COMINCO LTD.

Exploration

Eastern District

REPORT ON

GEOPHYSICAL SURVEYS

HALKIRK PROPERTY

FORT FRANCES AREA, ONTARIO

May 23, 1967

George D. Tikkanen
The Consolidated Mining and Smelting Company of Canada Limited

LOCATION MAP OF
HALKIRK PROPERTY
FORT FRANCES AREA
ONT.

SCALE: 1" = 40 CHS.
DATE: May 17, 1967
PLATE:

DRAWN BY: F.A. Herveth
TRACED BY:

<table>
<thead>
<tr>
<th>REVISED BY</th>
<th>DATE</th>
<th>REVISED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rainy Lake
A combined induced polarization and resistivity survey was made on the central portion of the Halkirk Property. The results show a wide range of anomalous effects, but several strong anomalies occur which warrant further investigation.

A magnetic survey was carried out, chiefly to aid in the interpretation of the IP results. The magnetic data shows abrupt variations, due to an extremely variable magnetite content and very shallow overburden. These considerations limit the usefulness of the magnetic results.
INTRODUCTION

The Halkirk property is located in Watten and Halkirk Townships, 15 miles ENE of Fort Frances, Ontario. Access is by way of Highway No. 11, approximately one-half mile northeast of the property.

The property is held by Cominco Ltd., 630 Dorchester Blvd., Montreal, P.Q., under option from M. Hupchuk, 1324 - 5th St. E., Fort Frances.

The geophysically surveyed property consists of the following 21 mining claims: 15832 to 15835, 15854 to 15859, 16013 to 16019, and 16498 to 16501, all inclusive.

Work to date by Cominco includes line-cutting and geological mapping.

GEOLOGY

The geology is fully covered in a separate report. Briefly, the area is underlain by a series of rocks which include altered gabbro on the northwest, then gabbro, altered volcanics, and metasediments on the southeastern edge of the property. Scattered sulphides were noted. Copper-nickel mineralization is sought.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Method:

The survey was performed by McPhar Geophysics Ltd., operator Gordon Trefenanko, between March 25 and April 24, 1967.

The survey was made with a McPhar frequency domain induced polarization unit, operating at 0.3 and 5 cycles per second.

About 9.7 line miles of survey were done at the standard reconnaissance electrode spacing of 200 feet, and in addition, 1.5 miles were resurveyed at a detail spacing of 100 feet, for a total survey coverage of 11.2 line miles. Readings were taken at n values of 1, 2 and 3 in all cases.

The lines were spaced at 400-foot intervals, with minor fill-in work at closer intervals.

Discussion:

The metal factor plan shows the surface projection of the IP anomalies, which were selected from a study of the data plots, and the plan also shows the second separation (n=2) values for the metal factor in contoured form. The second separation has been contoured to show line to line correlation of the results at an intermediate...
The anomaly locations will not necessarily coincide with the contoured peaks on the second separation, since the first and third separations, if anomalous, will have been considered as well in the location of the anomaly. The most profitable use of the contours is as a trend indicator.

The anomalies have been classified into three groups: definite, probable and possible. The grouping was based on the strength of the metal factor, the frequency effect, and the pattern of the anomaly. In general, the true metal factor should be related to the volume of chargeable material, however the survey measures the apparent metal factor, and a large volume with a small percentage of sulphides could show the same metal factor value as a smaller body with a higher percentage of sulphides. The apparent metal factor will approximate the true metal factor when the metal factor is unchanged for several readings within the anomaly, as is the case of an anomaly whose dimensions are large, and depth to the top is small, relative to the electrode spread. It is therefore possible for a small percentage of chargeable material to cause a relatively strong anomaly if the measured metal factor approaches the true metal factor.

Data Presentation:

The following IP and resistivity plans and data plots are included in this report:

1. Plan of Second Separation Metal Factors, Plate 52-C-HAL-P1.
2. Plan of Second Separation Resistivities, Plate 52-C-HAL-P2.
3. The following data plots:

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Dipole Length</th>
<th>Plate No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>48+00E</td>
<td>200'</td>
<td>I.P. - 17-1</td>
</tr>
<tr>
<td>44+00E</td>
<td>200'</td>
<td>I.P. - 17-2</td>
</tr>
<tr>
<td>40+00E</td>
<td>100'</td>
<td>I.P. - 17-3</td>
</tr>
<tr>
<td>40+00E</td>
<td>200'</td>
<td>I.P. - 17-4</td>
</tr>
<tr>
<td>36+00E</td>
<td>100'</td>
<td>I.P. - 17-5</td>
</tr>
<tr>
<td>36+00E</td>
<td>200'</td>
<td>I.P. - 17-6</td>
</tr>
<tr>
<td>32+00E</td>
<td>100'</td>
<td>I.P. - 17-7</td>
</tr>
<tr>
<td>32+00E</td>
<td>200'</td>
<td>I.P. - 17-8</td>
</tr>
<tr>
<td>28+00E</td>
<td>100'</td>
<td>I.P. - 17-9</td>
</tr>
<tr>
<td>28+00E</td>
<td>200'</td>
<td>I.P. - 17-10</td>
</tr>
<tr>
<td>28+00E</td>
<td>300'</td>
<td>I.P. - 17-11</td>
</tr>
<tr>
<td>24+00E</td>
<td>200'</td>
<td>I.P. - 17-12</td>
</tr>
<tr>
<td>20+00E</td>
<td>100'</td>
<td>I.P. - 17-13</td>
</tr>
<tr>
<td>20+00E</td>
<td>200'</td>
<td>I.P. - 17-14</td>
</tr>
<tr>
<td>16+00E</td>
<td>200'</td>
<td>I.P. - 17-15</td>
</tr>
<tr>
<td>12+00E</td>
<td>200'</td>
<td>I.P. - 17-16</td>
</tr>
<tr>
<td>8+00E</td>
<td>200'</td>
<td>I.P. - 17-17</td>
</tr>
<tr>
<td>4+00E</td>
<td>100'</td>
<td>I.P. - 17-18</td>
</tr>
<tr>
<td>4+00E</td>
<td>200'</td>
<td>I.P. - 17-19</td>
</tr>
<tr>
<td>0+00E</td>
<td>200'</td>
<td>I.P. - 17-20</td>
</tr>
</tbody>
</table>
Results:

Each anomaly is marked on the data plots, and comments are provided on the plots themselves. The more interesting anomalous features are further discussed below:

1. Line 40+00E from 3+00S to 4+50S:

This is the best response from a zone that continues southwesterly for 1200 feet. The resistivities are very low within the anomaly, the frequency effects show distinctly anomalous values, and the resulting metal factors are high. The pattern is very good. A strong magnetic anomaly occurs here as well. The anomaly lies within an area mapped as volcanics.

2. Line 40+00E from 1+00N to 1+00S:

This anomaly shows some depth, perhaps as much as 200 feet. It could extend to the surface in weaker form. The pattern is favourable, and all parameters are anomalous. The anomaly shows no apparent magnetic correlation but lies more or less on a gabbro-volcanic contact.

3. Line 20+00E from 1+00N to 2+50N:

Very low resistivities, with strong frequency effects, produce large metal factor values in a good pattern. A magnetic anomaly, about 2500 gammas, is associated with the IP response. It is apparently at very shallow depth in an area mapped as gabbro.

4. Line 4+00E from 3+00S to 5+00S:

This is a strong response on all parameters. The pattern is good but somewhat complex, perhaps suggesting a double zone. There is a moderately strong magnetic anomaly associated with this response. It is in an area of volcanics. Possibly it is related to strong anomalies occurring further east, more or less along strike (see the anomaly on line 40+00E).
5. Line 36+00W from 0 to 2N:

Although the data is incomplete, a relatively good anomaly is indicated in association with a magnetic anomaly. It occurs in an area of gabbro close to the volcanic contact.

6. Line 52+00W from 1+00S to 3+00S:

A strong but incomplete anomaly occurs in gabbro near volcanics. There is a possible magnetic correlation.

**MAGNETIC SURVEY**

**Method:**

The survey was performed by Cominco operator R. Souliere and a local helper, W. Pearson, between April 18 and 27, 1967, using a Sharpe MP-1 Fluxgate Magnetometer. This instrument has a maximum sensitivity of 20 gammas per scale division, and a maximum readability of 5 gammas.

Base stations were established, using the tops of pickets for horizontal and vertical location, at 400-foot intervals along the Base Line. Diurnal variation and instrument "drift" were controlled by using the standard looping procedure. Total coverage was 9.7 line miles, at a 50-foot reading interval, and a total of 978 stations were occupied during the survey.

**Results:**

Magnetic response on the property is very strong and highly variable, indicating the presence of magnetite as well as perhaps pyrrhotite. Changes in the vertical intensity of the magnetic field are very abrupt due to shallow overburden and a variable magnetite content, so that contouring would be very difficult and of doubtful value. However, magnetically disturbed zones are noted on each line, and are defined roughly as follows:

- Weakly disturbed zone: 500 to 1500 gammas local relief.
- Moderately disturbed zone: 1500 to 2500 gammas local relief.
- Strongly disturbed zone: More than 2500 gammas local relief.

Most of the strongly disturbed zones occur south of the Base Line and are underlain by volcanics. A fairly continuous trend of strongly disturbed zones indicates the presence of at least one magnetite-rich horizon, possibly stratigraphically controlled.

In addition to the strongly disturbed zones, other, weaker zones occur both in volcanics and in gabbro. In general these zones tend to line up to form anomalous trends which parallel geological strike. However, some of the weaker zones are isolated, appearing on one line and having no obvious along-strike extensions.
While strongly disturbed zones are thought to be largely due to magnetite, the other zones could be due, or partly due, to pyrrhotite. Although IP anomalies can be caused entirely by magnetite, IP traverses over many strongly magnetic zones located by this survey are non-anomalous, while other traverses show a good IP response correlating with a strong magnetic response. Since in general the magnetic intensity correlates with the magnetite content, if other factors are equal, the poor correlation between IP response and strong magnetic anomalies suggests that the IP response is influenced by sulphides occurring in the strong magnetic anomalies.

**CONCLUSIONS**

1. Induced polarization and resistivity surveys were carried out, totalling 9.7 line miles of reconnaissance using 200-foot electrode spacings, and an additional 1.5 line miles of detailed survey using 100-foot electrode spacings.

2. As expected, a large number of anomalous IP indications were obtained. Most of these are undoubtedly related to minor variations in the sulphide and magnetite content of the rocks.

3. The background IP effects are often moderately strong.

4. Definite anomalies occur in several places, and these show very low resistivities combined with good frequency effects. Further investigation is warranted on these zones.

5. The magnetic survey shows very abrupt changes over short distances, even though readings were taken every 50 feet. This is caused by shallow overburden depths and a quite variable magnetite content. Contouring was not considered feasible.

6. Strong anomalies can be traced from line to line, and these trends apparently reflect magnetite-rich horizons, mainly associated with the volcanics.

7. Correlation between IP results and magnetic results is only fair, suggesting that sulphides are an important cause of IP effects, and the IP effects from magnetite are less than might be suggested by the magnetic results alone.

Submitted by: George D. Aikkanen, Senior Exploration Geophysicist.

Toronto
May 23, 1967.
COMINCO LTD.

APPENDIX I

Notes on the Induced Polarization Method
NOTES ON THE INDUCED POLARIZATION METHOD

Theory:

Polarization is the separation of charge, or blocking action of metallic or electronic conductors within a medium of ionic solution conduction. Induced polarization refers to this blocking action when caused by an applied electric field.

In its geological context induced polarization, or I.P., refers to the electro-chemical blocking phenomenon exhibited by metallic minerals such as most sulphides and graphite, under the influence of an applied current. When a current is passed through the ground the conduction is ionic and is dependent upon ions in the water content of the ground, because most minerals have a much higher specific resistivity than ground water. The "metallic" minerals have specific resistivities which are much lower than ground water. The I.P. effect occurs at the interfaces between ionic conductive conditions in the ground waters and the electronic conductive conditions in the metallic minerals.

The blocking action, or I.P. effect, increases with the time during which the current is flowing, hence if the current is periodically reversed, a higher frequency current will show less blocking, or I.P. effect, than will a low frequency, since less time is available for the blocking to occur at the higher frequency. It is therefore possible to measure the I.P. effect by measuring the resistivities at two frequencies. Essentially, this is the basis of the frequency domain I.P. system.

The percent frequency effect is defined as \( \frac{\rho_L - \rho_H}{\rho_L} \times 100 \), where \( \rho_L \) and \( \rho_H \) are the resistivities at the low and high frequencies, respectively. The percent frequency effect is the parameter measured to show the I.P. effect, and is the frequency domain equivalent of the chargeability \( m \) used in time domain I.P. work.

The resistivity is actually the apparent resistivity, which is an averaged value. It is obtained from the current, potential, and geometry of the electrode system. The resistivity plotted is the low frequency resistivity value and the units are ohm feet/2\( \pi \). To convert these units to ohm meters, commonly used in some other I.P. systems, the ohm feet/2\( \pi \) values should be multiplied by 1.9.

The metal factor values are obtained by dividing the percent frequency effect by the resistivity and multiplying by a factor of 1000. The metal factor is proportional to the change in conductivity as the frequency of the applied current is varied, and can be shown to be equal to \( \frac{m_L - m_H}{\rho_L} \times 2\pi \times 10^5 \), where \( m_H \) and \( m_L \) are the conductivities at the high and low frequencies, respectively. The metal factor is generally more diagnostic than the frequency effect alone.
Procedure:

Current is applied to the ground at two current electrodes \( C_1 \) and \( C_2 \) spaced a distance \( x \) apart. The potential is measured at two potential electrodes \( P_1 \) and \( P_2 \) also spaced a distance \( x \) apart and in line with the current electrodes. For any given locations of \( C_1 \) and \( C_2 \), readings are taken when the distance between the nearest current and potential electrodes is equal to \( nx \), and \( n \) has values of 1, 2, 3, etc. The electrode spacing \( x \) is determined by the requirements of the survey. Larger values of \( x \) would be used when the object is greater depth penetration and faster progress, whereas smaller values of \( x \) are employed in more detailed surveys and provide more accurate anomaly location, but for the smaller values of \( x \) the penetration is less and the survey slower. The penetration is greater for the larger \( n \) values.

The values of the resistivity, metal factor and percent frequency effect are plotted on "pseudo-sections", where the plotting point is determined by the intersection of lines drawn at 45° from the horizontal, and originating at the mid-points of the current electrode spread and the potential electrode spread, as shown in the diagram. The resistivities are plotted and contoured above the line and the metal factors plotted and contoured below the line. The percent frequency effect is shown on a superscript at the metal factor value. Depths to causative bodies cannot be scaled from the "pseudo-section", however.

The most favourable type of anomaly would show a frequency effect high with a resistivity low, to provide a marked metal factor high. A frequency effect high, with little or no change in resistivity, to provide a metal factor high, mirroring the frequency effect high, is also favourable. Of lesser interest, but of possible importance, are those anomalies showing no frequency effect change, but a distinct resistivity low, to produce a metal factor anomaly. The type of anomaly, its strength, size and shape should be considered in relation to the geological setting and the target sought.
DIAGRAM SHOWING ELECTRODE ARRAY AND PLOTTING METHOD

X = ELECTRODE SPREAD LENGTH
n = ELECTRODE SEPARATION

STATIONS ON TRAVERSE LINE

Apparent Metal Factor with percent frequency
Effect shown as a superscript.
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
PL 1/2π OHM FEET

APPARENT METAL FACTOR
(SUPERScript SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION
SURFACE PROJECTION OF ANOMALOUS ZONES

PLOTTING POINT

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
$\rho/12\pi$ OHM FEET

APPARENT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
$\rho = 12 \pi$ OHM FEET

APPARENT METAL FACTOR
(SUPERScript SHOWS FREQUENCY EFFECT)

Data incomplete, but interesting

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES
- DEFINITE
- PROBABLE
- POSSIBLE

NOTE: LOGARITHMIC CONTOUR INTERVAL

Halikirk Property
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhor

RESISTIVITY
$\rho = \frac{1}{2\pi} \text{ ohm feet}$

APPARENT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

NOTE LOGARITHMIC CONTOUR INTERVAL

DEFINITE
PROBABLE
POSSIBLE

Holkirk Property
COMINCO LIMITED

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 200 Feet

SURVEYED BY: McPhar

RESISTIVITY

\[ \rho = \frac{12 \pi}{\text{OHM FEET}} \]

APPARENT METAL FACTOR

(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

- DEFINITE
- PROBABLE
- POSSIBLE

Plotting Point

NOTE LOGARITHMIC CONTOUR INTERVAL

Halikirk Property
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
$\rho / 2\pi$ OHM FEET

APPARENT METAL FACTOR
(SUPERScript SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
PΩ/2π OHM FEET

APPEARANT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
$\frac{\rho}{2\pi}$ OHM FEET

APPARENT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION
X — N X — X

SURFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

NOTICE LOGARITHMIC CONTOUR INTERVAL

NOTE: GOOD PATTERN

PROPERTY: Helkirk
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale — One Inch — 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
\( \rho / \pi \ \text{Ohm Feet} \)

APPARENT METAL FACTOR
(SUPERScript shows frequency effect)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

NOTE LOGARITHMIC CONTOUR INTERVAL

Halikirk Property
COMINCO LIMITED

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 200 Feet

SURVEYED BY: McPhar

RESISTIVITY

P = 12 IT OHM FEET

APPARENT METAL FACTOR

(SUPERSCRIPt SHOWS FREQUENCY EFFECT)

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhor

RESISTIVITY
Pa 1/2 \(
\pi \) OHM FEET

APPARENT METAL FACTOR

(EQUIPMENT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

Holkirk Property

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
P = 1277 OHM FEET

APPEARANT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 200 Feet

SURVEYED BY: McPhar

RESISTIVITY
$
\rho = 12\pi \text{ OHM FEET}$

**Note Logarithmic Contour Interval**
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhor

RESISTIVITY
$P_0/2\pi$ OHM FEET

APPARENT METAL FACTOR
(SUPERScript shows frequency effect)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES
- DEFINITE
- PROBABLE
- POSSIBLE

NOTE LOGARITHMIC CONTOUR INTERVAL

Holkirk Property
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 200 Feet
SURVEYED BY: McPhor

RESISTIVITY
\[ \rho = \frac{1}{2\pi} \text{ OHM FEET} \]

APPARENT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
P o 12π OHM FEET

APPARENT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION
SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

PLOTTING X POINT

NOTE LOGARITHMIC CONTOUR INTERVAL

Halkirk Property
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
$P_0/12\pi\ \text{ohm feet}$

APPROXIMATE METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES
- DEFINITE
- PROBABLE
- POSSIBLE

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 300 Feet

SURVEYED BY: McPhar

RESISTIVITY

\[ P = \frac{1}{2\pi} \text{ OHM FEET} \]

APPARENT METAL FACTOR

(SUPERScript SHOWS FREQUENCY EFFECT)

LINE NO. 2800 E

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
\( \rho \) = 12 \( \pi \) OHM FEET

APPARENT METAL FACTOR
(SUPERScript SHOWS FREQUENCY EFFECT)

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 200 Feet

SURVEYED BY: McPhor

RESISTIVITY

P = 1/2π ohm-feet

APPARENT METAL FACTOR

(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

PLOTTING POINT

NOTE LOGARITHMIC CONTOUR INTERVAL

Holbrook Property
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 100 Feet
SURVEYED BY: McPhar

RESISTIVITY
$R_0/2\pi$ OHM FEET

APPEARANT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

NOTE LOGARITHMIC CONTOUR INTERVAL

Strong of depth

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

Halkirk Property
COMINCO LIMITED
INDUCED POLARIZATION AND RESISTIVITY SURVEY
Scale—One Inch = 200 Feet
SURVEYED BY: McPhar

RESISTIVITY
\[ P_0/2\pi \text{ OHM FEET} \]

APPARENT METAL FACTOR
(SUPERSCRIPT SHOWS FREQUENCY EFFECT)

ELECTRODE CONFIGURATION

SURFACE PROJECTION OF ANOMALOUS ZONES

POSSIBLE

DEFINITE

PROBABLE

PLOTTING POINT

NOTE LOGARITHMIC CONTOUR INTERVAL
COMINCO LIMITED

INDUCED POLARIZATION AND RESISTIVITY SURVEY

Scale—One Inch = 200 Feet

SURVEYED BY: McPhar

Resistivity

\[ \rho = \frac{2\pi}{\text{OHM FEET}} \]

Apparent Metal Factor

(Superscript shows frequency effect)

Electrode Configuration

Surface Projection of Anomalous Zones

- DEFINITE
- PROBABLE
- POSSIBLE

Plotting Point

NOTE LOGARITHMIC CONTOUR INTERVAL
EXPLORATION

HALKIRK PROPERTY

GEOLOGICAL SURVEY REPORT

a) LOCATION:

Lat. N: 48° 40'
Long. W: 93° 05'
N.T.S: 52-C-11

Township: Watten and Halkirk
Province: Ontario
Mining Div: Ft. Frances

The property is situated on the mutual township line, 15 miles ENE of Fort Frances. It is accessible by aircraft, by boat from Fort Frances, or by a one-mile walk from Highway 11.

b) OWNERSHIP:

21 claims as outlined in section d, with ownership as follows:

50% M. Hupchuk, 1324-5th St. E., Fort Frances
50% G.A. Armstrong, 326-2nd St. E., Fort Frances

Subject to an option agreement with Cominco Ltd - dated July 15, 1966.

c) SURVEY SUBMITTED BY:

Cominco Ltd., 630 Dorchester Blvd., Montreal 2, Quebec

d) PROPERTY COVERED BY SURVEY:

<table>
<thead>
<tr>
<th>Claim Numbers</th>
<th>Date Staked</th>
<th>Date Recorded</th>
<th>Work Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.F. 15832-15835</td>
<td>July 19/65</td>
<td>Aug. 18/65</td>
<td>Aug. 18/66</td>
</tr>
<tr>
<td>F.F. 15854-15855</td>
<td>July 28/65</td>
<td>Aug. 18/65</td>
<td>Aug. 18/67</td>
</tr>
<tr>
<td>F.F. 15856-15858</td>
<td>July 28/65</td>
<td>Aug. 18/65</td>
<td>Aug. 18/66</td>
</tr>
<tr>
<td>F.F. 15859</td>
<td>July 28/65</td>
<td>Aug. 18/65</td>
<td>Aug. 18/67</td>
</tr>
<tr>
<td>F.F. 16013-16017</td>
<td>Aug. 2/65</td>
<td>Aug. 18/65</td>
<td>Aug. 18/66</td>
</tr>
<tr>
<td>F.F. 16018-16019</td>
<td>Aug. 4/65</td>
<td>Aug. 18/65</td>
<td>Aug. 18/66</td>
</tr>
</tbody>
</table>

NOTE: Claims 15832 - 15835, 15856 - 15858 and 16013 - 16019 are presently under extension to June 5, 1967.

e) DATES OF SURVEY:

TABLE OF FORMATIONS:

- Laurentian
  - Gabbro
  - Altered Gabbro (anorthositic)
- Keewatin
  - Altered Volcanic Rocks (amphibolites)
  - Sericite Schists
- Coutchiching
  - Metasediments (mica schist)

ROCK DESCRIPTIONS:

Gabbro
Dark gray to black on both fresh and weathered surfaces. Generally coarse grained and massive but sheared in places. Hornblende constitutes about 90% of the rock. Feldspar and garnet are present in minor amounts. At a few localities magnetite is present. The feldspar is labradorite. (Lawson - 1913)

Altered Gabbro
Variable in colour from medium gray to dirty white. Coarse grained. Poikilitic in structure accentuated by numerous small anhedral crystals of feldspar. The amount of feldspar increases from the odd anhedral near the unaltered gabbro, to almost 80 or 90%, in the typical altered gabbro, or anorthosite (?).

Altered Volcanic Rock (amphibolite)
Black on both fresh and weathered surfaces. Varies from massive to schistose but fine-grained in both cases. In the foliated type the cleavage is quite even and the faces have a lustrous sheen. The dominant constituent of these rocks is hornblende; feldspar and quartz are present in subordinate amounts.

Sericite Schists
Brown to grey on weathered surface, but distinctly grey-green on fresh surface. Very soft. Very fine-grained and well foliated with cleavage surfaces having a lustrous brown sheen due to the parallelism of sericite flakes. The rock is generally partially or entirely chloritized and has a distinct "soapy" feel.

Metasedimentary Rocks (Mica Schist)
Weathered surface light to medium brown, fresh surface grey and well foliated. Generally fine grained with a pronounced sheen in cleavage surfaces. Quartz and feldspar grains are equally abundant and compose about 85% of the rock. The foliation is accentuated by plates of biotite, generally segregated in layers. Associated with the biotite is a very minor amount of muscovite.
h) STRUCTURAL GEOLOGY

A large dome centered about Rice Bay is the predominant structural feature of the region. Adjacent to the dome on the south side is a NE-SW striking syncline. The fold is isoclinal and dips are almost vertical.

In the survey area, which covers a segment of the southern gabbro-volcanic contact, a series of faults were mapped approximately parallel to the axis of the syncline. These faults are marked by linear geomorphic features such as pronounced gullies, cliffs and chains of small lakes and swamps.

A major N-S trending fault is postulated in the eastern part of the property. The fault is marked by a long swamp. This fault displaces the above mentioned faults while the geology on the east side of the fault is considerably more complex than on the west.

i) MINERALIZATION

Mineralization in the surveyed area consists of widely scattered and sparsely disseminated pyrite, pyrrhotite, chalcopyrite and minor arsenopyrite. In general most of the mineralization is confined to the gabbro on the west side of the major N-S fault.

j) REFERENCES

Lawson, A.C. (1913) Archaean Geology of Rainy Lake Re-studied
G.S.C. Memoir 40.

Report By: V.A. Tanaka,
Exploration Geologist,
Cominco Ltd.

Approved By: R.J. Nicholson,
Senior Exploration Geologist.

APPENDIX

Property Development Completed to Date

1965-66 Staked, prospected - limited trenching
1966 Optioned to Cominco - July
1966 Line cutting, geological survey - Scale 1"= 400 feet.
MAGNETICALLY DISTURBED ZONES

WEAKLY DISTURBED ZONE

MODERATELY

INTENSELY
TRAVERSE INLET (RAINY LAKE)

The Consolidated Mining and Smelting Company of Canada Limited
HALKIRK PROPERTY
FORT FRANCES M.D., ONT.

LEGEND

LAURENTIA
ALIENATED GABBRO (AMPHIBOLITE)
ALTERED GABBRO (AMPHIBOLITE)
METAMORPHIC ROCKS (AMPHIBOLITE)
SERICITE SCHIST
SERICITE SCHIST
METASEDIMENTARY ROCKS (MICA SCHIST)
POSSIBLE FAULT
GEOLOGIC BOUNDARY
OUTCROP - LARGE, SMALL

CHALCOPYRITE, PYRITE, PYRRHOTITE, MAGNETITE

FOLIATION DIRECTION

SWAMP

CLAIM POSTS - LOCATED, ASSUMED
TRENCH
NOTE LINES 40, 48, & SOUTHERLY BUT UNCHAINED

DAT 1866
DEC. 1866

The Consolidated Mining and Smelting Company of Canada Limited
HALKIRK PROPERTY
FORT FRANCES M.D., ONT.