REPORT ON AN

AIRBORNE MAGNETIC - ELECTROMAGNETIC SURVEY

IN WARDEN TOWNSHIP, ONTARIO

AMAX POTASH LIMITED
7 King Street East,
Toronto, Ontario.
M5C 1A2

April 1979

A. Watts
I. INTRODUCTION

During the period between November 21 and December 8, 1978, Questor Surveys Limited carried out an airborne Input electromagnetic survey over two claims in south central Warden township for Amax Potash Limited.

The objective of the survey was to evaluate the claims for the presence of economic concentrations of conductive metallic minerals known to exist in the area, with a view to following up on the ground responses which lent sufficient encouragement.

II. PERSONNEL

Amax was represented by A. Watts, a staff geophysicist from Amax's Toronto office. S. Kilty was the Questor party manager, Clermont Ferrand the chief survey pilot. D. Watson of Questor paid a supervisory visit during the course of the survey.

III. SURVEY EQUIPMENT AND COVERAGE

The airborne survey was carried out utilizing the Mark VI Input electromagnetic system and a Geometrics G-803 proton precession magnetometer. A radar altimeter was used for vertical control. The outputs of these instruments together with fiducial timing marks are recorded by means of a galvanometer type recorder (Honeywell Visicorder) using light sensitive paper. A thirty-five millimeter continuous strip camera provided the required photographic record for adequate flight-path recovery. For a detailed description of the survey equipment see Appendix B.

Entire survey coverage totalled 1743 line miles at both 1/8 and ¼ mile line spacings. Coverage of the two claims in question totals approximately 1 (one) mile. Assessment credit of 40 days for the airborne electromagnetic and magnetics is requested in conformity with the Ontario Mining Act.
CLAIM MAP

PROJECT 839-07

WARDEN - 1
Warden Township
1" = ¼ mile
NTS: 42-A-9
IV. GEOLOGY

No outcrop was observed on the property. The claims are covered with glacial lacustrine clays overgrown with thick bush.

The nearest outcrop is located approximately $\frac{1}{2}$ mile south-east of post #2 of claim L-500066. A large rounded exposure of peridotite forms a low ridge at this point.

Diamond drilling carried out on strike with the claim group to the west revealed interflows of basic to intermediate volcanics with gabbro and diorite intrusives.

Both regional magnetics and the property survey by McIntyre illustrate the strike of the underlying geology to be east-west with the Amax claims to be in an area of higher magnetic relief than the northern portion of the township.

It is presumed that the claims are underlain by volcanic flow rocks of basic to intermediate composition. The magnetite rich body adjacent to the conductor may represent a gabbro or other basic intrusive.

V. PREVIOUS WORK

Observed in Field:

The only evidence of past exploration activity are the lines and claims established by McIntyre during their follow-up of the AEM anomaly in May 1975.

Assessment Files:

An AEM survey contracted by Kennco overflew the present claim group and detected a series of features to the west and a single isolated anomaly north of claim L-500066 on a patented lot.

There is no record of follow-up on this anomaly.

Work was carried out by Mespi, Kennco and Broulan-Reef to the west of the claims. This work involved ground geophysical surveys and some diamond drilling. Most of the conductive features tested were caused by graphite and/or pyrite units within basic to acid volcanic flow rocks.
McIntyre completed an In-phase - Out-of-phase AEM survey over several surrounding townships in 1973. An anomaly was detected in the location of the present claim group and evaluated with horizontal loop and magnetic surveys. A drill hole was recommended but was not located in the Amax geological survey.

VI. PRESENTATION OF AEM AND MAGNETICS

The symbols used to designate the electromagnetic anomalies are shown in the legend on the electromagnetic and magnetics plan map provided. The anomalies on each line are lettered in alphabetical order in the direction of flight. Their locations are plotted with reference to the fiducial numbers on the analog record.

All the anomaly locations, magnetic correlations, conductivity thickness values and amplitudes of channel number 2 are clearly depicted for each individual anomaly on the plan map itself.

The magnetics has been computer contoured at a contour interval of 20 gammas and is superimposed on the Input results.

VII. DISCUSSION OF AEM AND MAGNETIC RESULTS

Only one conductor was detected over the claim group. This is Anomaly B on flight-line 10180 S which is situated in the central portion of the claim group, immediately east of low swampy ground.

The Input profiles indicate the presence of weakly conductive overburden to the north of the anomaly, as indicated by departure from background of several hundred ppm (parts per million) on the first channel Input trace. The anomaly itself is poorly conductive, with an estimated conductivity-thickness product of less than 1 mho and a depth to the top of less than 20 feet. Poor conductivity and lack of well defined response characteristics point to a probable surficial source for Anomaly B, a localized increase in overburden thickness being the cause.
The magnetics indicates the presence of a strongly magnetic linear feature trending north-east, north of the claim group. This feature has been mapped as a diabase dyke, and because of the strong magnetic gradient created by the dyke, any subtle magnetic feature which might be associated with Anomaly B has been masked.

VIII. SUMMARY AND CONCLUSIONS

Input coverage of this claim group has revealed only one weakly conductive, and poorly defined response over the claim group. These factors coupled with indications of conductive overburden to the north point to a localised increase in conductivity and/or thickness of overburden as the source of the Input response.

No further work is deemed necessary on this claim group.

April 1979
Timmins, Ontario

A. Watts
A. H. Watts
Geophysicist
## APPENDIX A

**SCHEDULE OF CLAIMS**

**PROJECT 839-07**

<table>
<thead>
<tr>
<th>Claim No.</th>
<th>Township</th>
<th>Con.</th>
<th>Lot</th>
<th>Acres</th>
<th>Staking Date</th>
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<tbody>
<tr>
<td>500071</td>
<td>Warden</td>
<td>11</td>
<td>7</td>
<td>40</td>
<td>June 13, 1977</td>
</tr>
<tr>
<td>500066</td>
<td>Warden</td>
<td>11</td>
<td>6</td>
<td>40</td>
<td>June 13, 1977</td>
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</table>
APPENDIX B

EQUIPMENT

The aircraft are equipped with Mark VI INPUT (R) airborne E.M. systems and Geometrics G-803 proton precession magnetometers. Radar altimeters are used for vertical control. The outputs of these instruments together with fiducial timing marks are recorded by means of galvanometer type recorders using light sensitive paper. Thirty-five millimeter continuous strip cameras are used to record the actual flight path.

(I) BARRINGER/QUESTOR MARK VI INPUT (R) SYSTEM

The Induced Pulse Transient (INPUT) system is particularly well suited to the problems of overburden penetration. Currents are induced into the ground by means of a pulsed primary electromagnetic field which is generated in a transmitting loop around the aircraft. By using half sine wave current pulses and a loop of large turns-area, the high output power needed for deep penetration is achieved.

The induced current in a conductor produces a secondary electromagnetic field which is detected and measured after the termination of each primary pulse. Detection is accomplished by means of a receiving coil towed behind the aircraft on four hundred feet of cable,
and the received signal is processed and recorded by equipment in the aircraft. Since the measurements are in the time domain rather than the frequency domain common to continuous wave systems, interference effects of the primary transmitted field are eliminated. The secondary field is in the form of a decaying voltage transient originating in time at the termination of the transmitted pulse. The amplitude of the transient is, of course, proportional to the amount of current induced into the conductor and, in turn, this current is proportional to the dimensions, the conductivity and the depth beneath the aircraft.

The rate of decay of the transient is inversely proportional to conductivity. By sampling the decay curve at six different time intervals, and recording the amplitude of each sample, an estimate of the relative conductivity can be obtained. By this means, it is possible to discriminate between the effects due to conductive near-surface materials such as swamps and lake bottom silts, and those due to genuine bedrock sources. The transients due to strong conductors such as sulphides exhibit long decay curves and are therefore commonly recorded on all six channels. Sheet-like surface materials, on the other hand, have short decay curves and will normally only show a response in the first two or three channels.
(iii)

The samples, or gates, are positioned at 310, 490, 760, 1120, 1570 and 2110 micro-seconds after the cessation of the pulse. The widths of the gates are 180, 180, 360, 360, 540 and 540 micro-seconds respectively.

For homogeneous conditions, the transient decay will be exponential and the time constant of decay is equal to the time difference at two successive sampling points divided by the log ratio of the amplitudes at these points.

(II) GEOMETRICS G-803 PROTON PRECESSION MAGNETOMETER

The magnetometers which measure the total magnetic field have a sensitivity of 1 gamma and a range from 20,000 gammas to 100,000 gammas.

Because of the high intensity field produced by the INPUT transmitter, the magnetometer results are recorded on a time-sharing basis. The magnetometer head is energized while the transmitter is on, but the read-out is obtained during a short period when the transmitter is off. Using this technique, the head is energized for 1.15 seconds while the precession frequency is being recorded and converted to gammas. Thus a magnetic reading is taken every 1.3 seconds.
DATA PRESENTATION

The symbols used to designate the anomalies are shown in the legend on each map sheet, and the anomalies on each line are lettered in alphabetical order in the direction of flight. Their locations are plotted with reference to the fiducial numbers on the analog record.

A sample record is included to indicate the method used for correcting the position of the E.M. Bird and to identify the parameters that are recorded.

All the anomaly locations, magnetic correlations, conductivity-thickness values and the amplitudes of channel number 2 are listed on the data sheets accompanying the final maps.

GENERAL INTERPRETATION

The INPUT system will respond to conductive overburden and near-surface horizontal conducting layers in addition to bedrock conductors. Differentiation is based on the rate of transient decay, magnetic correlation and the anomaly shape together with the conductor pattern and topography.

Power lines sometimes produce spurious anomalies but these can be identified by reference to the monitor channel.
Railroad and pipeline responses are recognized by studying the film strips.

Graphite or carbonaceous material exhibits a wide range of conductivity. When long conductors without magnetic correlation are located on or parallel to known faults or photographic linears, graphite is most likely the cause.

Contact zones can often be predicted when anomaly trends coincide with the lines of maximum gradient along a flanking magnetic anomaly. It is unfortunate that graphite can also occur as relatively short conductors and produce attractive looking anomalies. With no other information than the airborne results, these must be examined on the ground.

Serpentinized peridotites often produce anomalies with a character that is fairly easy to recognize. The conductivity which is probably caused in part by magnetite, is fairly low so that the anomalies often have a fairly large response on channel #1; they decay rapidly, and they have strong magnetic correlation. INPUT E. M. anomalies over massive magnetites show a relationship to the total Fe content. Below 25 - 30%, very little or no response at all is obtained, but as the percentage increases the anomalies become quite strong with a characteristic rate of decay which is usually greater than that produced by massive sulphides.
Commercial sulphide ore bodies are rare, and those that respond to airborne survey methods usually have medium to high conductivity. Limited lateral dimensions are to be expected and many have magnetic correlation caused by magnetite or pyrrhotite. Provided that the ore bodies do not occur within formational conductive zones as mentioned above, the anomalies caused by them will usually be recognized on an E.M. map as priority targets.
**Type of Survey(s):** Aeromagnetic - electromagnetic

**Township or Area:** Warden

**Claim Holder(s):** Amax Potash Limited

**Survey Company:** Questor Surveys Limited

**Author of Report:** A. Watts

**Address of Author:** 1302, 7 King St. East, Toronto, Ontario

**Covering Dates of Survey:** November 17 to December 8, 1978 (linecutting to office)

**Total Miles of Line Cut:**

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**MINING CLAIMS TRAVERSED**

List numerically

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<th>(prefix)</th>
<th>(number)</th>
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<tbody>
<tr>
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<tr>
<td>1</td>
<td>500066</td>
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</tbody>
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**AIRBORNE CREDITS** (Special provision credits do not apply to airborne surveys)

- Magnetometer: 20
- Electromagnetic: 20
- Radiometric: 20

**DATE:** May 10, 1979

**SIGNATURE:** A. Watts

Author of Report or Agent

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**Res. Geol.**

**Qualifications**

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**Previous Surveys**

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<th>Type</th>
<th>Date</th>
<th>Claim Holder</th>
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</table>

**TOTAL CLAIMS:** 2
GEOPHYSICAL TECHNICAL DATA

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

<table>
<thead>
<tr>
<th>Number of Stations</th>
<th>Number of Readings</th>
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<table>
<thead>
<tr>
<th>Station interval</th>
<th>Line spacing</th>
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<table>
<thead>
<tr>
<th>Profile scale</th>
<th>Contour interval</th>
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<tbody>
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</tbody>
</table>

Instrument

Accuracy — Scale constant

Diurnal correction method

Base Station check-in interval (hours)

Base Station location and value

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MAGNETIC

Instrument

Accuracy — Scale constant

Diurnal correction method

Base Station check-in interval (hours)

Base Station location and value

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ELECTROMAGNETIC

Instrument

Coil configuration

Coil separation

Accuracy

Method: □ Fixed transmitter □ Shoot back □ In line □ Parallel line

Frequency (specify V.L.F. station)

Parameters measured

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GRAVITY

Instrument

Scale constant

Corrections made

Base station value and location

Elevation accuracy

---

INDUCED POLARIZATION

Instrument

Method □ Time Domain □ Frequency Domain

Parameters — On time

— Off time

— Delay time

— Integration time

Frequency

Range

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RESISTIVITY

Power

Electrode array

Electrode spacing

Type of electrode
**SELF POTENTIAL**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Method</td>
<td></td>
</tr>
<tr>
<td>Corrections made</td>
<td></td>
</tr>
</tbody>
</table>

**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) | Aeromagnetic - electromagnetic |
| Instrument(s) | Input configuration | Geometrics G-803 magnetometer |
| Accuracy | 1 gamma aeromag | 1 ppm for aeroelectromagnetic |
| Aircraft used | Trislander |
| Sensor altitude | 150' AEM | 400' AMAG |
| Navigation and flight path recovery method | visual - fiducial |
| Aircraft altitude | 400' | Line Spacing 1/8 |
| Miles flown over total area | 1800 | Over claims only 1 mile |
**GEOCHEMICAL SURVEY – PROCEDURE RECORD**

Numbers of claims from which samples taken

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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

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**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

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**SAMPLE PREPARATION**

( Includes drying, screening, crushing,ashing)

Mesh size of fraction used for analysis

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General

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THE TOWNSHIP OF
WARDEN
DISTRICT OF COCHRANE
LARDER LAKE
MINING DIVISION
SCALE: 1-INCH = 40 CHAINS

LEGEND
PATENTED LAND
CROWN LAND SALE
LEASES
LOCATED LAND
LICENSE OF OCCUPATION
MINING RIGHTS ONLY
SURFACE RIGHTS ONLY
ROADS
IMPROVED ROADS
KING'S HIGHWAYS
RAILWAYS
POWER LINES
MARSH OR MUSKEG
MINES

NOTES
400 surface rights reservation around all lakes and rivers.

DATE OF ISSUE
MAY 1, 1979
SURVEYS AND MAPPING BRANCH

PLAN NO.- M 397
ONTARIO
MINISTRY OF NATURAL RESOURCES
SURVEYS AND MAPPING BRANCH