5475

HELICOPTER GEOPHYSICAL SURVEY
KUTCHO CREEK AREA
BRITISH COLUMBIA
for
SUMITOMO METAL MINING CANADA LIMITED
by
AERODAT LIMITED
June 1974

CLAIM : KC

104I/1W

T. [illegible]
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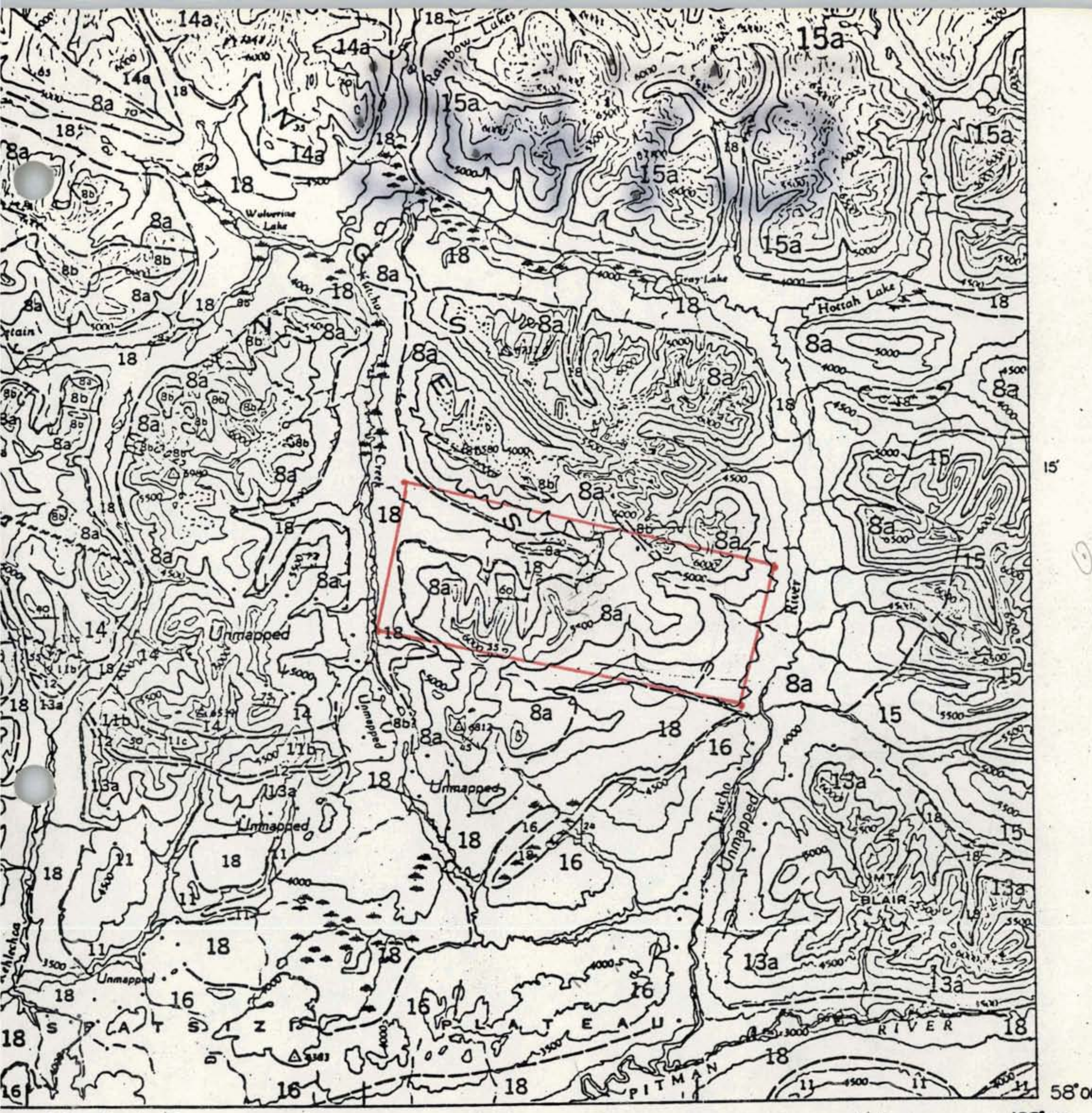


957, "Stikine River Area" 30' 15' 128°00'

INDEX MAP

MAP 29-1962
CRY LAKE
BRITISH COLUMBIA
SHEET 104I

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 5475 MAP 1

5475
MAP 1

Kutcho Airborne Geophysical Survey

Statement of Costs

d)	Travel (air)		$ 198.00
e)	Frontier Helicopters		1,329.05
h)	Preparation of Report		200.00
i)	(i)	Geophysical contractor	3,000.00
	(ii)	Photographic control mosaic	793.00
	(iii)	Supervision	500.00
			$6,070.05

T. Rodgers
18.IX.75

TABLE OF CONTENTS

LIST OF MAPS

1. INTRODUCTION

A combined four-channel electromagnetic and magnetic survey totalling 102 line miles was carried out for Sumitomo Metal Mining Canada Limited in the Kutcho Creek area of northern British Columbia on June 25, 1974. Three areas were surveyed, 1,2, and 3, and their locations are shown on the index maps on each sheet.

The survey was flown at a nominal line spacing of 660 and an average bird height of about 175, using Jet Ranger 206B helicopter CF-FHK operated by Frontier Helicopters. Survey airspeed averaged about 70 MPH. Ancillary equipment consisted of a Barringer Research AM-104 proton precession magnetometer with its bird at an average height of about 225 feet, a Bonzer radar altimeter, a deHavilland Mk VII sequence camera, an MFE 8-channel hot pen recorder and a 60Hz. monitor.

Appendix I provides details on the recorder channels and the data reduction procedure.

2. DATA PRESENTATION

2.1 Electromagnetics

The Airborne Electromagnetic Survey Profiles and Filtered Magnetic Map shows profiles of in-phase and quadrature EM response along all flight lines. These profiles have been transcribed digitally from the analog data, after removing a constant base level value. Contours of the filtered magnetic data are also given on the same sheet for reference.

The Airborne Electromagnetic Survey Interpretation Map is an interpretation map, which shows the inferred axes and strike directions of the significant conductors, together with the in-phase anomaly amplitude in parts per million (ppm) of the primary field strength and the apparent conductances derived from the vertical half-plane model. The apparent conductance is determined by applying the in-phase 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 the true conductance, which in the case of narrow, slab-like bodies is the product of the electrical conductivity and average thickness, depends upon how closely the body approximates the sheet-like form, and upon how nearly at right angles its strike direction is the flight line of the aircraft.

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

(i) the conductivity of the body changes 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 affect 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.

The conductance values are divided into groups, and the symbols given in the Airborne Electromagnetic Survey Interpretation Map indicate the range into which each analysis falls. This procedure generally tends to make the work of diagnosis easier. Thus, most overburdens have apparent conductances which fall into the lowest range on the scale (2 mhos), whereas conductive clay deposits may have apparent conductances in the next higher range (2-4 mhos). Also included as a general rule in the two lowest ranges are the very weak bedrock conductors and the "structural" conductors, such as unmineralized faults and shears.

Ordinarily, the flat-lying surficial deposits are easily distinguished from these bedrock and structural features by the shapes of their reponses, and wherever this has been possible they are identified in the map with the symbol S. The higher ranges in the scale of apparent conductances (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.

The apparent conductance of a rock unit, in mhos, is very largely an indicator of its electrical properties. The value is affected to some extent by the strike length of the body (if it is short), and by the dip; but these effects are comparatively minor, and are unlikely to cause more than a 30% change. A strong conductance (20 mhos) inidcates well-connected mineralization extending throughout a fairly large region, and this often suggests either graphitic zones or massive sulphides. Such features generally respond well to ground surveys using closely-coupled systems such as the horizontal loop method. Poor to moderate conductances (4 to 20 mhos) <u>may</u> originate from massive sulphides, if they are not well connected or if they are of a poorly-conducting variety such as pyrite or galena. Greater care and more thoughtful planning are often needed to detect these bodies in follow-up surveys on the ground.

Appendix II provides a tabulation of anomaly amplitude (in ppm), apparent conductances (in mhos), and apparent depths of burial for all significant EM conductors in the area. These interpretations are also presented in the Airborne Electromagnetic Survey Interpretation Map on a mosaic base to permit direct correlation with the available geology, and to assist in the ground follow-up program.

2.2. Magnetics

The Total Field Magnetic Map shows contours of the total magnetic field, uncorrected for regional variation.

Digital line filtering was used to obtain the magnetic contours shown in the Airborne Electromagnetic Survey Profiles and Filtered Magnetic Map. The filter (see inset) has a predetermined length and is run along the raw magnetometer profiles. Its coefficients are calculated to be such that, if the magnetic trends were perfectly two-dimensional and the flight line direction perpendicular to their strike, the anomalies would appear as if the survey has been performed at the north magnetic pole and at an elevation close to the bedrock surface. This will have the effect of bringing the anomalies into closer relationship with the outlines of the bodies that cause them, and of greatly increasing the resolution of overlapping magnetic effects. Since the assumptions upon which the method is based are only approximately fulfilled in practice, the filtering procedure is only partially effective. However, it does permit easier and more direct correlation between EM and magnetic responses. To keep the map simple, only the positive contours are shown.

It is generally considered that an EM anomaly with a magnetic correlation is more likely to be caused by a sulphide deposit than one without. 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 filtered magnetics. If the conductor is strongly magnetic, the amplitude of the in-phase EM anomaly will be weakened; and if the conductivity is also weak, the in-phase EM anomaly may even be reversed in sign.

3. HELICOPTER POSITIONING

Several positioning problems may produce distortion on the maps. One problem is the difficulty of recognizing ground features accurately at the low altitudes at which these surveys are flown. Some distortion occurs by assuming constant flying speed and direction between fiducial points, and some distortion occurs because of extension of the maps beyond the last fiducial points on the lines. On this area no large errors are apparent. The maximum error is probably about 100-200 feet. If more accurate anomaly location is desired before commencing ground follow-up, it is suggested that the positioning photography should be re-examined at the anomaly peaks.

4. REGIONAL GEOLOGY

The regional geology is described on Geological Survey of Canada Map 29-1962, Cry Lake, B.C.

The survey area is underlain by metamorphosed sediments, volcanics and intrusive rocks of Upper Devonian and Lower Mississippian age. Lithologies vary from limestone and conglomerate through chert, argillite and quartzite, to greenstone, diorite and meta-diorite. Ultra-mafic intrusive rocks of roughly the same age are known to outcrop along the northern boundary of the area.

The country rock strike is roughly east-west and the dip is approximately 50^{o}-60^{o}N.

No mineralization is mentioned in the area, though small occurrences of copper minerals have been noted in the Cassiar Batholith some fifteen miles to the north.

Surficial deposits of gravel, sand and silt occur along the Kutcho Creek valley in the western part of the area, and along east-west tributaries flowing into Kutcho Creek from the central part of the area. Similar deposits occur in the southeastern part of the area along a tributary of the Tucho River.

Ground elevation varies from approximately 4,000 in the Kutcho Creek Valley to more than 6,000 feet at one or two of the mountain peaks.

5. INTERPRETATION

The survey Areas 1,2, and 3 are discussed in order and conductors are numbered generally from west to east. No attempt is made in this report to identify the conductors geologically or to interpret the magnetic data in a geological sense. Rather, the conductors are described in terms of their electrical parameters, noting any magnetic association that could be of significance in their subsequent evaluation and identification.

5.1 Area 1

Conductor 1 extends along a creek at the south end of the area, and appears to be a genuine bedrock response of medium strength. The west end of the conductor coincides with a magnetic anomaly.

Conductors 2 and 3 are very weak responses of poor character. They are quite similar and the discrepancy in the apparent conductivity is due to the error in measuring small quantities.

Conductors 4 to 14 inclusive, are strong responses in a related multiple zone. Conductivity is generally variable across the zone. Conductors 4 and 13 are coincident with magnetic anomalies.

Responses 15, 16, 17 and 18 are weak and most likely represent part of a more extensive zone to the west.

Conductors 19, 20, and 21 are weak responses.

Conductor 22 is of weak to moderate strength on the edge of a more extensive multiple zone to the north.

Conductors 23 to 38 are part of a broad multiple zone. Responses are generally weak to moderate, and conductivity is at the low end of the spectrum. Although the responses do not correlate directly with magnetic anomalies, they are however, associated with a magnetic trend.

5.2 Area 2

Zones 39 and 41 are very weak conductors of low conductivity which could be interpreted as surface features. However, the responses are spatially related to a strong conductor to the north and most likely are bedrock features.

Conductor 40 is moderately strong and of the highest conductivity within the map area.

Conductor 42 is of medium strength and fair conductivity. It parallels conductor 40 and probably is related in origin.

Responses 43, 44 and 45 are weak in strength and conductivity, but are most likely bedrock features.

Responses 46 and 47 are moderately strong, and are part of a more extensive multiple zone. Conductor 47 coincides with a magnetic anomaly.

5.3 Area 3

Broad quadrature responses outlined by the EM profiles in the northeastern third of this area indicate that overburden thickness is greater here than in Areas 1 and 2. Although most of the conductors detected are of low conductivity, the sharp character of the quadrature responses suggests that most are genuine bedrock responses.

Conductor 48 is typical of a good character quadrature response. Although the conductivity is low, this conductor is most likely caused by a bedrock feature.

Conductors 49 and 50 might be the same conductors. Conductor 49 is the stronger response and is higher in conductivity.

Conductors 51, 52, 53, 54 and 55 are all weak, but definite bedrock responses.

Conductor 56 is within the active quadrature area and is most likely caused by a surface response.

6. CONCLUSIONS

The highest apparent conductivity within the areas surveyed was detected on conductor 40, line 16. Conductor 40 is generally high in conductivity all along its strike length. Other instances of high apparent conductivity are represented by the multiple zone of conductors 4 to 14 in Area 1. This zone however differs markedly from conductor 40 by its multiple character.

Assuming that conductor 40 is caused by sulphides of which pyrite is the main constituent, except for conductivity and character of response, no other criteria are suggested for a recognition of similar possible sulphide conductors. Since sulphides can occur in combinations of varying conductivities, any of the definite bedrock responses may represent sulphides.

Respectfully submitted,

AERODAT LIMITED

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

T. Rodgers
2.VI.75

APPENDIX I

The Flight Tape and Path Recovery

The flight tape is a roll of chart paper. It moves through the recorder console at a speed of 1.5 mm/sec. This provides a ground scale on the flight tape in feet/mm which is approximately equal to the helicopter flight speed in mph. Thus, for example, the ground scale of the flight tape is approximately 65 feet/mm when the helicopter flies at 65 mph.

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

Channel	Time Constant	Scale Units/mm	Noise
Radar altitude	1 sec	10 feet	10 feet
Maximum-coupled coil in-phase	1 sec	5 ppm	5 ppm
Maximum-coupled coil quadrature	1 sec	5 ppm	5 ppm
Maximum-coupled coil in-phase	6 sec	2 ppm	2 ppm
Maximum-coupled coil quadrature	6 sec	2 ppm	2 ppm
Magnetometer: 1 gamma/step	1 sec	2.5 gamma	2 gamma
Magnetometer: 10 gamma/step	1 sec	25.0 gamma	20 gamma

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 3 mm 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 beginning of 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 four navigator fiducial marks.

The camera fiducial marks indicate each point where a photograph was taken. These photographs are used to provide accurate photo-path 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 interpretation 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 in-phase EM trace.

APPENDIX II

Anomaly List

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
1A	8	14	2	0	196
1B	30	28	7	0	186
1C	10	16	2	0	180
1D	4	18	0	0	189
1E	5	19	1	0	175
1F	6	21	1	0	168
1G	5	17	1	0	174
1H	1	12	0	0	166
1J	3	8	0	42	148
1K	5	17	1	8	138
1M	6	16	1	0	171
1N	124	84	18	0	179
1O	145	107	17	0	168
1P	148	83	24	0	174
1Q	112	71	19	0	185
1R	87	62	16	0	186
1S	39	39	8	0	222
1T	52	33	15	0	228
1U	20	11	13	6	209
2A	16	7	16	3	243
2B	15	19	4	0	240
2C	30	29	7	0	201
2D	86	71	13	0	167
2E	78	64	12	0	182
2F	11	17	3	0	213
3A	25	37	4	0	194
3B	28	34	5	0	183
3C	19	24	4	0	237
3D	10	15	3	0	245
3E	22	11	15	0	230
4A	9	8	5	54	189
4B	23	29	5	0	202
4C	41	34	10	0	202

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
5A	35	23	12	0	221
5B	24	22	7	0	220
5C	5	8	2	24	196
6A	9	11	4	8	212
6B	37	60	4	0	162
6C	16	26	3	0	174
6D	5	12	1	0	206
7A	5	12	1	0	189
7B	7	9	2	27	192
7C	9	6	9	82	198
7D	4	6	2	38	206
8A	12	9	7	0	259
9A	17	17	6	4	186
9B	5	7	2	47	199
10A	1	5	0	0	199
10B	4	2	9	191	195
10C	4	8	1	33	190
10D	7	11	2	2	205
10E	5	8	2	25	203
11A	5	5	3	75	215
11B	6	11	1	0	209
12A	9	5	10	65	221
12B	6	4	8	90	222
12C	4	5	2	59	222
12D	6	12	1	0	201

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
12E	7	19	1	0	195
12F	5	9	1	0	215
13A	3	14	0	0	228
13B	7	7	4	77	174
13C	4	8	1	28	189
13D	4	7	2	79	172

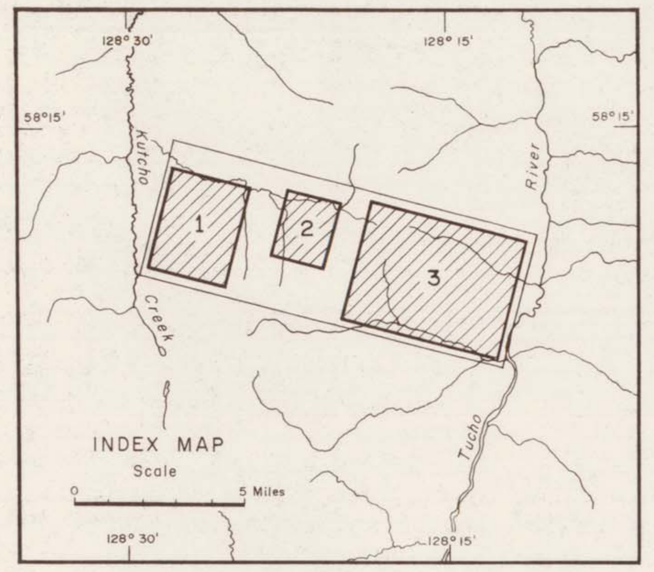
ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS

LINE AND ANOMALY	INPHASE PPM	QUADRATURE PPM	CONDUCTOR MHOS	CONDUCTOR DEPTH	BIRD HEIGHT
14A	7	8	3	2	231
14B	11	8	8	60	188
15A	4	8	1	47	176
15B	18	6	24	109	136
15C	6	7	3	91	159
16A	46	9	68	0	189
16B	10	6	11	70	204
17A	15	19	4	21	159
17B	12	18	3	0	198
17C	4	5	2	96	179
17D	5	10	1	12	183
17E	9	7	6	114	141
17F	28	13	19	58	142
17G	4	8	1	70	147

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
18A	1	5	0	25	171
18B	9	9	4	11	226
22A	5	5	3	85	202
23A	8	4	11	117	187
23B	3	11	1	5	171
24A	6	8	3	78	166
25A	7	11	2	47	156
25B	10	14	3	0	195
29A	4	6	2	107	154
30A	6	12	1	12	171
33A	7	11	2	43	162
34A	1	7	0	0	168
35A	8	11	3	35	184
40A	10	5	10	55	223

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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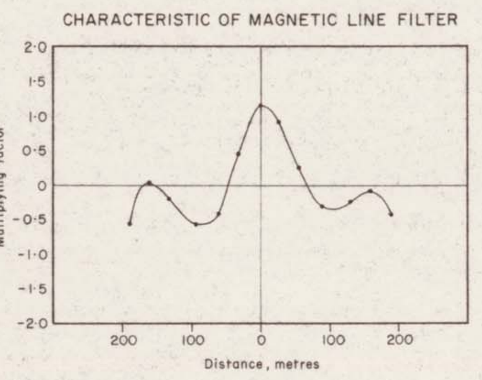

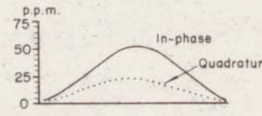

LEGEND

500 gammas
100 gammas
20 gammas
0 gammas

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 5475 MAP 3

MAP 2

AIRBORNE ELECTROMAGNETIC SURVEY PROFILES AND FILTERED MAGNETIC MAP

KUTCHO CREEK AREA

5475

SUMITOMO METAL MINING CANADA LTD.

MAP 3

1320 660 0 1320 2640 3960 Feet

JULY 1974

T. Rodger
P. Eng
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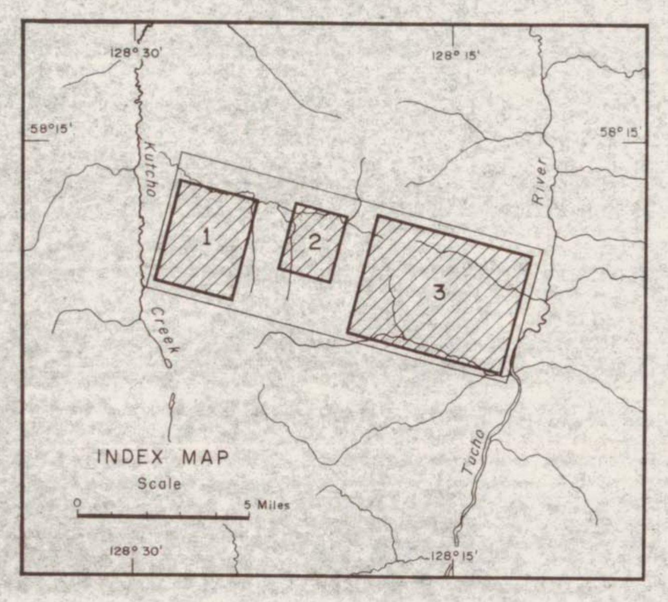

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LEGEND

1,000 gammas
200 gammas
50 gammas
25 gammas

MAP 3

TOTAL FIELD MAGNETIC MAP

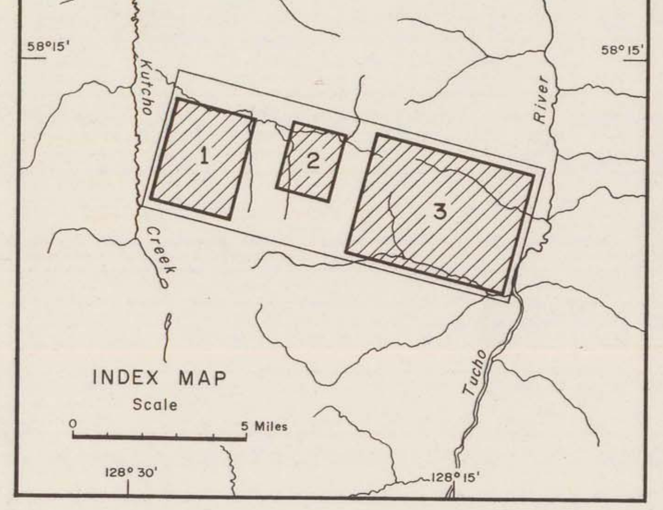
KUTCHO CREEK AREA

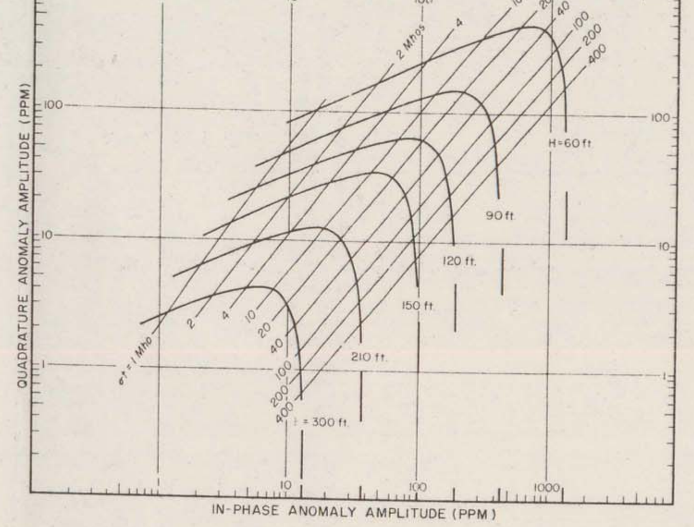
SUMITOMO METAL MINING CANADA LTD.

1320 660 0 1320 2640 3960 Feet

JULY 1974

5475
MAP4





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EM RESPONSE

Conductivity thickness in mhos

⑨	> 500
⑧	250 – 500
⑦	125 – 250
⑥	60 – 125
⑤	30 – 60
④	15 – 30
③	8 – 15
②	4 – 8
①	2 – 4
○	< 2
25	Inphase response

Horizontal control .... based on photo laydown

Average bird height .... 150 Feet

Line spacing .... 660 Feet

EM ANOMALY SYMBOLS

EM Anomaly A, in-phase amplitude 7 p.p.m. Conductivity thickness range 2 (see code)

24 Interpreted conductor axis "A" and apparent depth below surface

Conductor with coincident magnetic anomaly

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 5475 MAP 2

Claim location map +

MAP I

AIRBORNE ELECTROMAGNETIC SURVEY

INTERPRETATION MAP

KUTCHO CREEK AREA

5475
MAP 2

SUMITOMO METAL MINING CANADA LTD.

1320 660 0 1320 2640 3960 Feet

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