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COMINCO LTD.

EXPLORATION DIVISION WESTERN DISTRICT

REPORT D-71 ELKFORD

GEOPHYSICAL REPORT

CROSS MINERAL CLAIM

82J/2 and 3 SE

Fort Steele Mining Division

by

DIGHEM LIMITED

Toronto, Ontario

January 7, 1977

Report Compiled by:

G.L. WEBBER

Cominco Ltd.
Kootenay Exploration
2450 Cranbrook Street
Cranbrook, B.C.

Under the supervision of:
D.W. HEDDLE
P. Eng.

6501

COMINCO LTD.

EXPLORATION DIVISION

WESTERN DISTRICT

DIGHEM SURVEY

REPORT NO. D71

ELKFORD

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REPORT No. D 71
ELKFORD

DIGHEM SURVEY

OF

CROSS GROUP, ELKFORD AREA, BRITISH COLUMBIA

FOR

COMINCO LIMITED

BY

DIGHEM LIMITED

TORONTO, ONTARIO
APRIL 7, 1977

D. C. FRASER
PRESIDENT

LOCATION MAP

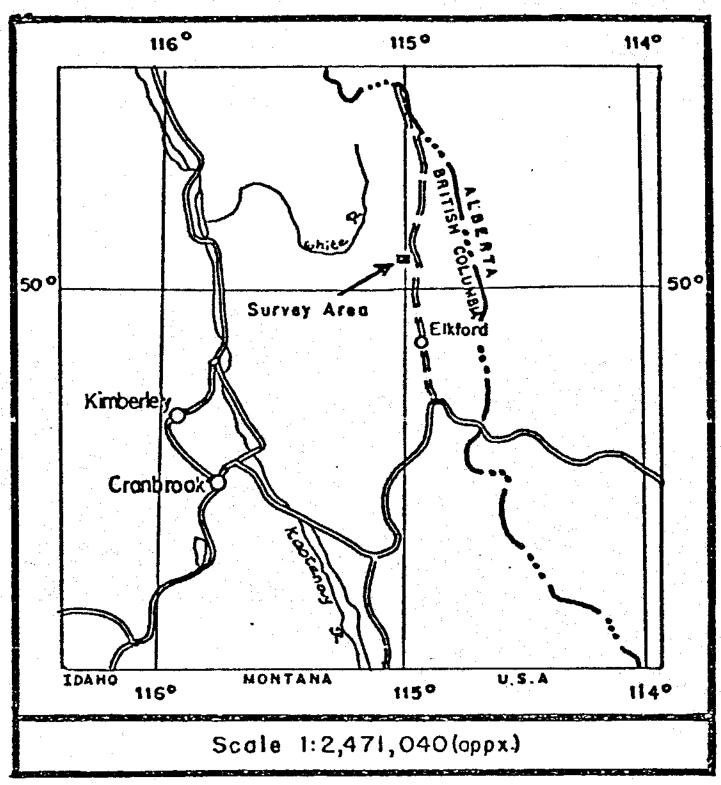


Figure 1. The survey area.

S U M M A R Y

A DIGHEM airborne electromagnetic/magnetic survey of 16 line-miles was flown over the Cross group for Cominco Limited in February, 1977, in the Elkford area of British Columbia. No EM anomalies were obtained, and the survey area is relatively non-magnetic.

INTRODUCTION

A DIGHEM survey of 16 line-miles was flown over the Cross group with a 200-foot line-spacing for Cominco Limited on February 4th, 1977, in the Elkford area of British Columbia (Figure 1). The Lama jet helicopter N65185 flew with an average airspeed of 60 mph and EM bird height of 160 feet. Ancillary equipment consisted of a Barringer Research AM-104 magnetometer with its bird at an average height of 210 feet, a Bonzer radaraltimeter, Geocam sequence camera, 60 hz monitor, MFE 8-channel hot pen analog recorder, and a Geometrics G-704 digital data acquisition system with a Facit 4070 punch paper tape recorder. The analog equipment recorded six channels of EM data at 918 hz, and one of magnetics and radaraltitude. The digital equipment recorded the magnetic field to an accuracy of one gamma.

The Appendix provides details on the analog data channels, their respective noise levels, and the data reduction procedure. The quoted noise levels are generally valid for wind speeds up to 20 mph. Higher winds may cause the system to be grounded because excessive bird swinging produces control difficulties in piloting the helicopter. The swinging results from the 50 square feet of area which is presented by the bird to broadside gusts. The DIGHEM system nevertheless can be flown under wind conditions that seriously degrade other AEM systems.

DATA PRESENTATION

The Three Conductor Models

DIGHEM anomalies are interpreted according to three conductor models, as follows:

1. Vertical dike (half plane)

   The vertical dike is the most suitable representation of steeply-dipping bedrock conductors. All anomalies plotted on the DIGHEM map are interpreted according to this model. The three receiver coils of DIGHEM allow correction for the response when the flight line crosses a conductor at an oblique angle. The following section entitled, "Electromagnetics; vertical dike interpretation", describes this model in detail, including the effect of using it on anomalies caused by conductive overburden.

2. Horizontal sheet (whole plane)

   The horizontal sheet is suitable for flatly dipping thin bedrock conductors and thin layers of conductive clay or lake silt. The conductance and depth values are given in the anomaly list appended to the rear of this report, but do not appear on the DIGHEM map. These values should be viewed with caution unless it is known that a horizontal sheet is a fair representation of the conductors. It is a highly specialized model with a limited application.

3. Conductive earth (half space)

The conductive earth model is suitable for flatly dipping thick bedrock conductors, saline water-saturated sedimentary formations, thick conductive overburden, and geothermal zones. The resistivity and depth values are given in the anomaly list, but do not appear on the DIGHEM map. A depth value of approximately zero in an area of deep cover is evidence that the anomaly is caused by conductive overburden. The minimum and maximum values of resistivity which can be recognized are 1 and approximately 1000 ohm-meters, respectively.

Electromagnetics; vertical dike interpretation

The EM anomalies appearing on a DIGHEM map are interpreted by computer according to the conductivity-thickness product in mhos of an oblique-striking vertical dike model. DIGHEM anomalies are divided into six grades of conductivity-thickness product, as shown in Table I. This product in mhos is the reciprocal of resistance in ohms. The mho is a measure of conductance, and is a geological parameter. Most swamps yield grade 1 anomalies but highly conducting clays can give grade 2 anomalies. The three-dimensional anomaly shapes often allow surface conductors to be recognized, and these are indicated by the letter S on the map. The remaining grade 1 and 2 anomalies could be weak bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: the ore bodies of the Magusi River camp (Noranda, Quebec) yield grade 4 anomalies, while Mattabi (Sturgeon Lake, Ontario) and Whistle (Sudbury, Ontario) give grade 5. Graphite and sulfides can span all grades but, in any particular survey area, field work may show that the different grades indicate different types of conductors.

Table 1. EM Anomaly Grades

Anomaly Grade	Mho Range
6	≥ 100
5	50 - 99
4	20 - 49
3	10 - 19
2	5 - 9
1	≤ 4

Strong conductors (i.e., grades 5 and 6) are characteristic of massive sulfides or graphite. Moderate conductors (grades 3 and 4) typically reflect sulfides of a less massive character or graphite, while weak bedrock conductors (grades 1 and 2) can signify poorly connected graphite or heavily disseminated sulfides. Grade 1 conductors may not respond to ground EM equipment using frequencies less than 2000 hz.

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductivity-thickness products. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near

Bathurst, New Brunswick, yielded a well-defined grade 1 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine-grained massive pyrite, thereby inhibiting electrical conduction.

The mho value is a geological parameter because it is a characteristic of the conductor alone. It generally is independent of frequency, and of flying height or depth of burial apart from the averaging over a greater portion of the conductor as height increases. Small anomalies from deeply buried strong conductors are not confused with small anomalies from shallow weak conductors because the former will have larger mho values.

On the DIGHEM map, the actual mho value and a letter are plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots, beside each anomly symbol, indicate anomaly amplitude on the flight record. The vertical column of dots gives the estimated depth. In areas where anomalies are crowded, the identifiers, dots and mho values may be obliterated. The EM grade symbols, however, will always be discernible, and the obliterated information can be obtained from the anomaly listing appended to this report.

The purpose of indicating the anomaly amplitude by dots is to provide an estimate of the reliability of the conductivity-thickness calculation. Thus, a conductivity-thickness value obtained from a large ppm anomaly (3 or 4 dots) will be accurate whereas one obtained from a small ppm anomaly (no dots) could be inaccurate.

The absence of amplitude dots indicates that the anomaly from the standard (maximum-coupled) coil is 5 ppm or less on both the inphase and quadrature channels. Such small anomalies could reflect a weak conductor at the surface, or a stronger conductor at depth. The mho value and depth estimate will illustrate which of these possibilities best fits the recorded data. The depth estimate, however, can be erroneous. The anomaly from a near-surface conductor, which exists only to one side of a flight line, will yield a large depth estimate because the computer assumes that the conductor occurs directly beneath the flight line.

Flight line deviations occasionally yield cases where two anomalies, having similar mho values but dramatically different depth estimates, occur close together on the same conductor. Such examples confirm that the mho value measurement of conductance is quite reliable whereas the depth estimate can be unreliable. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, conductive overburden responses, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be deeper or to one side of the flight line, or because it has a shallow dip.

A further interpretation is presented on the EM map by means of the line-to-line correlation of anomalies. This provides conductor axes which may define the geological structure over portions of the survey area.

The majority of massive sulfide ore deposits have strike lengths of a few hundred to a few thousand feet. Consequently, it is important to recognize short conductors which may exist in close proximity to long conductive bands. The high resolution of the DIGHEM system, and the line-to-line correlation given on the data maps, are especially important for a proper strike length evaluation.

DIGHEM maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a followup program. The actual mho values are plotted for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of conductors in terms of length, strike direction, conductance and depth. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.

The attached EM anomaly list provides a tabulation of all anomalies in ppm, and in mhos and estimated depth for the vertical dike model. The anomalies are listed from top to bottom of the map for each line. The list also includes an interpretation according to the horizontal sheet and conductive earth models, as described earlier.

Resistivity mapping

Areas of widespread conductivity have been encountered while surveying for base metals with DIGHEM. Under such conditions, anomalies can be generated by changes of only 20 feet in survey altitude, as well as by changes in conductivity. The typical flight record in conductive areas is characterized by inphase and quadrature channels which are continuously active; local peaks reflect either increases in conductivity of the earth or decreases in survey altitude. For such conductive areas, apparent resistivity maps should be produced from the airborne data. The advantage of the contoured maps is that anomalies caused by altitude changes are eliminated, and the contours reflect only those anomalies caused by conductivity changes. In areas of widespread conductivity, the conventional EM map may be practically useless. Contoured apparent resistivity maps improve the interpreter's ability to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden.

Conductive overburden diminishes the ability to an EM system to effectively explore the bedrock. The lower the resistivity of the cover, the more active the EM channels and the poorer the exploration. As a general rule of thumb, the effectiveness of the DIGHEM system for base metal exploration is given in Table II.

Table II. Influence of Conductive Cover On Base Metal Surveys.

Resistivity	Exploration effectiveness at 900 hz
> 300 ohm-m	excellent
100 to 300	good
30 to 100	moderate
< 30	poor

Apparent resistivity maps should be constructed when the exploration effectiveness (Table II) is moderate to poor, because the contour patterns can be helpful in differentiating between bedrock and overburden conductors.

Magnetics

The existence of a magnetic correlation with an EM anomaly is indicated directly on the EM photomosaic. An EM anomaly with magnetic correlation has a greater likelihood of being produced by sulfides than one that is non-magnetic. However, sulfide ore bodies may be non-magnetic (e.g., Kidd Creek near Timmins, Ontario) as well as magnetic (e.g., Mattabi).

The magnetometer data are digitally recorded in the aircraft to an accuracy of one gamma. The digital tape is processed by computer to yield a standard total field magnetic map contoured at 25 gamma intervals. The magnetic data also are treated mathematically to enhance the magnetic response of the near-surface gelogy, and an enhanced magnetic map is produced with a 100 gamma contour interval. The response of the enhancement operator in the frequency domain is shown in Figure 2.

The enhanced magnetic map bears a resemblance to a ground magnetic map. It therefore simplifies the recognition of trends in the rock strata and the interpretation of geological structure. The contour interval of 100 gammas is suitable for defining the near-surface local geology while de-emphasizing deep-seated regional features.

Apart from the difference in the contour interval, the enhanced magnetic map and the standard magnetic map are identical when magnetic basement rocks underlie several thousand feet of non-magnetic cover. The difference between the two maps increases with the amount of magnetization of the near-surface geology.

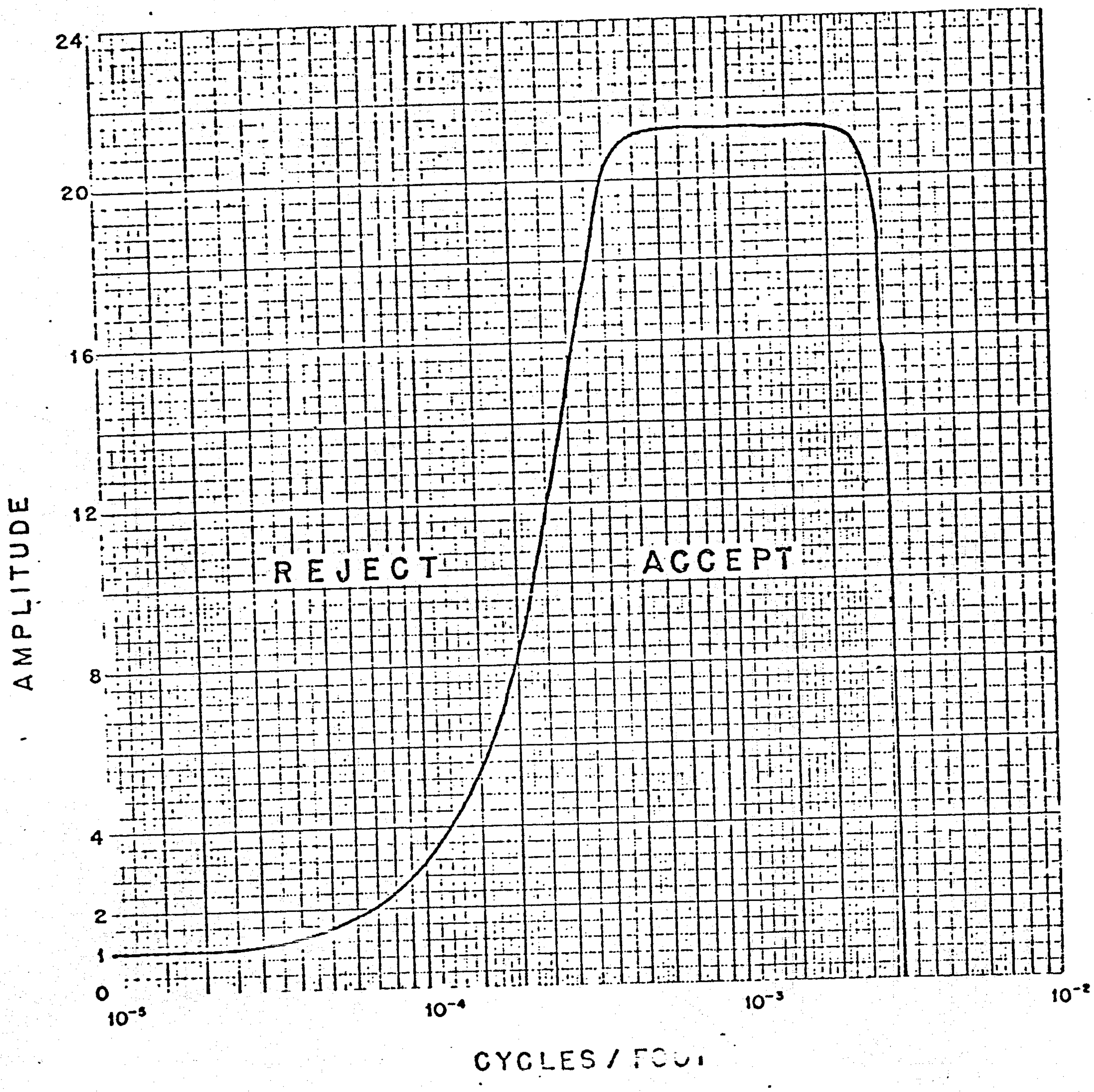


Figure 2 Frequency response of magnetic operator

The presence of a magnetic coincidence with an EM anomaly can result because the conductor is magnetic or because a magnetic body occurs in juxtaposition with the conductor. The majority of magnetic conductors represent sulfides containing pyrrhotite or magnetite. However, graphite and magnetite in close association can provide coinciding EM-magnetic anomalies. The truly magnetic conductors tend to follow closely the contoured magnetic highs. Such coincidence may be more evident on the enhanced magnetic map than on the standard magnetic map because of less disturbance from regional magnetic features. The enhancement, therefore, provides data maps which contribute to the evaluation of EM anomalies.

THE SURVEY AREA

There are no conductors in the survey area. The area is quite flat magnetically as can be seen by the contoured total field magnetic map. The lack of near-surface magnetic variations resulted in a complete lack of contours on the enhanced magnetic data set. Consequently, only the total field magnetic map was prepared for the Cross group.

Respectfully submitted,

Toronto, Ontario
April 7, 1977

D. C. Fraser
President

One map accompanies this report:

Magnetics	1 map sheet

APPENDIX

THE FLIGHT RECORD AND PATH RECOVERY

The flight record is a roll of chart paper which moves through the recorder console at a speed of 1.5 mm/sec. This provides a ground scale on the flight record in feet/mm which is approximately equal to the helicopter flight speed in mph. Thus, for example, the ground scale of the flight record is approximately 70 feet/mm when the helicopter flies at 70 mph.

The flight record consists of eight channels of information, where the label on the record illustrates which of the following ten selections were recorded:

Channel	Time Constant	Scale units/mm	Noise
Standard whaletail quadrature	4 sec	2 ppm	2 ppm
Standard fishtail quadrature	4 sec	2 ppm	2 ppm
Standard coil-pair (Max) inphase	1 sec	5 ppm	5 ppm
Standard coil-pair (Max) inphase	4 sec	2 ppm	2 ppm
Standard coil-pair (Max) quadrature	1 sec	5 ppm	5 ppm
Standard coil-pair (Max) quadrature	4 sec	2 ppm	2 ppm
Sferic monitor	1 sec	5 ppm	
Radar altitude	1 sec	10 feet	
Magnetometer: 1 gamma/step	1 sec	2.5 gammas	
Magnetometer: 10 gamma/step	1 sec	25 gammas	

The sferic monitor responds to electromagnetic signals having a frequency close to the transmitted frequency. Its purpose is to identify anomalies which are caused by environmental EM noise, e.g., distant lightning discharges and power line harmonics.

Several fiducial markers are used between the channels, as follows:

Fiducial	Occurrence
60-hz fiducials	occur only over power lines
camera fiducials	occur regularly at 3 mm intervals on every line
navigator fiducials	occur discontinuously on every line.

The 60-hz fiducials identify anomalies generated by power lines, allowing them to be either flagged on, or deleted from, the EM map.

The navigator fiducial marks represent points on the ground which were recognized by the aircraft navigator. These are the initial base points for flight path recovery. The flight line begins with an encircled navigator fiducial mark. This is followed by a series of unevenly-spaced fiducial marks moving right-wards along the record, which is in the direction of flight. The end of the line is flagged by a second encircled navigator fiducial mark.

The camera fiducial marks indicate each point where a photograph was taken. These photographs are used to provide accurate photo-path recovery locations for the navigator fiducials, which are then plotted on the geophysical maps to provide the track of the aircraft.

The navigator fiducial locations on both the flight records and flight path maps are examined by a computer for unusual helicopter speed changes. Such changes often denote an error in flight path recovery. The resulting flight path locations therefore reflect a more stringent checking than is provided by standard flight path recovery techniques.

/ap

STATEMENT OF QUALIFICATIONS

I, Jan Klein, with business address in Vancouver, B.C., and residential address in Richmond, B.C., hereby certify that

1. I am a Geophysicist

2. I am a graduate of the Technological University, Delft, Netherland, with a M.Sc in 1965

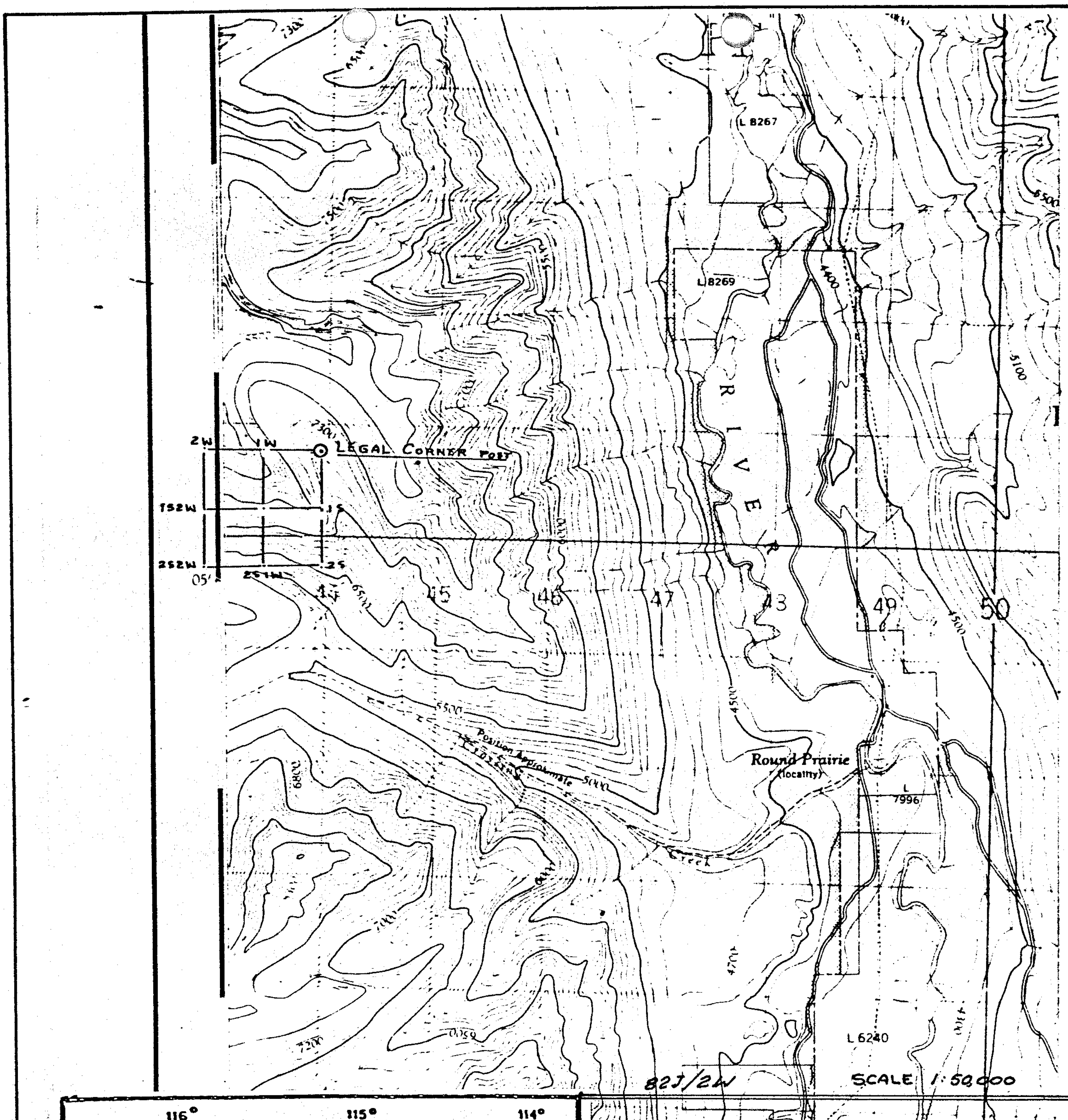
3. I am a member of the Associations of Professional Engineers of British Columbia, number 9796, and Ontario, number 2693000.

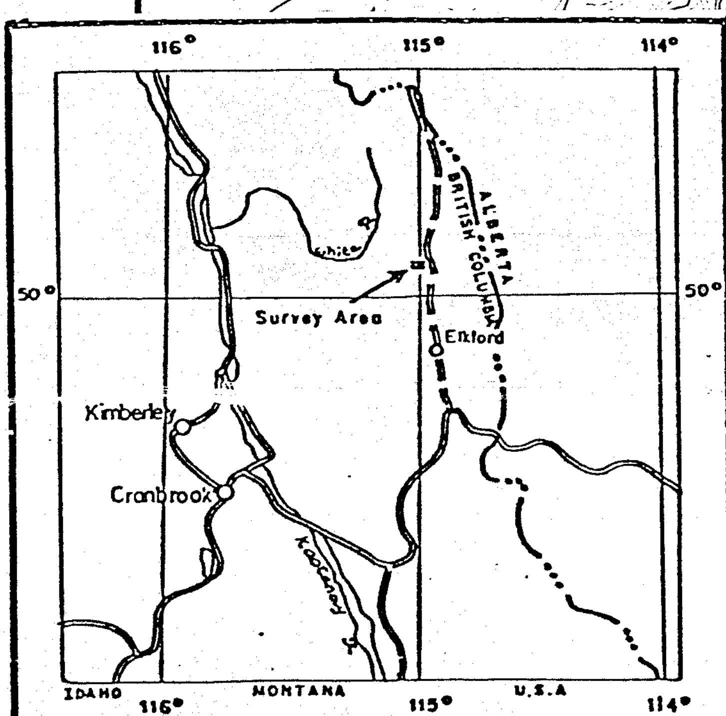
4. I personally supervised the airborne geophysical work and have assessed and reviewed the data resulting from this work.

Respectfully submitted

Jan Klein

J. Klein, M.Sc, P.Eng.





Scale 1:2,471,040 (appx.)

CROSS 1
(4 units)
LOCATED: Oct. 30, 1976
RECORDED: Nov. 2, 1976
RECORD NO. 89

Cominco

Drawn by: GLW		Traced by:		CROSS CLAIM MAP
Revised by	Date	Revised by	Date	NTS 82J/2W
				Scale:
				Date: Oct 20/77
				Plate:

NCI - 112A - CL

210-0610

IN THE MATTER OF THE

B.C. MINERAL ACT

AND

IN THE MATTER OF A DIGHEM SURVEY

CARRIED OUT ON THE CROSS MINERAL CLAIMS AND

ADJACENT AREA

in the Fort Steele Mining Division of the

Province of British Columbia

More Particularly N.T.S. 82J/2 and 3 SE

A F F I D A V I T

I, G.L. WEBBER, of the City of Kimberley in the Province of British Columbia, make Oath and say:

1. That I am employed as a Geologist by Cominco Ltd. and as such, have a personal knowledge of the facts to which I hereinafter depose;

2. That annexed hereto and marked as Exhibit "A" to this my Affidavit is a true copy of expenditures incurred on a Dighem Survey, on the Cross mineral claims.

3. That the said expenditures were incurred between the 27th day of October, 1976 to the 23rd day of September, 1977, for the purpose of mineral exploration on the above noted claims.

Sworn Before Me at CRANBROOK)
in the Province of British Columbia, this 28)
day of OCTOBER, 1977.)

G.L. Webber
G.L. WEBBER

[signature]
A Commissioner for taking Affidavits in the Province of British Columbia.

EXHIBIT "A"

STATEMENT OF EXPENDITURES

CROSS CLAIM

DIGHEM SURVEY:

Dighem Limited - Invoice No. 77-20.	$ 2,500.00

SALARIES:

Supervision: J. Klein, MSc., P. Eng.. . . . . . . 1 day @ $150/day.	150.00
Report Preparation: G.L. Webber . . . . 2 days @ $100/day.	200.00
TOTAL EXPENDITURES	$ 2,850.00

SIGNED: G.L. Webber
G.L. WEBBER

This is Exhibit "A" to the Statutory Declaration of G.L. Webber declared before me this 28 day of October, 1977.

A Commissioner for taking Affidavits in the Province of British Columbia.

CONCLUDING STATEMENT

Jan Klein, A MSc, P. Eng., of Cominco Ltd. personally supervised the Dighem airborne geophysical work on the Cross claim and assessed and reviewed the data resulting from this work.

Material Compiled by: G.L. Webber
G.L. WEBBER

APPROVED FOR
RELEASE BY:
G. HARDEN, Manager
Exploration
Western District

Distribution:

Mining Recorder (2)
Vancouver (1)

Dighem Limited

SUITE 4900 TORONTO - DOMINION CENTRE TORONTO, CANADA M5K 1E8
TEL. (416) 362-3878 TELEX 02-29087

D71-3

75716

Invoice No. 77-20
February 28th, 1977

Cominco Limited,
200 Granville Square,
Vancouver, B.C.
V6C 2R2

Attention: J. Klein

In Account With

DIGHEM LIMITED

To:

Dighem flying of verbal agreement with John Hamilton, 13 line-miles near Elkford — $2,500.00

ENTERED

DIGHEM LIMITED

D. C. Fraser
President

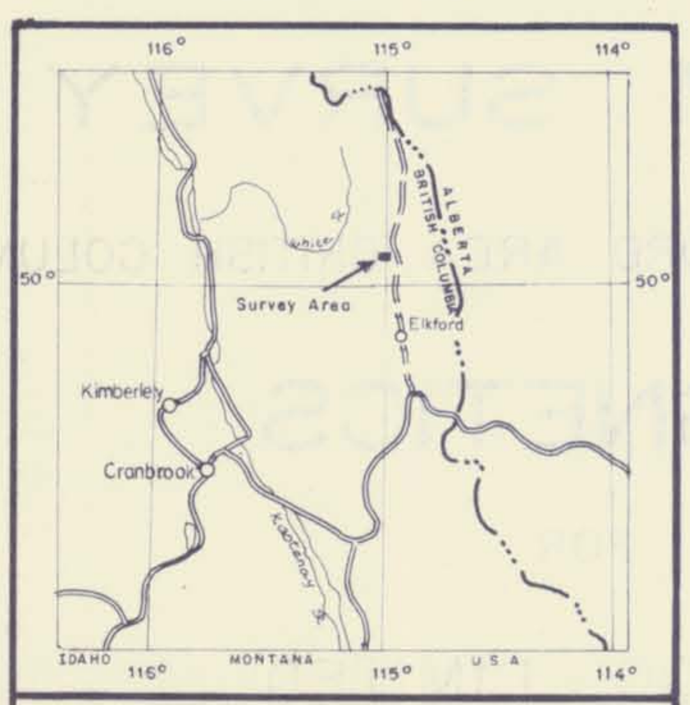
/ls
Job D71

Cranbrook Airborne

001-832-630 – W80A
D.W. Heddle

"The three-dimensional AEM system"

LOCATION MAP



Scale 1:2,471,040 (appx)

DIGHEM SURVEY

CROSS GROUP, ELKFORD AREA, BRITISH COLUMBIA

MAGNETICS

FOR

COMINCO LIMITED

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

0 200 400 800 1200 1600
FEET

Flight line

Fiducials and numbers

1252

1256

ISOMAGNETIC LINES

(total field)

1000 .... 1000 gammas

200 .... 200 gammas

.... 50 gammas

.... 25 gammas

.... magnetic depression

MINERAL RESOURCES BRANCH
ASSESSMENT REPORT
NO. 6501