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HELICOPTER MAGNETIC AND ELECTROMAGNETIC SURVEYS

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HELICOPTER MAGNETIC AND ELECTROMAGNETIC SURVEYS

GAGNON, QUEBEC

HUDBAY MINING LTD.

JUNE, 1978.

August 14, 1978.
Toronto, Ontario.

AERODAT LIMITED.
W. P. Boyko, M.Sc., P. Eng.

CERTIFICATION

I, W. P. Boyko, of the Town of Milton, Province of Ontario

do hereby certify as follows:

1. That I am a Member of the Association of Professional Engineers of Ontario.

2. That I graduated from the University of Saskatchewan in 1952, and hold a B.Sc. degree in Geological Engineering.

3. I graduated from the Post-Graduate Department of the University of Saskatchewan in 1953, with an M.Sc. degree in Economic Geology.

4. I completed a further three years of Doctorate studies at McGill University.

5. I have practiced my profession as geologist-geophysicist continuously for the past 25 years.

DATED THIS 4th day October, 1978, in the Town of Milton, in the

Province of Ontario.

W. P. Boyko

W. P. Boyko, P. Eng.

TABLE OF CONTENTS

LIST OF MAPS

1. INTRODUCTION

This report outlines the results of a combined airborne magnetic and electromagnetic survey, totalling 902 line kilometres, which was carried out for Hudbay Mining Ltd., in the Gagnon area of Quebec.

The survey was flown in two directions; 546 line kilometres were flown in a 080°direction at a spacing of 200 metres, and 356 line kilometres were flown in the 350° direction at a spacing of 300 metres.

The electromagnetic unit used was a Barringer-Aerodat system consisting of vertical, coaxial coils mounted approximately 9 metres apart in a "bird", towed 100 feet below the helicopter. The average bird height above ground was approximately 150 feet. Specifications of the instruments are given in Appendix I.

The survey was flown during the period June 4, to 6, 1978 using a Bell Jetranger II helicopter operated by Codiac Helicopters Limited of Moncton, New Brunswick. Data processing, interpretation and reporting were done in Toronto during June - August, 1978.

The survey was flown in twps:

1853, Jauffret and Belle Roche over the following mining claims:

357920	1-4	369989-370000	1-5
357959	1-4	372101-372110	1-5
364857-861	1-5	372111	1-4
369311-317	1-5	372112-126	1-5
369366-367	1-5	372128-144	1-5
369368	1-2	372145	1-3
369895-897	1-5	372212	1-5
369899-918	1-5	372334-337	1-5
369920-935	1-5		
369937-987	1-5	TOTAL	832

2. DATA PRESENTATION

2.1 Electromagnetics

Airborne Electromagnetic Survey Map shows inphase anomaly amplitude in parts per million (ppm) of the primary field strength, and apparent conductances derived from a vertical half-plane model. Axes and strike directions of the significant conductors are interpreted on this map. The apparent conductance is determined by applying the inphase and quadrature anomaly amplitudes to the phasor diagram for the vertical half-plane model, which is shown as an inset on the map. The relationship of apparent conductance to true conductance, which in the case of narrow, slab-like bodies is the product of the electrical conductivity and the average thickness, depends upon how closely the body approximates the sheet-like form, and upon how nearly at right angles its strike direction is to the flight line of the aircraft.

Conductance in mhos is the reciprocal of resistance in ohms and is a geologic parameter because it is characteristic of the conductor alone. It is generally independent of frequency and flying height (or depth of burial) and relatively independent of conductor strike length and dip. The inphase amplitude is a function of both flying height and dip, and is more strongly affected by conductor size than is conductance. Although the conductances presented are apparent only, they are most useful for comparative evaluation of conductors.

Apparent conductance values are divided into 10 ranges shown on the map legend. These are represented on the map as a number within a circle at the anomaly location. This procedure generally tends to make the work of diagnosis easier and is also useful in planning follow-up procedures. Thus, most overburdens have apparent conductances which fall into the lowest range on the scale (<2 mhos), whereas conductive clays may have apparent conductances in the next range (2-4 mhos). The higher ranges in the scale ($>$ 4 mhos) indicate that a significant fraction of the electrical conduction is electronic rather than electrolytic in nature. Materials which conduct electronically are limited to the metallic sulphides and to graphite. Thus, the higher apparent conductance categories are generally limited to graphite and to sulphide-bearing rocks. A strong conductance ($>$15 mhos) indicates well-connected mineralization extending throughout a fairly large region, and this often suggests either graphite zones or massive sulphides. Poor to moderate conductances (4-15 mhos) may originate from massive sulphides, if they are not well interconnected or if they are of a poorly conducting variety such as galena.

Also determined from the phasor curves but not shown in the Airborne Electromagnetic Survey are the apparent depths to the conductors. Althought the phasor curves are often able to distinguish between conditions of comparatively thick and thin overburden, the depth estimates are not generally reliable. Some of the more common reasons for this are:

- (i) the conductivity of the body may change with depth
- (ii) the conductor plunges
- (iii) the dip is substantially less than vertical
- (iv) interference from conductive overburden or host rock has distorted the anomalies
- (v) the body has too short a strike length to give a good half-plane response.

Any of the conditions enumerated above may effect the anomaly amplitudes. Some will cause roughly proportionate changes in both phases, so that the depth estimates tend to be more seriously affected than the conductance estimates. Appendix III provides a listing of respones together with amplitude (in ppm), apparent conductances, apparent depths to the conductor and sensor height.

Airborne Electromagnetic Survey Profiles Map shows profiles of inphase and quadrature EM response along the flight lines in addition to the information shown on the Electromagnetic Survey Map. These profiles are transcribed and plotted from magnetic tape recorded in flight, after assigning a suitable base-level value.

2.2 Magnetics

The Total Field Magnetic Map shows contours of the total magnetic field, uncorrected for regional variation. Whether an EM anomaly with a magnetic correlation is more likely to be caused by a sulphide deposit than one without depends on the type of mineralization. An apparent coincidence between an EM and a magnetic anomaly may be caused by a conductor which is also magnetic, or by a conductor which lies in close proximity to a magnetic body. The majority of conductors which are also magnetic are sulphides containing pyrrhotite and/or magnetite. Conductive and magnetic bodies in close association can be, and often are, graphite and magnetite. It is often very difficult to distinguish between these cases. If the conductor is also magnetic, it will usually produce an EM anomaly whose general pattern resembles that of the magnetics. Depending on the magnetic permeability of the conducting body, the amplitude of the inphase EM anomaly will be weakened; and if the conductivity is also weak, the inphase EM anomaly may even be reversed in sign.

3. RESULTS AND COMMENTS

3.1 Magnetic Data

In the survey area, complex structure with relatively narrow magnetic bands was difficult to contour by the Data Plotting Contour program, resulting in the appearance of disconnected anomalies. This is somewhat exaggerated by the spacing between flight lines and the large scale plotting of 1:10,000. This difficulty was further compounded on the north-south flying where spacing was wider and the lines intersected the structure at a small angle.

3.2 Electromagnetic Data

The predominantly banded distribution of electromagnetic anomalies in parallel zones suggests in general a formational origin. Direct correlation between magnetic and conductive sources are rare and results often suggest an alternation of magnetic and conductive bands.

It has to be kept in mind that without a detailed knowledge of the expected mineralization the conductive and magnetic properties form a far from adequate basis for the selection of ground follow-up targets. The base metal mineralization in this area may cover a wide range of conductivities. Magnetic coincidence may or may not be significant. On general consideration conductors with a long strike extension are considered to be of formational origin. Significant concentrations of sulphide minerals more likely will occur as bodies of limited strike length, and it is assumed that the higher concentration and width of such bodies will be expressed in a higher apparent conductance.

Electromagnetic responses have been correlated from line to line and have been joined across flight lines by conductor axes on the interpretation map. These have also been graded according to their electrical properties, profile character and magnetic relationship as follows.

3.3 Anomaly Grading

Grade A The shape of the anomaly is characteristic of a discrete conductor within bedrock as opposed to a broad overburden conductor. The profile is relatively noise free so that the anomaly is undisturbed. The anomaly amplitude is sufficiently strong relative to noise. It is greater than 4 mhos indicating electronic conduction.

Grade A+ Same criteria as A except that the anomaly also has a coincident magnetic response.

Grade B The standards are somewhat relaxed in comparison to those used for grade A. The shape is partway between an anomaly from a discrete source and from an overburden source. There is a lower signal-to-noise ratio than for A.

Grade B+ Grade B with magnetic correlation.

Grade C The shape is uncertain. σt is less than 3 mhos and there may be topographic effect and some noise.

Grade C+ Grade C with magnetic correlation.

Grade D A generally poor conductor in all respects. Its source is considered most likely as conductive overburden, barren faults but it could also be caused by low conductivity widespread sulphides, such as vein deposits.

All conductor axes are shown on the interpretation map. However, only the grade A and B, and possibly a few grade C, anomalies have much possibility of being caused by sulphide minerals.

3.4 Conductor Discussion

Conductor (1) has low apparent conductivity and generally poor profile character, except at 9-A where both quadrature and inphase profiles improve. Examination on the ground at this location may be considered if geological conditions warrant.

Zone (2) is comprised of at least two parallel conductors. Excellent profile character and apparent conductivity is displayed at 20-A and B.

Zone (3) is a vaguely defined multiple band of conductors correlating with a relatively low magnetic area. Several conductors within this zone have excellent profile character and apparent conductivity and have limited strike length. A majority of the conductors coincide with magnetic lows, characteristic of graphite conductors.

Conductors (4) and (5) resemble Zone (3) in relationship to magnetics and conductive characteristics. The local nature of these zones may up grade their importance.

Conductor (6) is a continuous, multiple zone along the eastern margin of Zone (3). Conductor (6A) is a double peak response flanking the main zone (6).

(7) is a multiple conductive zone quite clearly associated with a stratiform rock type.

Conductors (8) (9) (10) (11) (12) (13) and (14) are all good grade local anomalies. Conductive characteristics and relationship to magnetics are striking similar to the continuous multiple zones.

Anomaly (15) is a "classic" sulphide conductor. It has excellent profile character, local extent, an apparent conductivity of 7 mhos, and magnetic coincidence.

4. SUMMARY

On the basis of the survey results, 15 general conductive zones have been discussed. Several individual conductors may be within a described zone without specific reference being made to them. Evaluation of these is given on the Interpretation Map.

A number of Grade "A" conductive zones are thought to be of possible interest, and field investigation must ultimately be based on the added consideration of geologic setting.

Conductor (15) in particular, is considered to be anomalous in comparison with the other conductors, and warrants high priority examination.

Respectfully submitted,

AERODAT LIMITED.

W. P. Boyko, M.Sc., P. Eng.

APPENDIX I

Instrumentation

Electromagnetic Instrument

Type: Helicopter mounted inphase - quadrature instrument manufactured by Barringer Research Ltd., modified by Aerodat.

Coils: The transmitting and receiving coils are coaxial, 30 feet apart in a towed bird. The coil axis is in the direction of travel.

Frequency: 870 Hz

Noise level: approximately 1 ppm

Magnetometer

Type: Proton precession model AM-104 manufactured by Barringer Research Ltd., Toronto.

Cycling time: 1.13 seconds

Polarizing time: 0.587 seconds

Sensing head design: 5 inch diameter Toroid

Ancillary Equipment

Barringer eight-channel analogue recorder

De Havilland MK VII 35 mm Flight path Camera and intervalometer

Hoffman Radio Altimeter

APPENDIX II

Analogue Tape

The flight tape consists of eight channels of information as follows:

	Channel	Time Constant	Scale Units/mm	Noise
1.	Radar Altitude	1 sec	10 feet	10 feet
2.	EM - inphase	0.6 sec	2 ppm	1 ppm
3.	EM - quadrature	0.6 sec	2 ppm	1 ppm
4.	EM - inphase	4 sec	1/2 ppm	1/4 ppm
5.	EM - quadrature	4 sec	1/2 ppm	1/4 ppm
6.	Magnetometer	1 sec	5 gammas	2 gammas
7.	Noise monitor			
8.	Magnetometer	1 sec	50 gammas	2 gammas

In addition, three fiducial markers are used between the channels, as follows:

Fiducial	Occurrence
60-hz marker	occurs only over power lines
Camera fiducials	occurs regularly at 2.5 second intervals on every line
Navigator fiducials	occurs discontinuously on every line

The 60-hz. fiducial identifies anomalies generated by power lines, allowing them to be deleted from the EM map.

The navigator fiducial marks represent points on the ground which were recognized by the aircraft navigator. The begin-ing of the flight line is flagged by a pair of navigator fiducials. These are followed by a series of unevenly-spaced fiducials moving right-wards along the tape, which is the direction of flight. The end of the line is flagged by a string of three navigator fiducial marks.

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

The flight line numbers and anomaly letters as marked on the maps are taken directly from the flight tapes. The line numbers, followed by an E or W are displayed at the top of the tape above the radar altitude trace. The E or W corresponds to the flight direction of the particular line, which is survey east, or survey west. The anomaly letters, in alphabetic order by line, are found between the radar altitude trace and the upper inphase EM trace.

APPENDIX III

Production Data

Personnel:

Operator:	C. F. Bassani	9785 Thamesgate Dr. Mississauga Ont
Pilot:	Mason Watt	Kodiak Helicopters Moncton N.B

Total Line Kilometers Flown: 902

Aircraft: Bell Jet Ranger 206-B, Reg. C-GLLP

No. of Flights: 6

Survey Dates: June 4 to June 6, 1978

APPENDIX IV

Anomaly List

```
UNIT NUMBERS                13099 6 81112131415161726271819202122 1 2 3 4
PROCESS SWITCHES            2 2 1 1 1 0 1 0 0 1 1 0
PRINTER MAP SWITCHES        3 1 1 1 2 0 0 0 0 0 0 0 0 0 0
PLOTTER MAP SWITCHES        4 2 1 0 0 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0
 AG TAPE SWITCHES           5 0 0 0 0
CHART CHANNEL LIMITS        6        32.20     36.20     27.00     33.60     23.00     27.00    18.
                                     22.40     13.80     17.80      9.20     13.20      0.0      4.
WIDTHS AND LAGS             7         4.00      4.00      4.00      4.00      4.00      4.00     4.
                                      0.0       0.08      0.08      0.08      0.08      0.16     0.
FULL SCALE VALUES           8         1.00     80.00     80.00     20.00     20.00    200.00 2000.
BONZER CALIBRATION          9       6      1.00      2.00      3.00      4.00      5.00      6.00
                                           0.37      0.74      1.11      1.48      1.85      2.22
                                           0.0     100.00    200.00    300.00    400.00    500.00
                                           0.0     100.00    200.00    300.00    400.00    500.00
TOLERANCES                 10         0.10      0.75      1.00      2.00      0.40      0.15
MAG TAPE PARAMETERS        11        20.00     20.00      0.20      0.50     20.00      8.0010000.
MAG TAPE LAGS              12         1.06      2.06     10.00      0.50      0.50      0.50     0.
SPEED PARAMETERS           13         7.22      0.10     15.00     45.00      3.00      2.00
PRINTER SPECS              14          100        66       120    0.4230    0.2540       300
PLOT SPECS                 15      0.3937500.0000500.0000    0.0700    0.0550    0.1350    0.07
EM SYMBOL LIMITS           16           10         2.        4.        8.       15.       30.      6
                                                 125.      250.      500.        0.
RESPONSE CODES             17    S M C                         24A B C D E F G H J K M N O P
HISTOGRAM SPECS            18         5.00         3         9
TITLE                      19    J7811 MAP 1 LINES 1-17 1:10000 SP. 200 METERS
MAG FILTER SPECS           20         0.0      73.00    118.00    100.00 1000.00      0.0     30.
EM FILTER SPECS            21            1     0.640         1     0.150      650.         0
THRES, LENGTH, FREQ        22     5.00     30.00      1.00
MAG BASE LEVELS            2356000.0040000.00
SCALES - FPR,PRT,PLT       2410000.0020000.0010000.00
MAP ORIGIN, CM, CW ROTATION, DEG  25        0.0       0.0       0.0
TRSP X-Y,METERS, L-R       26           0.        0.        0.        0.        0.        0.
MAP DIMENSIONS - IN        27        36.00     33.00
EM PROJECTION ANGLE, DEG, EM SCALE, PPM/CM 28        80.00     20.00
PRINTER, PLOTTER MAP SWITCHES, LIMITS 29    1 1 0 0 0 0

DMAX,TMAXC,TMAXT    34.56    10.63   767.20
```

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
8A	3	3	3	171	196
8B	1	4	0	73	153
8C	2	5	1	100	140
9A	3	9	1	51	132
10A	1	3	0	144	155
11A	1	2	0	140	170

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

```
       1..     5    10    15    20    25    30
          .XXXXX
          .X
     10..
          .
          .
    100..
          .
          .
   1000..
               5    10    15    20    25    30
```

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
19A	3	3	3	200	167
20A	17	15	6	34	164
20B	16	13	8	49	164
20C	2	3	2	186	163
21A	8	2	24	157	166
21B	7	3	16	159	174
23A	3	4	2	101	220
24A	6	2	14	188	169
24B	5	2	14	218	149
24C	5	5	4	138	144
24D	5	4	4	174	142
24E	4	11	1	15	163
24F	4	13	1	24	139
24G	3	7	1	54	160
25A	2	12	0	0	157
25B	3	11	0	0	199
25C	4	3	5	175	174
26A	5	7	2	65	176
26B	8	5	8	156	137
26C	3	2	4	220	182
27A	1	4	0	108	139
27B	2	4	1	110	150
27C	2	3	1	184	154
27D	24	12	15	41	168
27E	24	5	47	79	148

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
27F	10	2	39	159	153
28A	5	6	3	105	160
28B	2	3	2	185	151
28C	9	6	9	116	162
28D	5	2	11	172	184
28E	7	4	8	147	164
28F	4	2	8	196	172
28G	2	1	5	307	144
29A	12	9	8	54	188
29B	34	17	18	13	172
29C	12	5	19	98	176
29D	24	12	16	60	149
29E	10	4	17	139	151
29F	11	1	76	167	141
29G	12	2	43	130	162
30A	1	3	0	140	145
30B	7	9	3	92	136
30C	13	8	10	85	159
30D	12	6	13	100	166
30E	10	5	14	110	171
30F	17	10	11	43	181
30G	11	4	19	105	177
30H	10	2	35	147	165
30J	12	13	5	45	165
30K	3	4	2	164	130
31A	26	19	10	28	157
31B	11	7	10	85	175
31C	15	9	11	64	170
31D	16	8	14	79	157
31E	21	6	33	56	178
31F	5	1	29	252	150

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
31G	49	25	20	22	141
31H	2	2	2	216	169
32A	9	18	2	12	150
32B	7	5	7	99	197
32C	35	23	13	0	178
32D	57	36	16	6	141
32E	2	3	2	188	148
33A	6	7	4	41	221
33B	21	9	18	0	225
33C	16	11	9	0	228
33D	4	3	3	92	241
33E	36	24	12	15	154
33F	5	5	4	149	152
34A	29	13	19	46	152
34B	5	3	7	186	146
34C	24	19	9	27	158
34D	14	6	19	16	243
34E	7	5	6	101	184
34F	7	5	7	77	223
34G	2	3	1	212	126
34H	4	4	3	147	164
35A	6	4	6	116	195
35B	3	3	4	200	168
35C	10	7	7	57	199
35D	8	4	11	134	166
35E	4	4	4	115	207
35F	13	8	11	71	178
35G	3	2	5	227	150
36A	2	8	0	38	156

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANUMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	DEPTH	BIRD HEIGHT
36B	4	4	3	161	146
36C	2	5	1	125	141
36D	59	14	54	10	156
36E	59	15	51	19	147
36F	3	5	1	110	150
36G	17	11	11	45	178
36H	5	3	7	173	179
36J	4	6	2	103	168
37A	2	5	1	85	168
37B	9	10	4	39	189
37C	4	3	4	141	194
37D	5	5	4	138	152
37E	8	4	14	48	259
37F	34	22	13	25	150
37G	9	6	9	136	143
37H	10	5	11	154	127
37J	10	5	12	135	148
38A	3	2	7	262	143
38B	6	5	4	140	144
38C	4	6	2	119	144
38D	5	4	4	172	150
38E	5	4	6	133	184
38F	3	7	1	53	176
38G	1	6	0	44	140
39A	6	7	3	90	171
39B	8	3	16	115	196
39C	5	2	15	134	230
39D	6	2	12	192	161
39E	14	4	29	104	165
39F	8	11	3	52	160
39G	33	11	29	40	158
39H	51	35	13	2	147
39J	12	4	20	127	154

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
39K	26	13	17	68	136
40A	19	15	8	45	158
40B	4	5	2	104	170
40C	0	10	0	0	136
40D	38	23	14	21	149
40E	5	4	4	158	147
40F	7	5	8	124	171
40G	15	2	65	77	195
40H	14	2	68	99	177
40J	13	3	38	124	156
40K	16	11	10	35	188
40M	12	4	20	84	191
40N	10	3	28	70	235
40O	5	3	10	194	159
40P	10	10	4	87	141
40Q	12	15	4	66	130
41A	10	12	4	73	139
41B	6	10	2	59	142
41C	6	4	8	105	213
41D	8	4	14	168	139
41E	39	9	54	41	153
41F	7	4	11	157	157
42A	65	48	13	0	141
42B	64	50	13	1	132
42C	65	40	17	10	132
42D	7	4	8	146	161
42E	3	4	3	171	152
42F	7	7	3	109	144
42G	13	14	4	43	155
42H	3	2	5	250	166
43A	23	25	6	24	141

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
43B	7	15	1	22	145
43C	9	4	14	85	212
43D	5	4	5	170	142
43E	13	8	11	93	156
43F	15	12	8	81	137
43G	33	17	17	42	144
43H	14	11	7	78	146
44A	6	5	5	130	162
44B	4	3	4	195	154
44C	17	16	6	57	137
44D	4	2	7	232	139
44E	11	4	17	143	143
44F	9	6	8	126	153
44G	26	18	11	52	136
44H	15	11	8	92	131
44J	14	6	15	22	234
44K	10	3	28	170	137
44M	9	5	9	125	159
44N	15	18	4	56	126
44O	10	11	4	64	155
44P	16	14	7	27	179
45A	4	9	1	30	163
45B	4	13	0	0	153
45C	4	21	0	0	127
45D	2	6	0	61	153
45E	8	4	11	62	235
45F	3	3	4	195	162
45G	6	5	5	109	180
45H	2	3	1	220	125
45J	14	1	258	143	143
45K	30	7	44	74	135
45M	1	3	0	158	127
46A	15	12	8	66	150

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
46B	6	5	5	114	179
46C	3	7	1	75	151
928A	6	7	4	100	159
928B	4	5	2	111	167
928C	11	3	30	138	158
928D	8	4	12	54	249

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

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      1..   10   20   30   40   50   60
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    100..XXXX
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   1000..
            10   20   30   40   50   60
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LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
33A	6	7	4	41	221
33B	21	9	18	0	225
33C	16	11	9	0	228
33D	4	3	3	92	241
33E	36	24	12	15	154
33F	5	5	4	149	152
34A	29	13	19	46	152
34B	5	3	7	186	146
34C	24	19	9	27	158
34D	14	6	19	16	243
34E	7	5	6	101	184
34F	7	5	7	77	223
34G	2	3	1	212	126
34H	4	4	3	147	164
35A	6	4	6	116	195
35B	3	3	4	200	168
35C	10	7	7	57	199
35D	8	4	11	134	166
35E	4	4	4	115	207
35F	13	8	11	71	178
35G	3	2	5	227	150
36A	2	8	0	38	156
36B	4	4	3	161	146
36C	2	5	1	125	141
36D	59	14	54	10	156
36E	59	15	51	19	147
36F	3	5	1	110	150
36G	17	11	11	45	178
36H	5	3	7	173	179
36J	4	6	2	103	168
37A	2	5	1	85	168

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
37B	9	10	4	39	189
37C	4	3	4	141	194
37D	5	5	4	138	152
37E	8	4	14	48	259
37F	34	22	13	25	150
37G	9	6	9	136	143
37H	10	5	11	154	127
37J	10	5	12	135	148
38A	3	2	7	262	143
38B	6	5	4	140	144
38C	4	6	2	119	144
38D	5	4	4	172	150
38E	5	4	6	133	184
38F	3	7	1	53	176
38G	1	6	0	44	140
39A	6	7	3	90	171
39B	8	3	16	115	196
39C	5	2	15	134	230
39D	6	2	12	192	161
39E	14	4	29	104	165
39F	8	11	3	52	160
39G	33	11	29	40	158
39H	51	35	13	2	147
39J	12	4	20	127	154
39K	26	13	17	68	136
40A	19	15	8	45	158
40B	4	5	2	104	170
40C	0	10	0	0	136
40D	38	23	14	21	149
40E	5	4	4	158	147
40F	7	5	8	124	171
40G	15	2	65	77	195
40H	14	2	68	99	177

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
40J	13	3	38	124	156
40K	16	11	10	35	188
40M	12	4	20	84	191
40N	10	3	28	70	235
40O	5	3	10	194	159
40P	10	10	4	87	141
40Q	12	15	4	66	130
41A	10	12	4	73	139
41B	6	10	2	59	142
41C	6	4	8	105	213
41D	8	4	14	168	139
41E	39	9	54	41	153
41F	7	4	11	157	157
42A	65	48	13	0	141
42B	64	50	13	1	132
42C	65	40	17	10	132
42D	7	4	8	146	161
42E	3	4	3	171	152
42F	7	7	3	109	144
42G	13	14	4	43	155
42H	3	2	5	250	166
43A	23	25	6	24	141
43B	7	15	1	22	145
43C	9	4	14	85	212
43D	5	4	5	170	142
43E	13	8	11	93	156
43F	15	12	8	81	137
43G	33	17	17	42	144
43H	14	11	7	76	146
44A	6	5	5	130	162
44B	4	3	4	195	154

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
44C	17	16	6	57	137
44D	4	2	7	232	139
44E	11	4	17	143	143
44F	9	6	8	126	153
44G	26	18	11	52	136
44H	15	11	8	92	131
44J	14	6	15	22	234
44K	10	3	28	170	137
44M	9	5	9	125	159
44N	15	18	4	56	126
44O	10	11	4	64	155
44P	16	14	7	27	179
45A	4	9	1	30	163
45B	4	13	0	0	153
45C	4	21	0	0	127
45D	2	6	0	61	153
45E	8	4	11	62	235
45F	3	3	4	195	162
45G	6	5	5	109	180
45H	2	3	1	220	125
45J	14	1	258	143	143
45K	30	7	44	74	135
45M	1	3	0	158	127
46A	15	12	8	66	150
46B	6	5	5	114	179
46C	3	7	1	75	151
47A	5	14	1	20	144
47B	10	10	5	90	137
47C	3	4	2	158	150
47D	4	8	1	66	147
48A	26	18	10	39	148

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
48B	24	18	9	35	153
48C	3	5	2	151	125
48D	7	8	4	75	168
48E	11	16	3	33	150
49A	3	14	0	0	143
49B	3	6	1	78	163
49C	15	17	5	41	146
49D	12	14	4	53	146
49E	8	6	6	120	155
49F	4	11	1	47	131
50A	2	3	1	151	171
50B	6	7	3	94	161
50C	6	17	1	8	143
50D	4	9	1	44	152
51A	4	8	1	85	134
51B	7	8	3	97	144
51C	7	6	4	84	183
51D	3	5	1	115	155
52A	3	4	3	168	155
52B	2	4	1	166	130
52C	4	6	2	106	163
52D	7	13	2	36	157
52E	5	8	2	87	141
52F	2	4	1	139	137
53A	5	4	4	192	130
53B	44	17	27	39	137
55A	2	4	1	149	135

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
55B	4	7	1	101	133
55C	4	12	1	30	133
55D	4	6	2	122	136
55E	4	8	1	78	138
55F	3	8	1	53	157
56A	9	14	3	60	131
56B	4	4	3	160	153
56C	5	9	1	48	169
56D	1	5	0	74	142
56E	3	6	1	100	152
56F	5	9	2	65	151
56G	5	11	1	57	140
57A	6	8	3	91	155
58A	1	3	0	147	152
58B	15	22	3	12	151
58C	1	4	0	90	144
59A	2	3	1	166	149
59B	5	6	2	128	130
59C	2	2	2	246	139
59D	12	18	3	60	117
59E	2	5	0	85	137
60A	2	5	1	102	151
60B	9	5	10	142	140
61A	16	18	5	45	139
61B	6	15	1	22	137
62A	8	3	13	158	157

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
63A	13	9	8	89	149
64A	3	4	3	152	171
65A	3	5	1	108	138
66A	3	3	3	208	156
67A	7	6	5	90	188
68A	1	3	0	103	197
69A	8	5	7	147	138
70A	3	5	1	88	183
71A	3	3	4	163	195
71B	1	2	1	268	121
951A	4	9	1	65	144
951B	5	5	4	168	132

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

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LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
78A	3	4	2	150	159
78B	4	4	3	137	167
78C	1	3	0	92	160
79A	2	1	5	327	124
79B	2	1	9	345	129
79C	3	2	5	285	144
81A	3	9	1	22	170
82A	4	1	16	181	221
84A	3	3	3	177	152
84B	4	2	6	213	160
86A	2	1	6	199	248
87A	2	2	1	228	124
87B	5	5	3	163	125
87C	15	15	6	92	109
87D	31	24	10	55	116
87E	57	30	19	33	121
87F	64	24	31	26	128
87G	11	13	4	61	144
87H	9	11	3	70	142
88A	9	8	5	100	146
88B	11	9	7	94	147
88C	6	3	9	189	148
88D	4	2	7	235	146
89A	3	6	1	133	111

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
89B	4	3	4	203	138
89C	2	4	1	146	145
90A	3	1	8	305	132
90B	8	3	18	162	158
91A	1	4	0	110	124
91B	15	11	9	63	163
91C	7	5	6	150	135
91D	36	14	26	33	156
91E	32	18	15	55	128
91F	8	6	8	153	128
91G	12	5	16	126	147
92A	3	4	1	134	159
92B	8	7	6	114	152
92C	18	14	8	64	139
92D	18	15	8	56	146
92E	3	5	1	52	207
92F	5	6	2	70	190
92G	5	6	3	115	159
93A	2	4	0	101	151
93B	3	7	1	96	118
93C	6	6	4	143	129
93D	3	3	3	227	140
94A	1	3	0	122	154
94B	2	5	0	61	154
94C	4	4	3	155	146
94D	5	9	2	86	129
94E	3	4	2	148	149
94F	3	3	2	193	151
95A	4	6	2	127	139

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
95B	4	8	1	77	137
95C	2	3	2	210	138
95D	1	2	1	227	146
95E	2	5	0	98	124
95F	2	7	0	52	129
95G	4	11	1	53	131
95H	5	14	1	35	126
96A	3	7	1	82	135
98A	3	2	6	226	160
98B	3	3	2	191	152
100A	5	3	7	195	151
103A	9	6	7	130	142
103B	5	5	4	131	169
104A	2	3	1	193	144

ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

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    1..    5    10   15   20   25   30
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22 0/05
12

ASSESSMENT REPORT

ON

AN AIRBORNE ELECTROMAGNETIC

AND MAGNETIC SURVEY

OVER

832 MINING CLAIMS SITUATED

IN

TWPS. 1853, JAUFFRET & BELLE ROCHE

P.Q.

October 3/78

K.O. Giesbrecht

TABLE OF CONTENTS

LIST OF PLATES

APPENDICES

INTRODUCTION

This assessment report is to accompany a report and maps (2 copies) entitled "Helicopter Magnetic and Electromagnetic Surveys, Gagnon, Quebec Hudbay Mining Ltd". The survey was conducted by Aerodat Limited for Hudbay Mining during the period June 4-6, 1978.

LOCATION

The airborne survey (a total of 902 ln/km) was flown over a 832 claim block of ground registered in the name of Hudbay Mining Ltd and located in twp 1853, Jauffret, & Belle Roche in the Province of Quebec. (see Plate 1).

RESULTS OF SURVEY

Results of the Helicopter magnetic and electromagnetic survey are summarized in the report and maps by Aerodate Limited (W.P. Boyco, M.Sc., P. Eng.,) attached.

COST OF SURVEYING

The following is a summary statement of the costs relating to flying the airborne survey. Supporting invoices are included in Appendix A.

STATEMENT OF COSTS

A.	direct flying costs	$22,550.00
B.	mobilization and demobilization	3,000.00
C.	additional reproduction	93.00
D.	administration & overhead	2,564.30

Total Cost $28,207.30

Signed: E.C. Burgan

E.C. Burgan
Exploration Manager
Hudbay Mining Ltd
Eastern Division

HOW THE WORK IS TO BE APPLIED

By effect of renunciation (sec 78) of 480 mining claims, the entire cost (28,207.30) of the airborne survey is to be applied evenly over the remaining 352 claims. This is a net cost of $\frac{28,207.30}{352}$ = $80.13 per claim. The retained (352) and renounced (480) claims are shown on Plate 1 and listed below.

RETAINED CLAIMS (352)

LIC #	CLAIM #'s	TOTAL CLAIMS	EXPIRY DATE
357920	1-4	4)	
357959	1-4	4)	Feb 14-17/79
357857-861	1-5	25)	
369311-317	1-5	35)	
369366-367	1-5	10)	Oct 6-20/78
369368	1-2	2)	
369910-911	1-5	10)	
369915-918	1-5	20)	
369920-922	1-5	15)	
369923-930	1	8)	
369934	4-5	2)	
359935	1-5	5)	
369937	1-5	5)	
369938	1	1)	
369939	1-5	5)	
369941	1-4	4)	Mar-May/79
369943	1-3	3)	
369945	1-2	2)	
369947	1	1)	
369951-953	1-5	15)	
369954	1,4,5	3)	
369955	4-5	2)	
369956	1-5	5)	
369957	5	1)	
369958	1-5	5)	
369960	1-5	5)	

RETAINED CLAIMS CONT'D (352)

LIC #	CLAIM #'s	TOTAL CLAIMS	EXPIRY DATE
369962	2-5	4)	
369964	3-5	3)	
369966	4-5	2)	
369968	5	1)	
369975-984	4-5	20)	
369989-994	4-5	12)	
369995-370000	1-5	30)	Mar-May/79
372101	1-5	5)	
372111	3-4	2)	
372115-121	1-5	35)	
372126	1-5	5)	
372128-132	1-5	25)	
372212	1-5	5)	
372336	1	1)	
372337	1-5	5)	

Comments on above claims

The following 33 mining claims are presently under development licence.

a)

357920-1-4	- 4
357959-1-4	- 4
357857-861-1-5	-25
	33

b) Application for development licence and annual rent of $470 has been made on the following 47 mining claims.

369111-369317	1-5	- 35
369366-369367	1-5	- 10
369368	1-2	- 2
		47

Assessment work has been filed on 27 of these claims (see Assessment Report on Diamond Drilling on claims 364859-3 and 364859-4 twp. 1853, February 78, K. Giesbrecht).

The assessment requirement for the remaining 20 claims should be met from filing the present airborne survey.

c) application for development licences and payment of annual rental on the remaining 272 claims will be made before they are due to expire in March, 1979.

RENOUNCED CLAIMS

LIC #	CLAIM #'s	TOTAL CLAIMS	LIC #	CLAIM #'s	TOTAL CLAIMS
369895-897	1-5	15	369962	1	1
899-909	1-5	55	963	1-5	5
912-914	1-5	15	964	1-2	2
923-930	2-5	32	965	1-5	5
931-933	1-5	15	966	1-3	3
934	1-3	3	967	1-5	5
938	2-5	4	968	1-4	4
940	1-5	5	969-974	1-5	30
941	5	1	975-984	1-3	30
942	1-5	5	985-987	1-5	15
943	4-5	2	989-994	1-3	18
944	1-5	5	372102-110	1-5	45
945	3-5	3	111	1-2	2
946	1-5	5	112-114	1-5	15
947	2-5	4	122-125	1-5	20
948-950	1-5	15	133-144	1-5	60
954	2-3	2	145	1-3	3
955	1-3	3	334	1-5	5
957	1-4	4	335	1-5	5
959	1-5	5	336	2-5	4
961	1-5	5			

TOTAL 480 CLAIMS

APPENDIX A

INVOICES FOR COST
SUMMARY STATEMENT.

AERODAT LIMITED

2785 THAMESGATE DRIVE · MISSISSAUGA · ONTARIO L4T 1G5

TELEPHONE:
(416) 678-2446

September 1, 1978.

Hudbay Mining Ltd.,
1200, 10 King Street East,
Toronto, Ontario. M5C 1C3

Attention: Mr. E.C. Burgan

In account with:

Aerodat Limited,
2785 Thamesgate Drive,
Mississauga, Ontario. L4T 1G5

Re: Airborne Geophysical Survey - Gagnon area, Quebec, in accordance with agreement dated April 3, 1978.

902 km @ $25/km	$22,550.00
Mobilization and demobilization	3,000.00
	$25,550.00
Checkmate #13375 (additional reproduction)	93.00
	$25,643.00
Received to date	21,000.00
Now due	$ 4,643.00

78/09/07

DIST. BY NB VERIFIED BY FINAL APPROVAL BY [illegible] 78-09-07

CO	VENT	A1	ACCOUNT	MAJOR	SUB-1	SUB-2	SUB-3	SUB-4	GROSS	NET
14			7076	2075	380				$ 4,643.00	