1835

REPORT ON
AIRBORNE GEOPHYSICAL SURVEYS ON
HARMAX GROUP OF MINERAL CLAIMS
UNUK RIVER AREA
NORTHWESTERN BRITISH COLUMBIA
56° ~~N, 129°~~ W 130 S.W.
ON BEHALF OF
GRANDUC MINES LIMITED

by

Jan Klein, M.Sc., P.Eng.

and

R. O. Crosby, B.Sc., P.Eng.

Vancouver, B.C. October 8, 1968

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SUMMARY

Helicopter-borne electromagnetic and magnetometer surveys were executed over approximately 45 square miles in the Stewart area, British Columbia. A number of conductors with favourable electrical characteristics have been revealed. In several cases a corresponding magnetic response is evident. Six test lines were flown over the Granduc Mine and some conductor intersections were obtained. Due to lack of ground control photos the relationship of these conductors to the known mineralization is uncertain. Recommendations have been made for a ground follow-up program.

REPORT ON AIRBORNE GEOPHYSICAL SURVEYS STEWART AREA, BRITISH COLUMBIA ON BEHALF OF GRANDUC MINES LIMITED (N. P. L.)

INTRODUCTION

During August 1968 airborne geophysical surveys were executed on behalf of Granduc Mines Limited (N. P. L.) in the Stewart area, British Columbia, covering approximately 45 square miles.

The airborne survey included electromagnetic and magnetometer measurements. The former employed a Scintrex HEM-701 electromagnetic unit and the latter a Scintrex NPM-1 nuclear resonance, total intensity magnetometer. Appendix A, attached, gives full technical details of the airborne geophysical equipment and the ancillary equipment employed, as well as the treatment of data resulting from these surveys. In the case of the present surveys a Bell Jet Ranger 206A helicopter, on charter from Pegasus Airlifts (Burlington, Ontario), was employed as the basic transport vehicle.

The electromagnetic survey lines were flown N50E at a 1000 ft. line interval. Flight navigation and flight path recovery have been based upon photomosaics on the scale of approximately 1" = 2000 ft. The magnetometer sensor was flown in the electromagnetic "bird".

The purpose of the present program was to map the distribution of subsurface conductors in the areas covered. In the Stewart area the targets of economic interest are copper and other sulphide bodies. The electromagnetic data provide the basic information relating to the possible presence of such bodies. The purpose of the magnetometer survey results is primarily one of correlation with conductors.

PRESENTATION OF DATA

The results of the geophysical surveys are presented on Plate 1a and 1b on the scale of 1" = 2000 ft. On the plates are shown some topographic features and flight lines. Plate 1a shows the magnetic contours. The contours are at an interval of 100 gammas or less, according to magnetic relief. Plate 1b shows the electromagnetic results. Conductor half-widths and peak locations are shown, coded as described in Appendix A. The in-phase amplitude, in-phase/out-of-phase ratio and magnetic correlation (if any), are indicated for each conductor intersection.

The EM and magnetometer data are presented together with altimeter and fiducial recording on a dual trace Moseley recorder.

The original geophysical traces are on the following scales:

EM	1" = 100 parts per million
Magnetometer	1" = 100 gammas, with automatic steps of 500 gammas. The magnetic base level is 50,000 gammas.

DISCUSSION OF RESULTS

The electromagnetic responses of interest obtained during the current survey are listed in Table 1, with some comments. They fall generally in the second or third category and show poor to good conductivity.

Conductors have been connected between flight lines where this appeared logical. Some conductors display a corresponding magnetic response, which may be due either to a higher magnetite or pyrrhotite mineralization, both known to be present in this part of British Columbia. The higher magnetic intensities are likely due to magnetite.

Electromagnetic disturbances (often with a negative sign) due to sudden altitude differences of the system, resulting in changes in coil configuration in respect to the target area, are also present.

Six test lines were flown over the Granduc Mine. No aerial photos or topographical maps were available for compilation of the information obtained, and therefore only the data of interest are listed in Table 2. Eight conductor intersections were obtained on these lines, ranging from "poor" to "good" but their relationship to the known mineralization cannot be established for lack of positioning photos.

No geological information was available at the time of writing the present report to comment upon the geological significance of the electromagnetic results.

As a first approximation the selection of targets for ground follow-up could be based on the above considerations, weighted by all geological information directly available to Granduc Mines Limited (N. P. L.).

To examine selected targets on the ground and determine their precise location, a combination of surveys on small grids, possibly comprising geological, geochemical, Turam electromagnetic and magnetometer investigations, is recommended.

Respectfully submitted,

Toronto, Ontario.
October 8th, 1968.

Jan Klein, M.Sc., P.Eng.
Geophysicist.

R. O. Crosby, B.Sc., P.Eng.
Geophysicist

TABLE 1 - GRANDUC MINES LIMITED (N. P. L.)

Line No.	Peak Location at Fiducial	Electrical Character		Magnetic Character	Comments
		Category	Conductivity		
5A	1029	1	medium	no correlation	
B	1098	1	medium	no correlation	
7A	1636	2	good	no correlation	
B	1722	3	medium	correlation	
9A	2398	3	good	no correlation	
B	2415	3	good	no correlation	
C	2557	2	good	correlation	
10A	2706	3	good	correlation	
B	3029	3	good	no correlation	
11A	3089	2	good	no correlation	
B	3209	3	good	no correlation)	form a conductor system
12A	3775	3	medium	no correlation)	
15A	208	3	good	correlation	
17A	915	3	good	no correlation	
B	1009	3	medium	no correlation	
20A	1866	3	poor	correlation	
B	1943	3	medium	no correlation	
25A	3593	3	medium	correlation)	form a conductor system
26A	4008	3	medium	correlation)	
40A	5162	1	good	correlation	
41A	7236		good	no correlation	
B	7265		medium	correlation	

TABLE 2 - GRANDUC MINES LIMITED (N. P. L.)

Test Line No.	Peak Location at Fiducial	Electrical Character	Magnetic Character
4A	7691	poor	correlation
B	7692	poor	correlation
C	7695	medium	correlation
5A	7744	medium	correlation
B	7747	medium	correlation
C	7755	good	correlation
6A	7786	good	no correlation
B	7804	good	no correlation

APPENDIX 'A'

DESCRIPTION OF AIRBORNE SYSTEMS

ELECTROMAGNETIC SYSTEM - SCINTREX HEM-701

Equipment

The Scintrex HEM-701 is a solid state, fixed-configuration, electromagnetic system especially designed for helicopter transport. It consists of two coaxial coils, one serving as transmitter and the other as receiver, which are mounted, 30 ft. apart, in a rigid "bird" with their axes horizontal and in the direction of flight. The bird is towed approximately 100 ft. below the helicopter, by means of a suitable cable which also carried electrical signals and power to and from the bird.

The system operates at 1600 Hertz. Changes in the alternating magnetic field at the receiver coil are observed and these changes are converted into two components, one whose phase is the same as that of the transmitted signal (the "In-Phase" component), and the other whose phase is 90^{o} apart (the "Out-of-Phase" component). These changes are expressed in terms of the normal undistorted primary field. They are so small as to be expressed usually in parts-per-million or p.p.m.

The In-Phase and Out-of-Phase variations are presented in graphic time-shared form on a single channel of a graphic recorder. The full scale chart width employed is commonly 1000 p.p.m., although in areas of low geologic noise levels 500 p.p.m. may be employed. At one or more points during each flight the scale sensitivity is checked by means of calibration signals, usually 100 p.p.m. on each trace.

The reference or "zero" level for each EM trace is an arbitrary one and is obtained empirically from the regional level of each trace. These levels may drift slowly during a flight because of temperature changes affecting the bird dimensions. These drifts are very gradual and are readily distinguishable from much quicker, local changes due to conductors of a geologic origin. Similarly, severe turbulence effects sometimes introduce low-order, primarily in-phase disturbances which are of such short period that they may also readily be distinguished from the effects of geologic conductors.

Man-made disturbances are often to be seen, including power lines, pipe lines, metal fences, railways, etc. The former are generally recognizable as such because they usually show through as cyclic noise of irregular shape and phase relationship. Non-energized, grounded power lines (e.g. 3 phase systems) may also give rise to proper conductor indications, however. Such indications, as well as those from pipe lines and metal fences, etc. are usually of short duration and can be distinguished from proper geologic sources except for very narrow, near-surface lenses. In some instances ground investigation may be necessary in order to resolve the ambiguity of possible source. Whereas the airborne geophysical crew attempts to note visible man-made conductors of the above types, the ground moves by so rapidly at the low flight elevation employed that 100% recognition of such sources cannot be expected from the air.

The normal terrain clearance of the bird is 100 ft. - 200 ft. depending on the surface topography and tree cover, etc., with the helicopter 100 ft. above. The established useful depth of detection of the system for moderate-to-large conducting bodies is about 350 ft. sub-bird under conditions of low extraneous geologic noise, i.e. where the general level of conductivity of the overburden and rock types of the area is low. The useful depth of detection of the system is therefore between 150 ft. and 250 ft. beneath the ground surface under these conditions.

Interpretation of Results

The EM records are interpreted to determine the presence of conducting bodies and to obtain some information relating to their character. The intervalometer time marks (see below) are synchronized with the positioning camera film strip (also see below) and thereby permit the relating of the conductors with appropriate ground locations. The altimeter data (see below) indicate, for each conductor, what the terrain clearance was at the time of detection.

A plan is prepared, either using a subdued photo-mosaic ("grayflex") or an overlay from a mosaic or topographic plan as base. The flight path of each survey line is obtained by means of "tie points", which are features on the mosaic or topographic plan which are also recognizable on the positioning camera film. The flight path is interpolated between these tie points.

For each conductor the following quantities are measured and recorded.

a) Half width. This is the distance between the points of half the maximum conductor disturbance. For a very thin, steeply dipping body or pipe line, etc., the half width will be about 1.6 times its depth below the bird. If the bird is at a mean conductor clearance of 150 ft. the half width would be about 250 ft. Larger half widths reflect either more deeply buried or, more likely, thicker conductors.

Flat-lying conductors (e.g. overburden) characteristically give large half widths.

The conductor half width is indicated on the plan by an open bar symbol along the flight line. In the event of very narrow conductors only the peak location may be shown (see below).

b) Peak Location. The in-phase conductor peak location is shown on the plan by a circle in the appropriate location. In the case of broad conductors or closely spaced multiple conductor zones there may be more than one peak, in which event all major peaks are shown. If a conductor is of short half width there may be no room for a half width bar and only the peak circle will be shown. A conductor which is likely man-made will be indicated by an X rather than by a circle.

c) In-Phase and Out-of-Phase Amplitudes. These amplitudes are scaled from the EM traces and noted in parts per million. On the flight plan, opposite each peak location (circle) will be given the peak in-phase amplitude and the ratio of peak in-phase to peak out-of-phase response (see below).

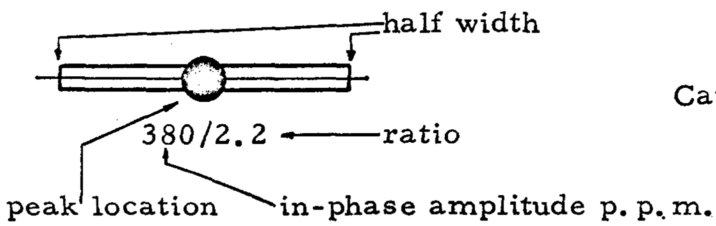
d) Conductor Coding. Conductor intersections are graded in electrical categories 1, 2 and 3, based on the in-phase amplitude but taking into account the terrain clearance. For tabular bodies such as sheet-like ore deposits, strata bound conductors and overburden, their response drops off almost in accordance with the inverse cube power of the elevation. Assuming an average 50 ft. of overburden, a category 1 conductor has a peak in-phase response equivalent to 350 p.p.m. or over at 100 ft. bird terrain clearance. A category 2 conductor has a peak in-phase response under similar conditions of between 100 p.p.m. and 350 p.p.m. A category 3 conductor has an equivalent peak in-phase response of less than 100 p.p.m.

The respective peak circles are shaded to reflect their electrical category, with category 1 fully shaded, category 2 half shaded and category 3 unshaded.

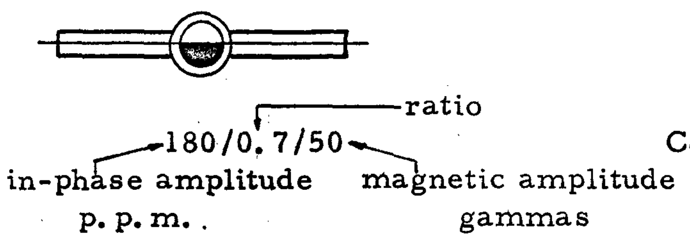
For each conductor peak the ratio of peak in-phase to peak out-of-phase amplitude is calculated and plotted on the plan. This ratio is indicative of a conductivity-size factor for the conductor. Large, high conducting bodies such as massive sulphides or graphite and sea-water, etc., generally have ratios of 3 or over. Moderate conductivity-size bodies will have ratios between 1 and 3. Poor conductivity bodies (e.g. most overburden and some sulphide and graphitic zones) will have ratios of less than 1. In areas where there is a clear differentiation in conductivity between the targets of potential economic interest and other possible conductors, the ratio is a diagnostic feature. In some areas, however, there is an overlap of conductivity ranges and then the ratio cannot be too rigidly relied upon.

Where magnetic data is available, preferably from a coincident recording magnetometer, any correlating magnetic activity will be noted for the pertinent conductor peak. A conductor peak with apparently direct magnetic correlation will be indicated by a double concentric circle. Although a conducting body which is appreciably magnetic is more likely to be a sulphide body than one which is non-magnetic, there are many very important base metal ore bodies which are quite non-magnetic.

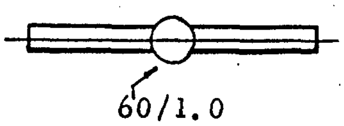
Examples of conductor coding are given below.



Category one, no magnetic correlation.



Category two, magnetic correlation.



Category three, no magnetic correlation.

X

Probably man-made conductor.

MAGNETOMETER - SCINTREX NPM-1

The Scintrex NPM-1 nuclear resonance airborne magnetometer is based on a Newmont modification of a Varian Associates magnetometer and is produced under license to both companies. It is a very light weight, solid state unit, especially designed for use in a helicopter or light fixed-wing aircraft where weight is an important consideration.

Its cycle period is 1.1 seconds. Each cycle it measures the total intensity of the earth's magnetic field and this quantity, in gammas, is recorded, in analogue form, on a suitable graphic recorder. The full scale sensitivity is usually 1000 gammas and the recorder automatically steps each 500 gammas. In very active areas a full scale sensitivity of 5000 gammas with steps of 2,500 gammas may be employed. Only the magnetic variations are actually recorded although the absolute base level may be established from the NPM-1 as well.

The magnetic sensing head may be on a cable as much as 100 ft. below the aircraft or, in some installations, may be rigidly attached to the aircraft on a suitable boom.

The intrinsic noise level of each reading is about 5 gammas.

Where it is intended to contour the NPM-1 information it is customary to fly tie lines across the survey grid. A fixed magnetic field monitor is often used as well, on the ground, primarily to indicate periods of magnetic storms during which the aeromagnetic data should be considered as unreliable.

The aeromagnetic data may be contoured if desired, using a contour interval of 25 gammas or up, depending on the amount of magnetic relief. Alternatively they may be used simply for purposes of correlation with simultaneously obtained electromagnetic data to determine which conductor zones are appreciably magnetic.

ANCILLARY EQUIPMENT

1. Altimeter

A Bonzer, high frequency solid state radioaltimeter is employed to continuously indicate the mean terrain clearance of the helicopter or other transporting aircraft. The altimeter is installed in the aircraft (unless otherwise indicated) so that the elevation of the sensing birds (electromagnetic or magnetic) will be less by the usual vertical displacement of these birds below the aircraft.

The output of the Bonzer may be expressed in analogue form on a suitable graphic recorder, or may be, for convenience, converted to a semi-digital form on a recorder side pen. In the latter event the altimeter record is a series of spaced pulses whose separation is proportional to the mean terrain clearance.

2. Positioning Camera

A Vinten Mark 3 16 mm positioning camera is employed with a wide angle lens. Photographs of the ground are taken with sufficient frequency to give a complete record of the flight path of the aircraft or helicopter. The frequency of exposure is controlled by the intervalometer referred to below.

3. Intervalometer

A Scintrex IA-2 intervalometer provides regularly spaced timing pulses which drive the positioning camera exposure mechanism and produces synchronous "fiducial marks" on the side pen of the geophysical graphic recorder or recorders. Because of the synchronization of the geophysical traces and the positioning camera it is then possible to relate the geophysical events of interest to their proper ground location. The timing pulse frequency may be adjusted in accordance with the ground speed of the aircraft so that an adequate flight path record is obtained.

SEIGEL ASSOCIATES LIMITED

GEOPHYSICAL CONTRACTORS AND CONSULTANTS

79 MARTIN ROSS AVE.
DOWNSVIEW, ONTARIO
CANADA

TELEPHONE 633-2450
636-0801
TELEX 02-29891

November 20, 1968

Invoice 68176

Granduc Mines Limited (N.P.L.)
1105 - 900 West Hastings St.
Vancouver, B. C.

Re: Airborne Geophysical Services,
Stewart, British Columbia

Item 1		
Mobilization and demobilization		$ 2,000.00
Helicopter charges:		
August 2, 4.8 hr @ $150.00 per hr.	$720.00	
August 4, 4.3 hr @ $150.00 perhour	$645.00	1,365.00
Item 2		
a. August 3, 1 day @ $325.00 per day		325.00
b. N/A		
c. N/A		
Item 3		
Line miles of geophysical data		
274 line miles @ $7.50 per line mile		2,055.00
Item 4		
N/A		
Item 5		
Helicopter rentals:		
August 3, 9.8 hr. @ $150.00 per hour		1,470.00
		$ 7,215.00
Less: down payment		1,000.00
		$ 6,215.00

ACCT. No. 3052
PRICES O. K. ✓
EXTEN. CHKD. ✓
O. K. FOR PAYMENT
CHEQUE No. 1619 - Jan 7/69

8

Declared before me at the *City*

of *Vancouver*, in the

Province of British Columbia, this *1st*

day of *May 1969*, A.D.

Erik A. Ostensoe.

Jill Sumner

A Commissioner for taking Affidavits within British Columbia or
A Notary Public in and for the Province of British Columbia.
SUB - MINING RECORDER

LEGEND:

10 ← 2657 FLIGHT LINE, FLIGHT LINE NUMBER & FLIGHT DIRECTION WITH NUMBERED CONTROL POINT.

ISOMAGNETIC CONTOURS

7925 / 8100 / 8500 CONTOUR INTERVALS 25, 100 & 500 GAMMAS

7200 MAGNETIC LOW

REFERENCE LEVEL 50,000 GAMMAS

To accompany geophysical report on Harmax Group in Skeena Mining Division, by J. Klein and R. O. Crosby, dated October 8, 1968.

HARMAX Gp.

Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1835 MAP #1

PLATE 1a

GRANDUC MINES LIMITED (N.P.L.)

STEWART AREA, B.C.

AIRBORNE GEOPHYSICAL SURVEY

N.P.M.- 1

SCALE: 1" = 2000'

SURVEY BY SEIGEL ASSOCIATES LIMITED
AUGUST, 1968

MEAN FLIGHT ALTITUDE 200'
MEAN FLIGHT LINE SPACING 1000'

1835 R. O. Crosby

①

To accompany geophysical report on Harmax Group in Skeena Mining Division, by J. Klein and R. O. Crosby, dated October 8, 1968.

LEGEND:

10 ←2657—	FLIGHT LINE, FLIGHT LINE NUMBER & FLIGHT DIRECTION WITH NUMBERED CONTROL POINT
●	1st CATEGORY H.E.M. ANOMALY
◓	2nd CATEGORY H.E.M. ANOMALY
○	3rd CATEGORY H.E.M. ANOMALY
◉ 72/2/100	H.E.M. ANOMALY WITH MAGNETIC CORRELATION and 72 P.P.M. IN-PHASE / Ratio of IN PHASE over OUT OF PHASE / Magnetic Correlation AMPLITUDE IN GAMMAS
▭○▭	EXTENT OF H.E.M. ANOMALY AND PEAK LOCATION
▬ ▬ ▬	CONDUCTOR AXIS

HARMAX Gp.

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1835 MAP #2

PLATE Ib

GRANDUC MINES LIMITED (N.P.L.)

STEWART AREA, B.C.

AIRBORNE GEOPHYSICAL SURVEY

H.E.M. — 701

SCALE: 1" = 2000'

SURVEY BY SEIGEL ASSOCIATES LIMITED
AUGUST, 1968

MEAN FLIGHT ALTITUDE 200'
MEAN FLIGHT LINE SPACING 1000'

1835 R. O. Crosby (2)