron formation band in this area, magnetic data suggests that the duplication is of depositional origin. That is, the actual depositional zone of iron formation thickens to the west with repetitive cycles of iron formation deposition within it.

The Wiggle Creek gold prospect is located at 7+50 N on Line 4W. At this location a magnetic reading of 44,000 gammas was recorded. This, however, is due to the presence of cherty magnetite iron formation proximal to the gold prospect, and does not relate to the presence of highly magnetic material in the prospect itself.

In the South Grid area (see Map No. 1 in pocket) a strong series of high magnetic readings has been defined trending east-west in the vicinity of the base line. The magnetically anomalous area (3000 gammas +) extends over a 3,000 foot width at the east end of the grid, narrowing to nil at the west end of the grid. Minor magnetic activity, locally no more than a few hundred gammas, extends over the rest of the grid area.

Cherty magnetite iron formation in beds 50 to 300 feet in width are believed defined by magnetic readings of 10,000 gammas and greater. In the eastern portion of the South Grid, broadening of the strongly anomalous area may indicate folding. Or, as suggested in the North Grid area, it may be due to thickening of the depositional zone, and the presence of multiple bands of magnetite iron formation. Toward the west the iron formation assumes a single linear trace, and weakens considerably.

Some discontinuity of magnetics in the South Grid area suggests the presence of northwesterly-trending faulting. However, this feature is better defined in the analysis of the VLF-EM data.

VLF-EM SURVEY RESULTS:

In the North Grid area (see Map No. 2 and Map No. 3 in pocket) the VLF-EM conductors indicated are weak to moderate in strength. On Map No. 3, which shows the filtered values in contour form, eight moderately conductive zones have been defined (anomalies A to H inclusive). These are formational responses, and interestingly often occur peripheral to highly magnetic zones. These anomalies (A to F inclusive) are interpreted to indicate the presence of pyritic and/or graphitic zones lying at the contacts of cherty magnetite iron formation zones. This is best exemplified in the case of the A and B anomalies which lie respectively to the north and south of the Wiggle Creek gold prospect. The prospect itself is not defined electromagnetically.

In the North Grid area conductors also appear to be offset in certain cases. This, as indicated on Map No. 3, is probably the result of right hand movement along N 45° W faults within the grid area.

The South Grid VLF-EM results are shown on Map No. 2 and Map No. 4 (in pocket), the latter being the contour plan derived from filtered VLF-EM data. Several moderate to strongly conductive zones are indicated, mainly assuming a west to S 60° W bearing. At the west end of the grid area a directional swing to the northwest is apparent. This is probably due to fold closure at the west end of the Savant Lake basin. The conductors appear of formational origin for the most part, although overburden-outcrop interfaces and wet overburden may have produced detectable conductivity in some cases.

Inspection of the VLF-EM data of the South Grid area suggests that conductors may be grouped in three main categories. These are the "J" Group (J-1 to J-7), a linear series of anomalies in the north portion of the grid which are not associated with magnetics; the "K" Group (K-1 to K-11), a linear series of anomalies in the central grid area which are closely associated with magnetic anomalies; and the "L" Group (L-1 to L-10), which lies in the southern portion of the grid, and are not associated with any notable magnetic activity. The northernmost conductivity in the South Grid area, designated anomaly "I", is not associated with magnetics, and is probably continuous with the G-H anomaly series of the North Grid area.

The "K" Group of anomalies is currently of greatest interest because of their similarity in character to those spatially associated with the Wiggle Creek gold prospect in the North Grid area. It is notable that conductivity in this anomaly series appears peripheral to magnetite iron formation, as in the North Grid area, and is thus probably due to pyritic and/or graphitic concentrations in the contact areas.

Discontinuity of VLF-EM anomaly trends in the South Grid area suggests the presence of right-hand, N 45° W fault movement. One such zone is indicated on Map No. 4 (in pocket), passing through the base line at 28E. Others may intersect the base line at 4W and 52E.

A discrete, circular zone of low conductivity is apparent in the 8E, 7+00N to 16E, 7+00N area of the South Grid. This may indicate the presence of a small granitic or dioritic intrusive mass.

INTERPRETIVE CONSIDERATIONS

Geological data available on the Raylloyd-Ram Petroleums property are not extensive. Governmental mapping of the area by W.D. Bond and others has been largely of a reconnaissance nature, but provides a general picture of conditions consistent with the results of geophysical surveying.

Base metal exploration has been carried out in the general area by INCO and other companies in the past. Two drill holes completed by INCO within the present property area are shown on Maps No. 1, 2 and 4 (in pocket). These are located at 3+00S on Line 0 (anomaly K-8), and 20+50S on Line 16W (anomaly L-7) of the South Grid. The first of these holes intersected slate and andesite tuff with minor graphitic and pyritic mineralization. The source of the strong conductivity in this location was not defined, and no assay data are available. The second , more southerly drill hole intersected graphitic schist and an 18 foot zone of sulphide mineralization estimated to contain 35 percent pyrite. Again, no assay data are available, but Mr. R.G. Ramsay tested some drill cuttings from the location obtaining values from 15 to 70 ppb Au. This latter hole, unlike the first, appears to have been drilled in a very weak portion of the conducting zone. As far as is known INCO did not assay the drill core from these holes for gold.

The Wiggle Creek gold prospect is very limited in extent, and does not yield direct geophysical response magnetically or electromagnetically. However, it is spatially associated with magnetite iron formation, and localized within a pyritic facies of the iron formation sequence. This same condition has been observed in other parts of the Savant Lake basin, notably in the One Pine Lake area to the east.

It is probable that gold in the Savant Lake area is of paleobasinal origin. That is, it was chemically or otherwise concentrated in certain depositional environments during, and as part of, early basinal sedimentation. Since all known gold occurrences of significance in the area are iron formation-associated, the most favourable depositional locus can be identified with some measure of statistical assurance. Also, redistribution of gold in the area appears limited, so that the original stratigraphic controls on gold distribution may be expected to remain effective.

Accordingly, pyritic conductive zones defined by VLF-EM survey lying close to magnetite iron formation, and forming part of the iron formation sequence, must be considered attractive targets. Such zones should be carefully evaluated for gold potential. In the Raylloyd-Ram Petroleums property area these would include anomalies A to F in the North Grid area, and the "K" anomaly series in the South Grid area.

Some copper and zinc sulphide mineralization has been reported from the Savant Lake area in past exploration. Thus, although geological conditions favourable for the occurrence of base metal deposits do not appear to be present on the Raylloyd-Ram Petroleum property, the possibility exists, and all strongly conductive zones defined warrant evaluation.

EVALUATION REQUIREMENTS

Eight moderately conductive zones have been defined in the North Grid area, and twenty-eight moderate to strongly conductive zones in the South Grid area (anomaly L-5 lies outside the property boundary). Of these, a total of seventeen are associated with magnetite iron formation, and are located peripheral to highly magnetic areas. These, of course, are of highest priority in respect to the possible occurrence of auriferous pyritic zones.

Many of the conductive zones lie in areas in which outcrop occurs. As such, it is suggested that the next phase of exploration on the property consist of thorough prospecting and trenching in anomalous locations. A light diamond drill might be employed in many cases to test shallowly-buried conductors. Pyritic mineralization should be geochemically tested to ascertain if gold is present in anomalous amounts, and if so, the defined conductor should be examined in detail.

Some areas, notably those containing anomalies J-1 to J-8, and L-1 to L-6 appear heavily overburden-covered. These conductors are not associated with magnetics, and may not be caused by bedrock features. They will require drilling for adequate evaluation, but this should not be undertaken until the initial phase of anomaly evaluation is completed.

CONCLUSIONS & RECOMMENDATIONS

Effective geophysical coverage has been completed over the entire Raylloyd-Ram Petroleums property. Approximately thirty-six moderately to strongly conductive locations have been defined, seventeen of which are closely associated with magnetic iron formation.

Prospecting and trenching are suggested as the most effective and least costly means of performing evaluation of the anomalies and structural features which have been defined. Such methods will not allow evaluation of all anomalies, but will be effective in many cases. They will also provide much information which will be found valuable in planning the extent and type of future work requirements.

The Wiggle Creek gold prospect, in itself limited in extent as presently known, provides a model for gold occurrence in the area. Similar features should be looked for in the anomaly evaluation process.

Respectfully Submitted,

G.M. Hogg, P.Eng.

REGISTERED PROFESSIONAL ENGINEER
G. M. HOGG
PROVINCE OF ONTARIO

G.M. HOGG & ASSOCIATES

CERTIFICATE OF QUALIFICATION

I, Glen M. Hogg, of the City of Toronto, County of York, in the Province of Ontario, Canada, do hereby certify that:

1. I am a Consulting Engineer, principal of the firm of G.M. Hogg & Associates Ltd., with an office located at 28 Thompson Avenue, Toronto, Ontario.

2. I am a member of the Association of Professional Engineers of Ontario, a registered Consulting Engineer with that organization, and designated as a Specialist in the Field of Geological Engineering, Classes of Exploration and Development, as per Regulation 59/73 of the Professional Engineers Act, R.S.O. 1970.

3. I am a graduate of Queen's University of Kingston, Ontario, having received the degree of Master of Science in Geological Sciences from the Faculty of Applied Science in 1952. I have since practised professionally in the field of mineral exploration and development.

4. I have knowledge of, ard experience in the region in which the Raylloyd-Ram Petroleum property is located.

5. In addition to my personal knowledge of the area, I have made use of the records of the Ministry of Natural Resources of Ontario, and Raylloyd Mines & Explorations Ltd. in the preparation of this report. I examined the property relevant to this study on September 8th and 9th, 1981.

6. I have no interest, direct or indirect, in the property on which this report is written, nor do I expect to receive any.

Dated this 6th day of August, 1982.

REGISTERED PROFESSIONAL ENGINEER
G. M. HOGG
PROVINCE OF ONTARIO

G.M. Hogg, P.Eng.

APPENDIX I

Some Sources of Information on the Savant Lake Area, and the Raylloyd-Ram Petroleum Property.

Appendix I

Some Sources of Information on the Savant Lake Area, and the Raylloyd-Ram Petroleums Property.

O.D.M. Vol. 37, Pt4, 1928 - Lake Savant Area, District of Thunder Bay, E.S. Moore.

ODM-GSC Map 1119G, 1961 - Kashaweogama Aeromagnetic Sheet.

GSC Econ.Geol.Rept. 22, 1965 - Geology of Iron Deposits in Canada, Vol 1, G.A. Gross.

ODM Map No. 2196, 1970 - Geol. Compilation Series, Sioux Lookout-Armstrong Sheet. J.C. Davies et al.

MNR Geoscience Rept.160,1977 - Geology of McCubbin, Poisson, and McGillis Townships, Savant Lake Area. W.D. Bond

Northern Miner Press, 1940-41- References to Exploration in Savant Lake Area.

Sept.5, 1940 Issue, pp 1
Sept.19, 1940 Issue, pp 1
Sept.26, 1940 Issue, pp 6
Oct. 3, 1940 Issue, pp 1
Oct. 31, 1940 Issue, pp 1
Nov. 21, 1940 Issue, pp 1
Dec. 12, 1940 Issue, pp 7
Mar. 20, 1941 Issue, pp 19

PDA Recorder, July 1981 - Stargazer Resources Exploration Program, Savant Lake Area.

Private Report, April, 1980 - Report on Geophysical Surveys , One Pine Lake Area. Paterson, Grant, Watson Ltd. for Ram Petroleums Ltd.

Private Report, April, 1981 - Savant Lake Airborne Geophysical Survey for Ram Petroleums Ltd. Geophysical Surveys Inc. (Available in MNR Assessment Files)

Private Report, April, 1981 - Savant Lake Airborne Geophysical Survey for Stargazer Resources Ltd. Geophysical Surveys Inc. (Available in MNR Assessment Files)

Private Report, November,1981 - A Report on the Raylloyd-Ram Petroleums Gold Property, Savant Lake, Ontario. G.M. Hogg.

APPENDIX II

Geophysical Instrument Specifications

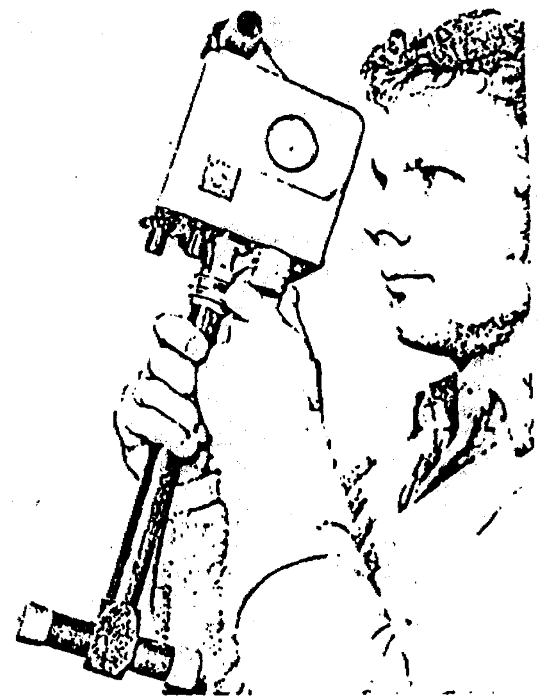
EM16

VLF Electromagnetic Unit

Pioneered and patented exclusively by Geonics Limited, the VLF method of electromagnetic surveying has been proven to be a major advance in exploration geophysical instrumentation.

Since the beginning of 1965 a large number of mining companies have found the EM16 system to meet the need for a simple, light and effective exploration tool for mining geophysics.

The VLF method uses the military and time standard VLF transmissions as primary field. Only a receiver is then used to measure the secondary fields radiating from the local conductive targets. This allows a very light, one-man instrument to do the job. Because of the almost uniform primary field, good response from deeper targets is obtained. The EM16 system provides the in-phase and quadrature components of the secondary field with the polarities indicated. Interpretation technique has been highly developed particularly to differentiate deeper targets from the wealth of surface indications.



PRINCIPLE OF OPERATION

e VLF transmitters have vertical antennas. The magnetic signal component is then horizontal and concentric around the transmitter location.

Specifications

Source of primary field:	VLF transmitting stations.
Transmitting stations used:	Any desired station frequency supplied with the instrument in the form of plug-in tuning units. Two tuning units can be plugged in at one time. A switch selects either station.
Operating frequency range:	About 15 – 25 kHz.
Parameters measured:	(1) The vertical in-phase component (tangent of the tilt angle of the polarization ellipsoid). (2) The vertical out-of-phase (quadrature) component (the short axis of the polarization ellipsoid compared to the long axis).
thod of reading:	In-phase from a mechanical inclinometer; out-of-phase from a calibrated dial. Nulling by audio tone.
Scale range:	In-phase ± 150%; Out-of-phase ± 40%.
Readability:	± 1%.
Reading time:	10 – 40 seconds depending on signal strength.
Operating temperature range:	– 40 to 50° C.
Operating controls:	ON-OFF switch, battery testing push button and meter, station selector switch, volume control, quadrature dial ± 40%, inclinometer dial ± 150%.
Power Supply:	6 size AA (penlight) alkaline cells. Life about 200 hours.
Dimensions:	16 x 5.5 x 3.5 in (42 x 14 x 9 cm).
Weight:	2.5 lbs (1.1 kg).
Instrument supplied with:	Monotonic speaker, carrying case, manual of operation, 3 station selector plug-in tuning units (additional frequencies are optional), set of batteries.
Shipping weight:	10 lbs (4.5 kg).

SCINTREX

MF-2-100 Portable Fluxgate Magnetometer

The MF-2-100 is the latest in a successful line of portable analogue reading fluxgate magnetometers by Scintrex.

Hand-held measurements can be made with an accuracy of a few gammas while precision of one gamma is possible using a portable, lightweight tripod.

The internal sensor provides vertical component measurements for normal field surveys while a remote sensor is available as an accessory for horizontal or other component measurements, or for study of the magnetic properties of rocks.

Features

Compact, internal sensor package permits rapid field surveys.

Rugged and lightweight for portable field use.

Self leveling and orientation insensitive sensor measures vertical component of magnetic field.

High sensitivity in all field strengths.

Low power requirements permit long life of standard dry cell or optional rechargeable batteries.

Will measure accurately anywhere, even in the presence of steep magnetic gradients.

Direct analogue readout can be recorded on any analogue recorder for base station use.

Can be used for measurements of magnetic susceptibility and remanance by bringing samples near to sensor.

State-of-the-art solid state circuitry ensures very low temperature drift.

APPENDIX III

VLF-EM Data Processing Procedure

VLF-EM Data Processing

D. C. FRASER, Chief Geophysicist,
Geophysical Engineering and Surveys Limited,
(Keevil Mining Group Limited),
Toronto, Ontario

ABSTRACT

Geophysical Engineering and Surveys Limited of the Keevil Mining Group have routinely conducted ground surveys with VLF-EM receivers for the past two years. Both Crone's Radem and Ronka's EM16 have been used.

VLF-EM dip-angle data often yield complex patterns which require considerable study for a proper interpretation. A method was developed which allows field operators to transform the noncontourable dip angles into contourable data, producing conductor patterns which are immediately apparent to exploration personnel untrained in VLF-EM interpretation.

VLF-EM contoured data generally peak very close to the top of a conductor, thereby allowing drill holes to be spotted accurately. However, the data generally should not be used alone to select drill targets because structures may be sufficiently conductive to yield strong anomalies. Thus, magnetic and/or vertical-loop EM correlations may be considered as necessary criteria for drilling.

VLF-EM surveys can replace IP surveys in certain environments. For example, the Restigouche orebody in the Bathurst camp of New Brunswick yielded a VLF-EM anomaly as distinct as that obtained by IP, although the body did not respond to vertical- or horizontal-loop EM. However, the cupriferous breccia pipes of the Tribag mine near Batchawana, Ontario yield strong IP anomalies but not VLF-EM anomalies, illustrating that disseminated ore targets should be sought with IP rather than with VLF-EM.

INTRODUCTION

A METHOD HAS BEEN DESCRIBED (Fraser, 1969) which enables somewhat noisy, noncontourable dip-angle data to be transformed into less noisy, contourable data. This data processing is performed routinely by field personnel, and simply involves additions and subtractions.

Both magnetic and VLF-EM data can be collected by a single individual as part of a ground evaluation program. The VLF-EM method can provide contour maps which may be as useful to exploration geologists as magnetic maps. The key to the usefulness, however, lies in the data processing, because raw dip-angle data frequently are more confusing than elucidating. This point is illustrated in *Figure 1*, which presents dip-angle data from the Temagami mine in Ontario. Clearly, the complex pattern requires some thought for proper interpretation. Conversely, *Figure 2* provides a conductor pattern which is immediately apparent even to those untrained in VLF-EM interpretation. It is obtained from the data of *Figure 1*, using the method described in the Appendix. The contoured units are expressed in degrees. Only the positive quantities are contoured.

D. C. FRASER obtained a Bachelor's and a Master's degree in geology at the University of New Brunswick and, in 1966, a Ph.D. degree in geophysics at the University of California at Berkeley. He has performed research on induced polarization, resistivity, magnetics, gravity and electromagnetics, including the design of new interpretation methods employing, in part, digital filtering and correlation techniques. Recently, he has been involved to a considerable extent in mapping conductivity inhomogeneities, first with ground equipment as a thesis problem, and then with airborne equipment in collaboration with Barringer Research Limited.

Dr. Fraser has worked for several petroleum and mining companies and currently is chief geophysicist of Geophysical Engineering & Surveys Limited, a member of the Society of Exploration Geophysicists and of the CIM, and a past president of the Canadian Exploration Geophysical Society.

PAPER PRESENTED: at the 72nd Annual General Meeting of the CIM, Toronto, April, 1970.

KEYWORDS: Geophysical exploration, Data processing, Electromagnetic surveys, Dip angles, VLF-EM surveys, Filter theory, Contouring.

CIM TRANSACTIONS: Vol. LXXIV, pp. 11-13, 1971.

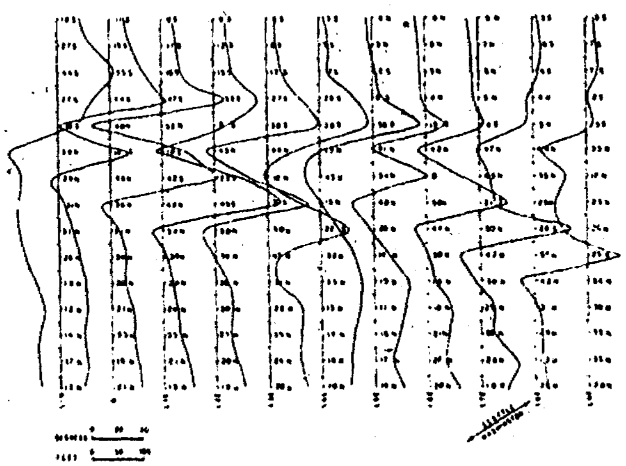


FIGURE 1 — Dip-angle VLF-EM data in the vicinity of the Temagami mine. The arrow defines the primary field direction from the transmitter at Seattle, Washington (after Fraser, 1969).

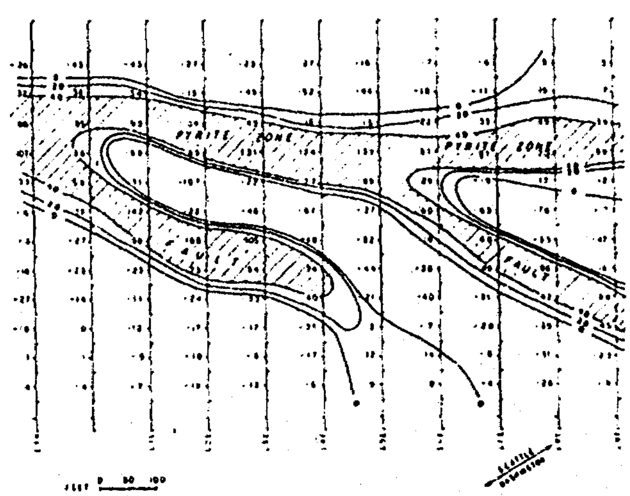


FIGURE 2 — Contoured VLF-EM data, in degrees, as calculated from the map of Figure 1 (after Fraser, 1969).

FIELD EXAMPLES

The following field examples were chosen to illustrate the three primary uses to which VLF-EM has been applied by Geophysical Engineering and Surveys Limited.

General Prospecting

General prospecting or ground evaluation provides the most common use for VLF-EM. Ground often is obtained which requires only a general approach to exploration, as when there is insufficient geological information regarding the specific target sought. In such cases, magnetic and VLF-EM surveys are routinely performed without the guidance of a geophysicist. VLF-EM conductors are tested by short traverses with vertical-loop EM. The anomaly patterns generally are sufficiently clear so that mapping, trenching, drilling or abandonment will be decided without consulting a geophysicist. Exceptions can occur when patterns become complex.

Figure 3 illustrates a survey in which two strong VLF-EM conductors were obtained. The southern anomaly has vertical-loop EM correlation and the northern one does not. The VLF-EM anomaly with vertical-loop correlation also coincides with a magnetic anomaly, and probably is due to magnetic sulphides. It will be drilled shortly. The other equally strong VLF-EM anomaly without vertical-loop correlation does not parallel the magnetic patterns, and probably is due to a fault.

In Place of IP

There are certain environments where VLF-EM can be used as an alternate to IP. These are the environments characterized by massive or heavily disseminated sulphides which occur within 300 feet of surface and yet do not respond to conventional EM. IP was considered to be the most suitable geophysical method for the detection of such bodies (Hallof, 1967). However, it is well worth testing VLF-EM in these environments because of the very substantial cost savings that result if the method is responsive. As an example, *Figure 4* illustrates a VLF-EM survey over the Restigouche orebody in the Bathurst area of New Brunswick. *Figure 5*, showing IP chargeability contours, allows a comparison to be made of the relative merits of IP and VLF-EM for this type of mineralization. The Restigouche body did not respond to vertical- or horizontal-loop EM because of the high sphalerite content of the massive sulphides.

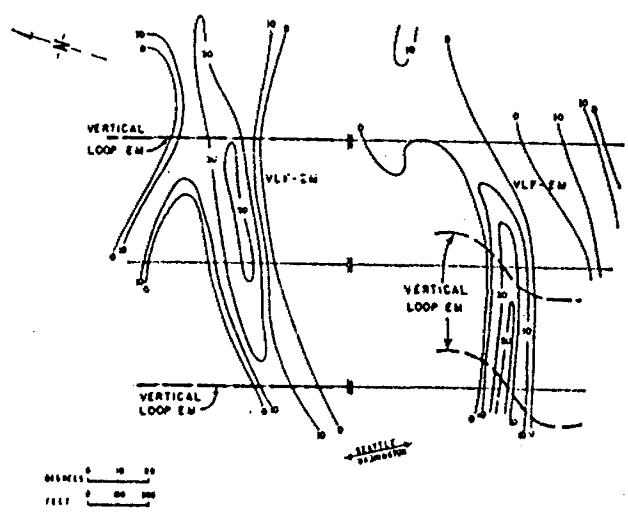


FIGURE 3 — Contoured VLF-EM in degrees and vertical-loop EM profiles (1,200 hz) from a property evaluation survey in the Uchi Lake area.

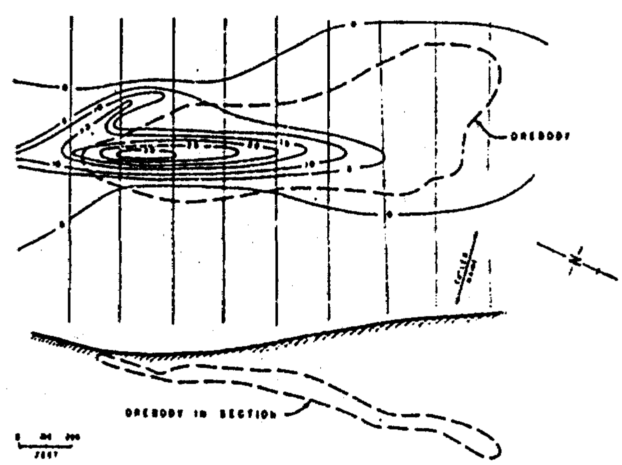


FIGURE 4 — Contoured VLF-EM in degrees from the Restigouche orebody, illustrating that the method is a viable alternate to IP in this environment (cf. Figure 5).

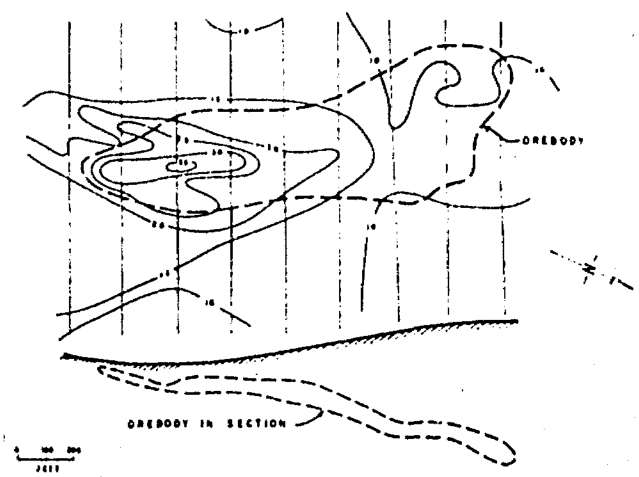


FIGURE 5 — Gradient-array IP chargeability in milliseconds over the Restigouche orebody, for comparison with the VLF-EM data of Figure 4.

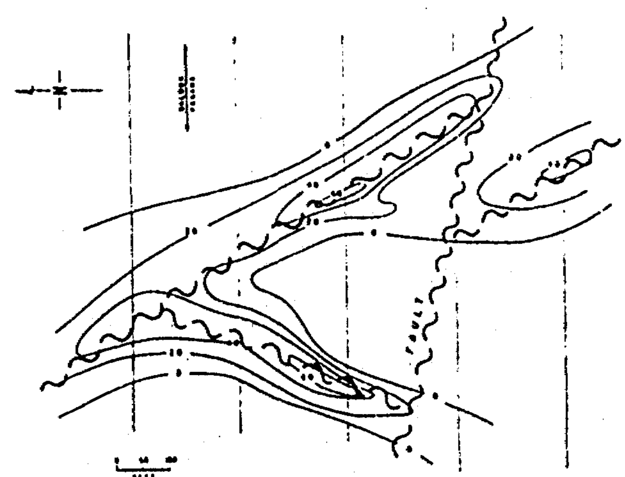


FIGURE 6 — Contoured VLF-EM in degrees from a fault-mapping survey in the Cobalt area.

Other environments described in Hallof (1967) would not be as amenable to the use of VLF-EM in place of IP. A truly disseminated copper deposit will not provide a VLF-EM anomaly but will yield a large IP effect, as was found to be the case for the breccia pipes of the Tribag mine near Batchawana, Ontario.

Structural Interpretation

Inasmuch as VLF-EM responds well to structures, the method has been applied to the mapping of faults. An example is shown in *Figure 6*, which depicts a portion of a survey in the Cobalt area of Ontario. The property was a silver prospect where the veins were postulated to be associated with faults. VLF-EM appeared to be the most reasonable geophysical method available to aid in tracing these faults. Considerable drilling has been done on this property, and the fault interpretation was verified.

Figure 2 illustrates that faults can be as conductive to VLF-EM as massive pyrite. In this Temagami example, the faults contain a brecciated matrix with some hematite cementing. They yield a strong IP anomaly, but are non-conductive to conventional EM.

DEPTH OF EXPLORATION

The relatively high transmitted frequency of approximately 20,000 hz severely limits the depth of exploration in areas of conductive overburden. As an example, penetration of the 100 to 200 feet of clay in the Timmins area often is not achieved.

In regions where the overburden has a less exceptional conductivity, such as the Bathurst area, depth of exploration generally is limited to about 300 feet. This depth was predicted from model curves in Fraser (1969), and appears to be true in practice, as over the Restigouche deposit (*Figure 4*).

CONCLUDING REMARKS

VLF-EM surveys are exceptionally easy to perform, but the dip-angle data may be exceedingly difficult to interpret correctly. This latter point has produced unfavourable comments regarding the utility of VLF-EM as a prospecting tool. The data-processing method used to transform somewhat noisy, noncontourable dip angles into less noisy, contourable data greatly increases the value of VLF-EM surveys.

The efficiency of data flow is significantly increased in the case of an active mining company performing such surveys in large quantities. This is because the contoured maps may be used directly by geologists in charge of their various projects, rather than requiring a geophysicist to study each dip-angle map.

Contoured VLF-EM maps form a useful complement to magnetic maps. The survey and data-processing cost is similar to that for a hand-held fluxgate magnetometer.

For general exploration in the Shield, VLF-EM conductors generally should be tested with vertical-loop EM to separate massive sulphides (and graphite) from conductive structures. As such structures can be mapped with VLF-EM, this provides another use for the method. Further, some massive and heavily disseminated sulphides, which do not respond to conventional EM, will yield VLF-EM anomalies as distinct as those obtained by IP. These three uses of VLF-EM, i.e., for general prospecting, mapping of structures and as a judicious alternate to IP, form our primary applications of VLF-EM to property evaluation.

APPENDIX

The Data-Processing Technique

THE DATA-PROCESSING TECHNIQUE is described in detail by Fraser (1969), where it is also discussed in terms of filter theory*. The method is very simple to apply, as is shown by the example of *Figure 7*. This figure illustrates that the contourable quantity is the sum of the values at two adjacent stations minus the sum at the next two adjacent stations. The above-referenced paper presents a tabulation method suited to the processing of this dip-angle data. The calculations are performed in the field by the instrument operators.

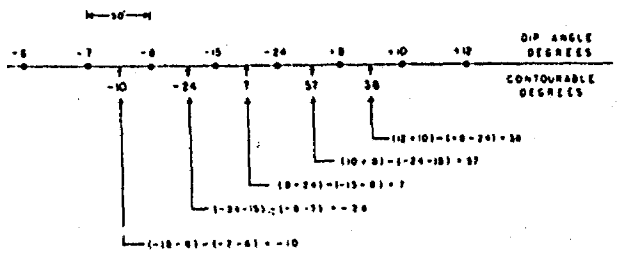


FIGURE 7 — Example of the data processing calculations, illustrating that the contoured quantities are obtained simply from additions and subtractions performed on the dip angles.

A 50-foot station interval is recommended to avoid the problem of near-surface conductors appearing as deeper conductors, as could occur if the station spacing was larger. In actual practice, data are collected at 100-foot intervals, with 50-foot readings being taken where anomalies occur. Later, 50-foot artificial data are interpolated in non-anomalous areas prior to performing the calculations. This procedure avoids some confusion in the contour patterns which would result from near-surface 'geological noise'.

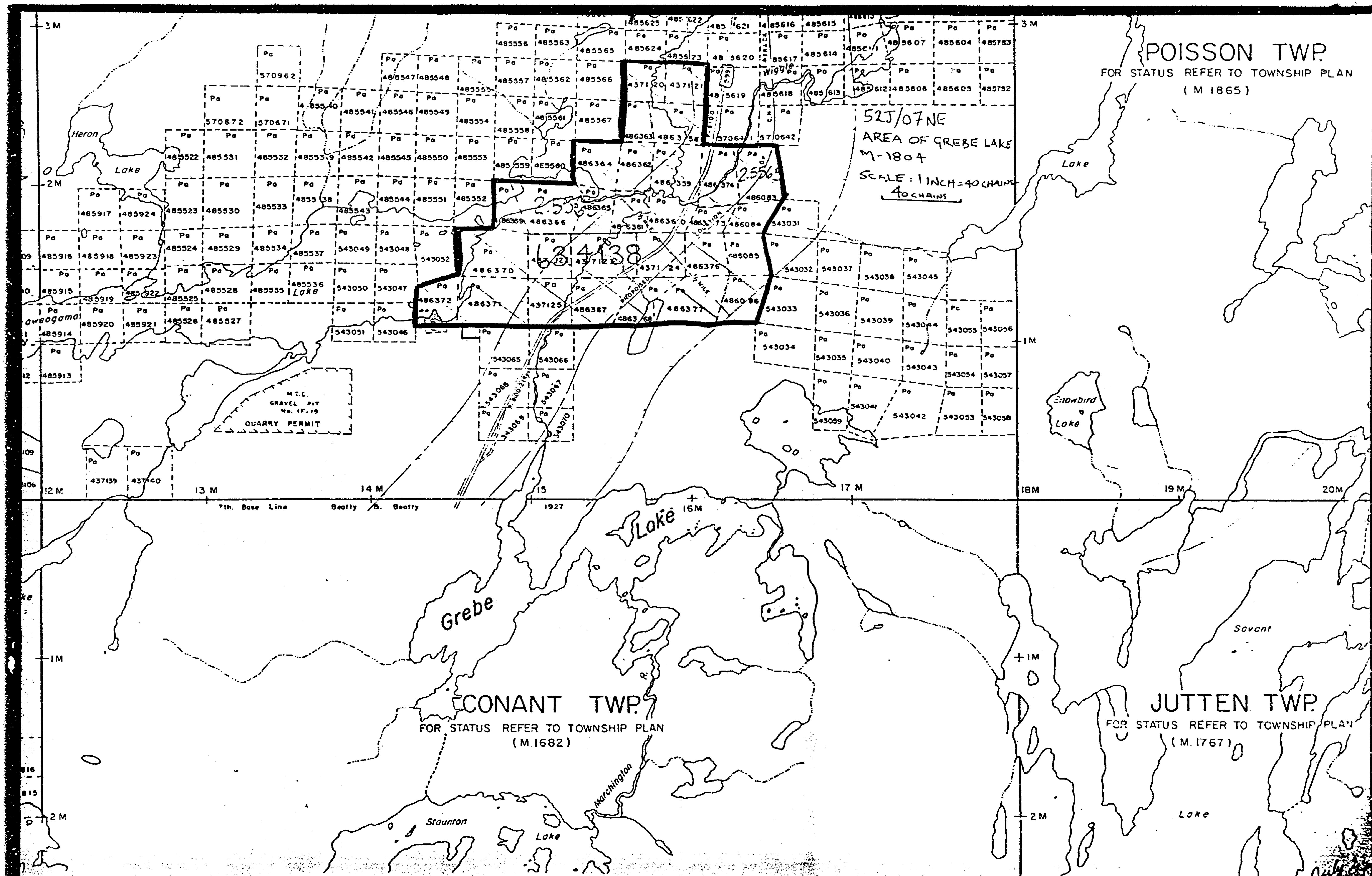
Normally, only the positive values are contoured, because the negative quantities generally represent anomaly flanks. Consequently, the inclusion of negative contours would serve only to confuse the conductor patterns. However, if a backward crossover was produced by a geological source, an erroneous interpretation of the contour map and the dip-angle profiles would result. To date, such a crossover has not been recognized on the predominantly in-phase dip-angle data.

REFERENCES

Fraser, D. C., (1969), Contouring of VLF-EM Data; *Geophysics*, Vol. 34, pp. 958-967.

Hallof, P. G., (1967), The Use of Induced Polarization Measurements to Locate Massive Sulphide Mineralization in Environments in which EM Methods Fail; paper presented at Canadian Centennial Conference on Mining and Groundwater Geophysics, Niagara, Ontario.

*The technique is analogous to passing the dip-angle data through a bandpass filter which (1) completely removes DC bias and greatly attenuates long wave lengths, (2) completely removes Nyquist frequency noise, (3) phase-shifts all frequencies by 90 degrees and (4) has the bandpass centered at a wave length of five times the station spacing.

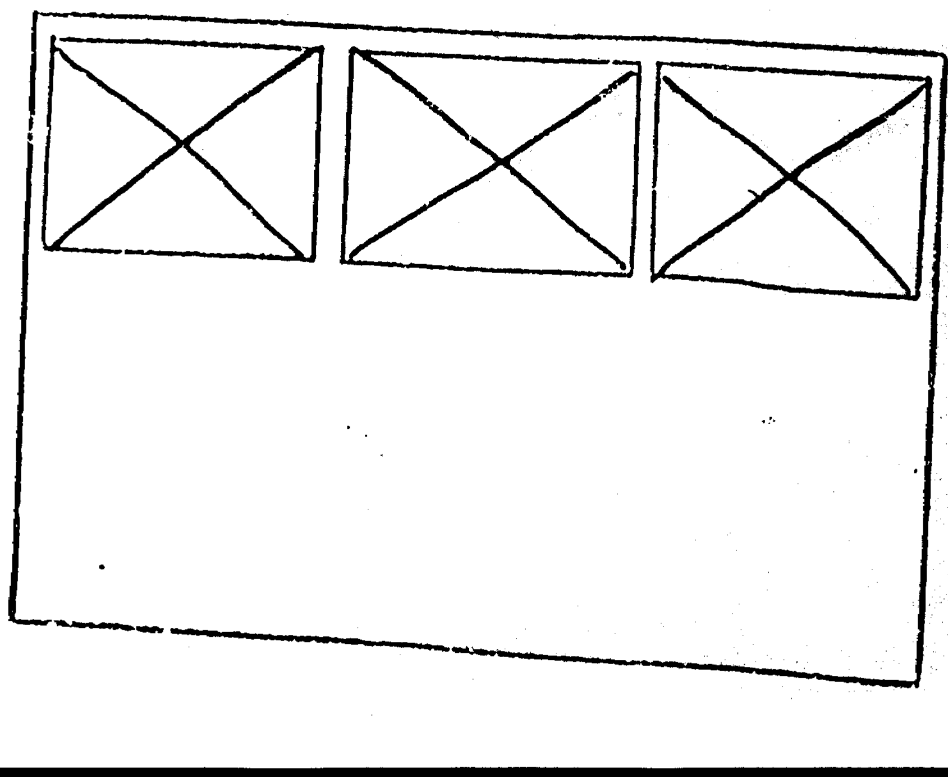


POISSON TWP.
FOR STATUS REFER TO TOWNSHIP PLAN
(M 1865)
52J/07NE
AREA OF GREBE LAKE
M-1804
SCALE: 1 INCH=40 CHAINS
40 CHAINS
634138
Heron Lake
Lake
Snowbird Lake
M.T.C.
GRAVEL PIT
No. 1F-19
QUARRY PERMIT
7th. Base Line
Beatty & Beatty
1927
Grebe Lake
Savant
Lake
CONANT TWP.
FOR STATUS REFER TO TOWNSHIP PLAN
(M.1682)
JUTTEN TWP.
FOR STATUS REFER TO TOWNSHIP PLAN
(M.1767)
Staunton Lake
Marchington

SEE ACCOMPANYING MAP(S) IDENTIFIED AS

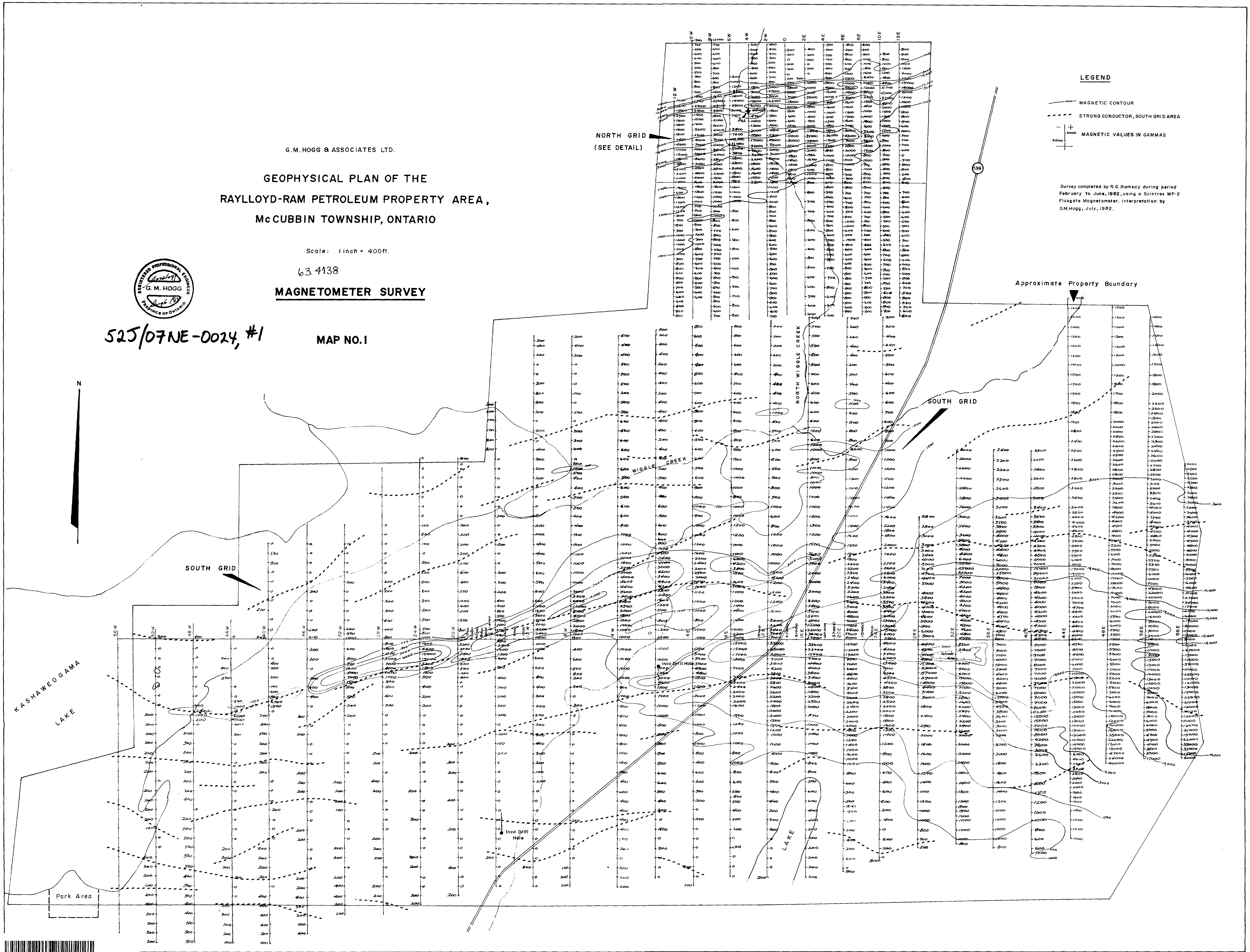
52J/07NE-0024 #1-3

LOCATED IN THE MAP CHANNEL IN THE FOLLOWING SEQUENCE (X)



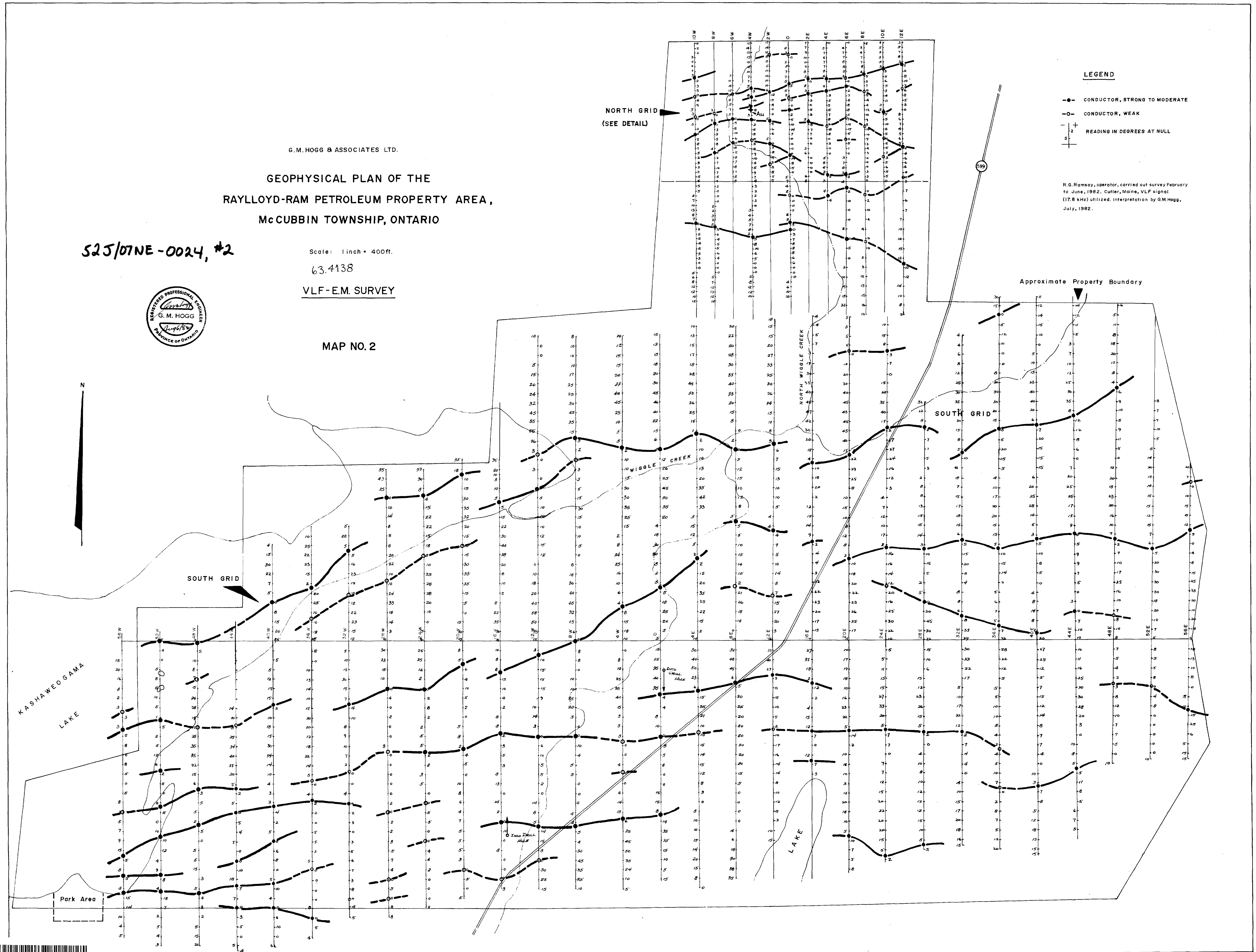
FOR ADDITIONAL INFORMATION SEE MAPS:

52J/07NE-0024 #4



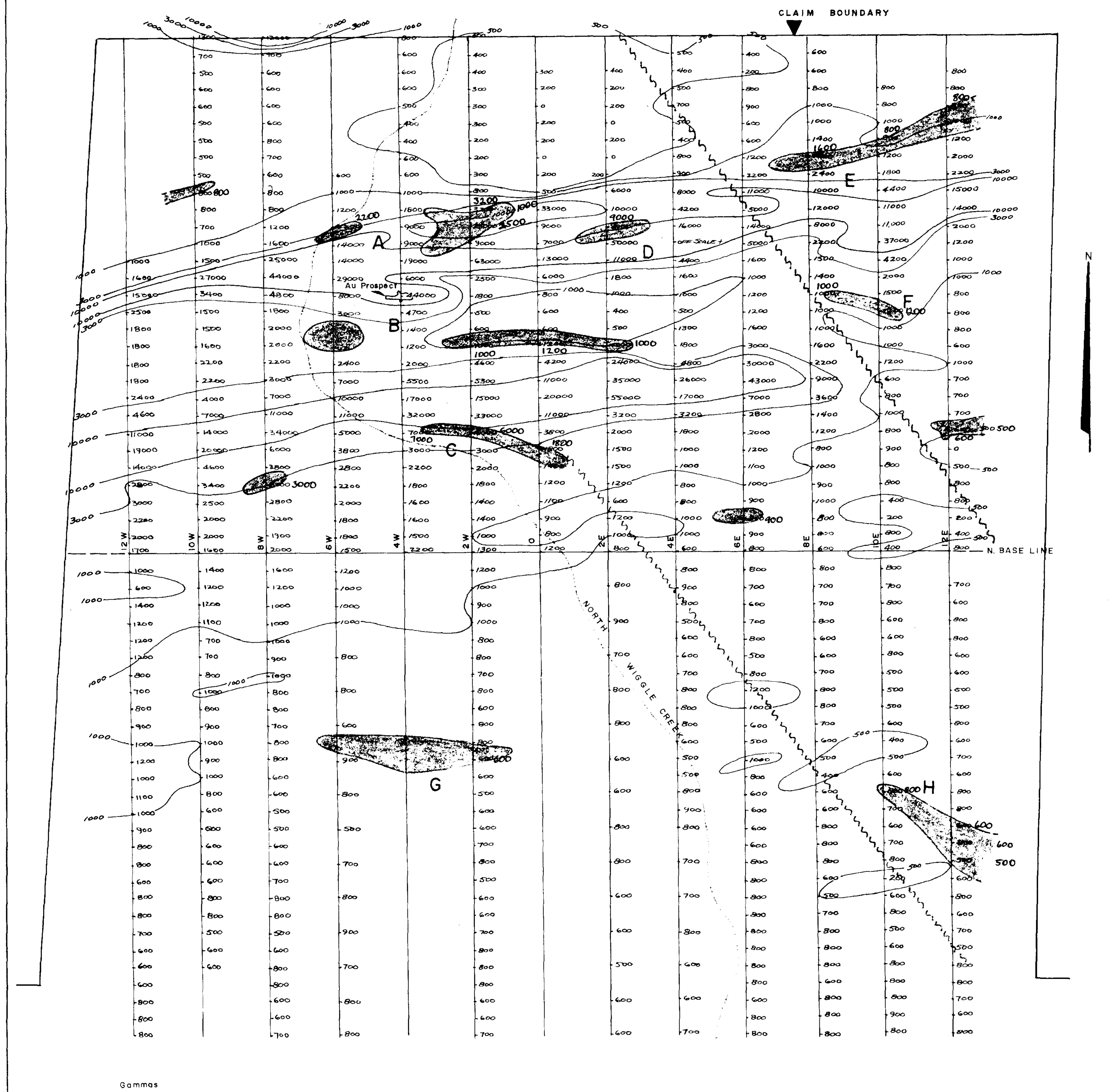
52J07NE0018 52J07NE0024 GREBE LAKE

200



52J07NE0016 52J07NE0024 SREBE LAKE

210



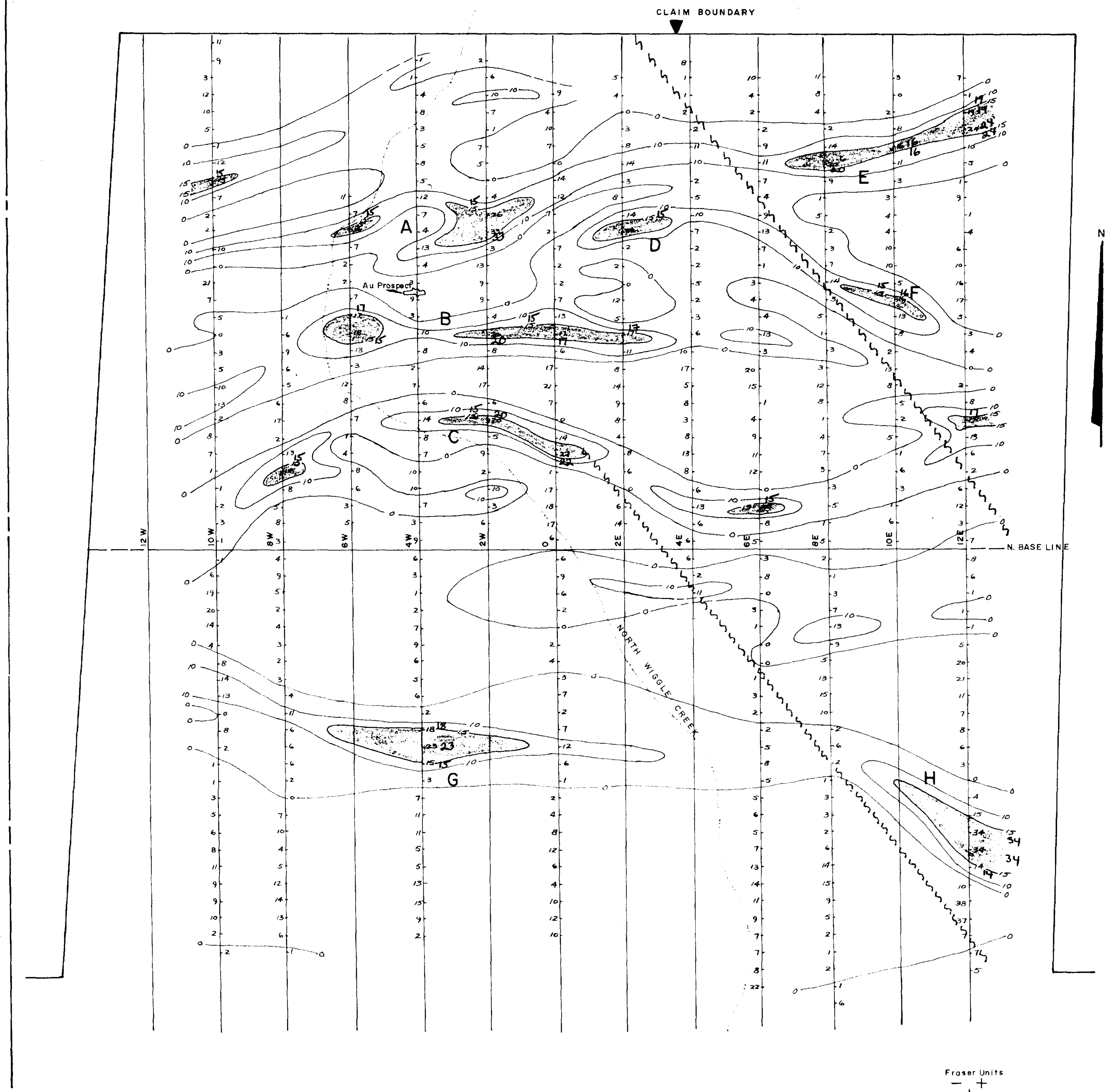
MAGNETIC CONTOUR PLAN

Gammas

Magnetic Contour

VLF-EM Anomaly Location

Inferred Fault



VLF-EM CONTOUR PLAN

Fraser Units

VLF-EM Contour

VLF-EM Anomaly (15+ units)

Inferred Fault

63.4138

G. M. HOGG & ASSOCIATES LTD.

DETAIL GEOPHYSICAL PLAN OF THE NORTH GRID AREA, RAYLLOYD-RAM PETROLEUM PROPERTY McCUBBIN TOWNSHIP, ONTARIO

REGISTERED PROFESSIONAL ENGINEER G. M. HOGG PROVINCE OF ONTARIO

Scale: 1 inch = 200 ft.

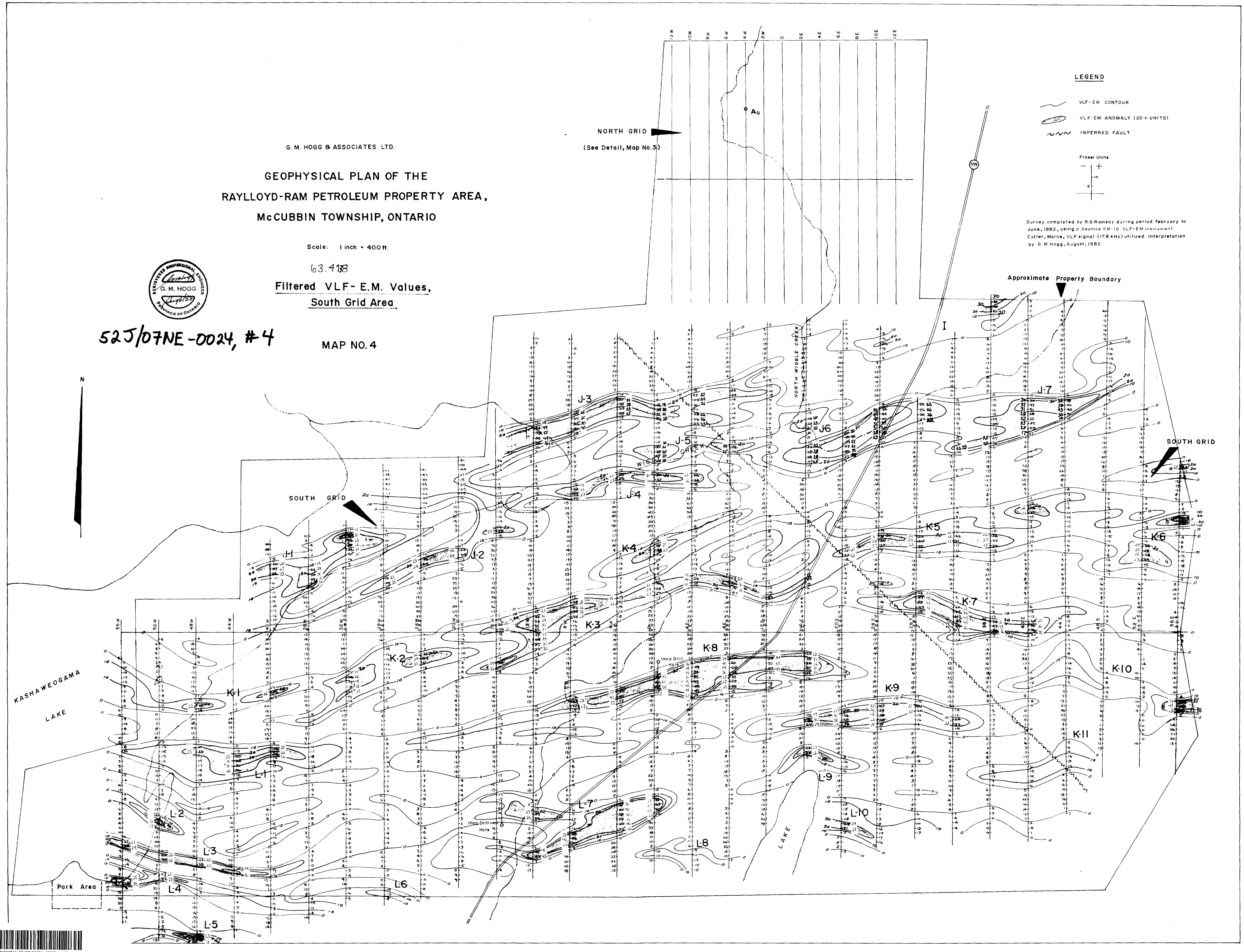
MAP NO. 3

52J/07NE-0024, #3

G.M.H JULY, 1982

52J07NE0016 52J07NE0024 GREBE LAKE

220



G. M. HOGG & ASSOCIATES LTD.
GEOPHYSICAL PLAN OF THE
RAYLLOYD-RAM PETROLEUM PROPERTY AREA,
McCUBBIN TOWNSHIP, ONTARIO
Scale: 1 inch = 400 ft.
63.4188
Filtered VLF- E.M. Values,
South Grid Area
52J/07NE-0024, #4
MAP NO. 4
G. M. HOGG
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
NORTH GRID
(See Detail, Map No.3)
LEGEND
VLF-EM CONTOUR
VLF-EM ANOMALY (20+UNITS)
INFERRED FAULT
Fraser Units
Survey completed by R.G.Ramsay during period February to June, 1982, using a Geonics EM-16 VLF-EM instrument. Cutler, Maine, VLF signal (17.8 kHz) utilized. Interpretation by G.M.Hogg, August, 1982.
Approximate Property Boundary
SOUTH GRID
NORTH WIGGLE CREEK
WIGGLE CREEK
KASHAWEOGAMA
LAKE
LAKE
Park Area
Inco Drill Hole
Au
N
J-1
J-2
J-3
J-4
J-5
J6
J-7
K-1
K-2
K-3
K-4
K-5
K-6
K-7
K-8
K-9
K-10
K-11
L-1
L-2
L-3
L-4
L-5
L-6
L-7
L-8
L-9
L-10
I
230