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MARLIN DEVELOPMENTS LTD.
GEOPHYSICAL REPORT ON AN
AIRBORNE MAGNETIC AND VLF-EM SURVEYS
TAN CLAIMS
SKEENA MINING DIVISION
NTS: 104A/5W & 104B/8E
LATITUDE: 56° 20'N LONGITUDE: 130° 0'W
AUTHOR: Jeffrey C. Murton, B.Sc., P.Geoph.
DATE OF WORK: MARCH 3 & 7, 1990
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GEOLOGICAL BRANCH
ASSESSMENT REPORT

20,256
Part 2 of 2

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ILLUSTRATIONS

INTRODUCTION:

On March 3 and 7, 1990 an airborne reconnaissance magnetic and VLF-EM survey was conducted over the **Tan claims** by Western Geophysical Aero Data Ltd. for **Marlin Developments Ltd..**

The intention of this survey is to direct further exploration to favorable target areas and to assist in the geological mapping of the property. Approximately 310.3 line kilometers of airborne magnetic and VLF-EM data has been collected, processed, and displayed in order to evaluate this property.

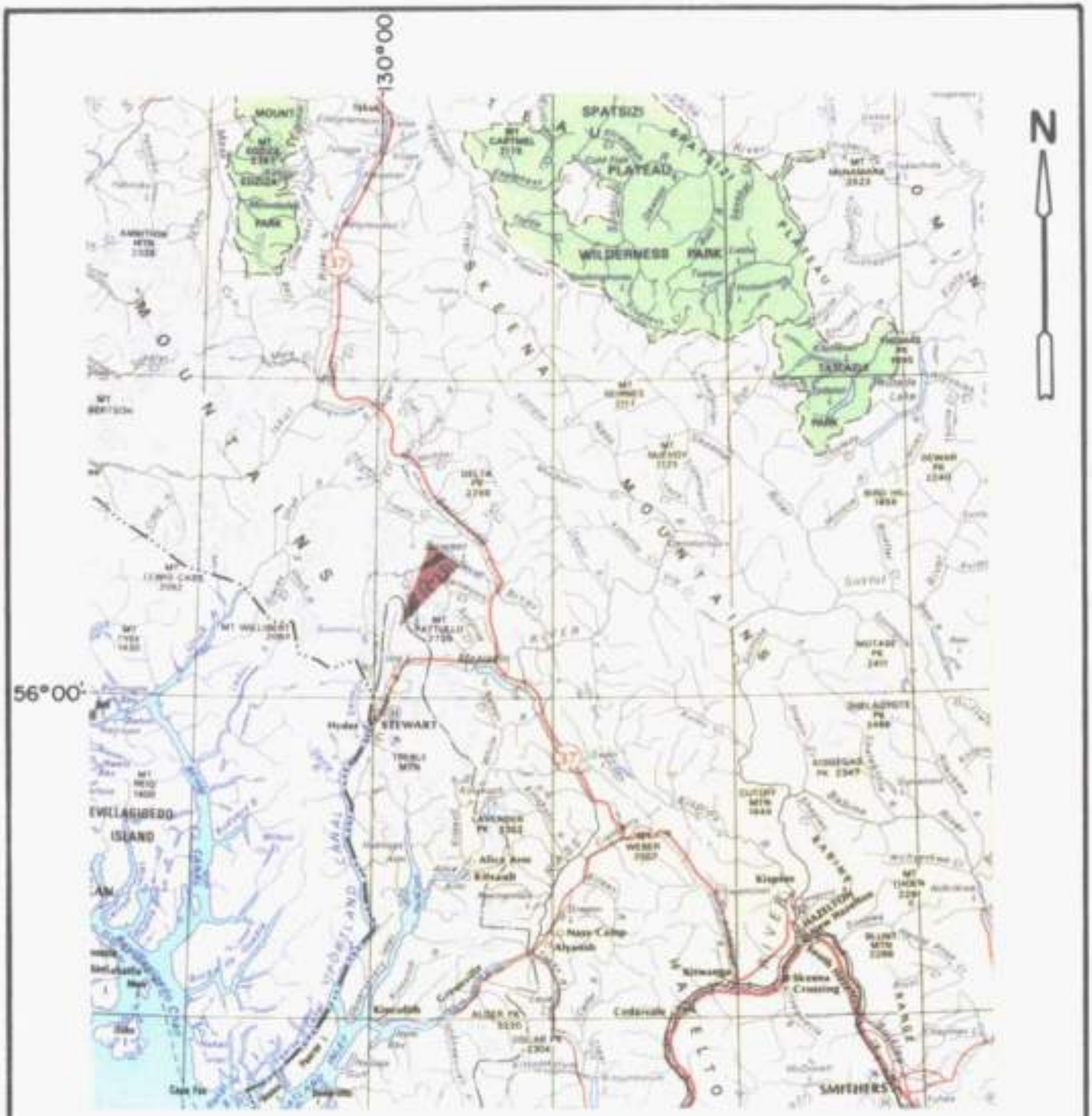
LOCATION AND ACCESS

The **Gil claims** are located 42 kilometres north of Stewart, B.C. (Figure 1). The property lies south and east of Bowser River (Figure 2).

There is year-round highway access to Stewart. Property access was gained by a thirty minute helicopter charter ride to the area east of Bowser River.

AIRBORNE MAGNETIC AND VLF-EM SURVEY:

This geophysical survey simultaneously monitors and records the output signals from a Barringer Research proton precession magnetometer and a Herz dual-frequency VLF-EM receiver. The sensors are installed in an aerodynamically stable "bird" which is towed thirty metres below a helicopter. Fixed to the helicopter skid is a shock and gimbal-mounted, downward-facing video camera. A video signal is recorded and later reviewed and correlated with a recent air photograph in order determine the precise locations of the flight paths. The elevation of the helicopter above the ground is recorded by a radar altimeter and monitored by the pilot and navigator in order to maintain a constant ground clearance.



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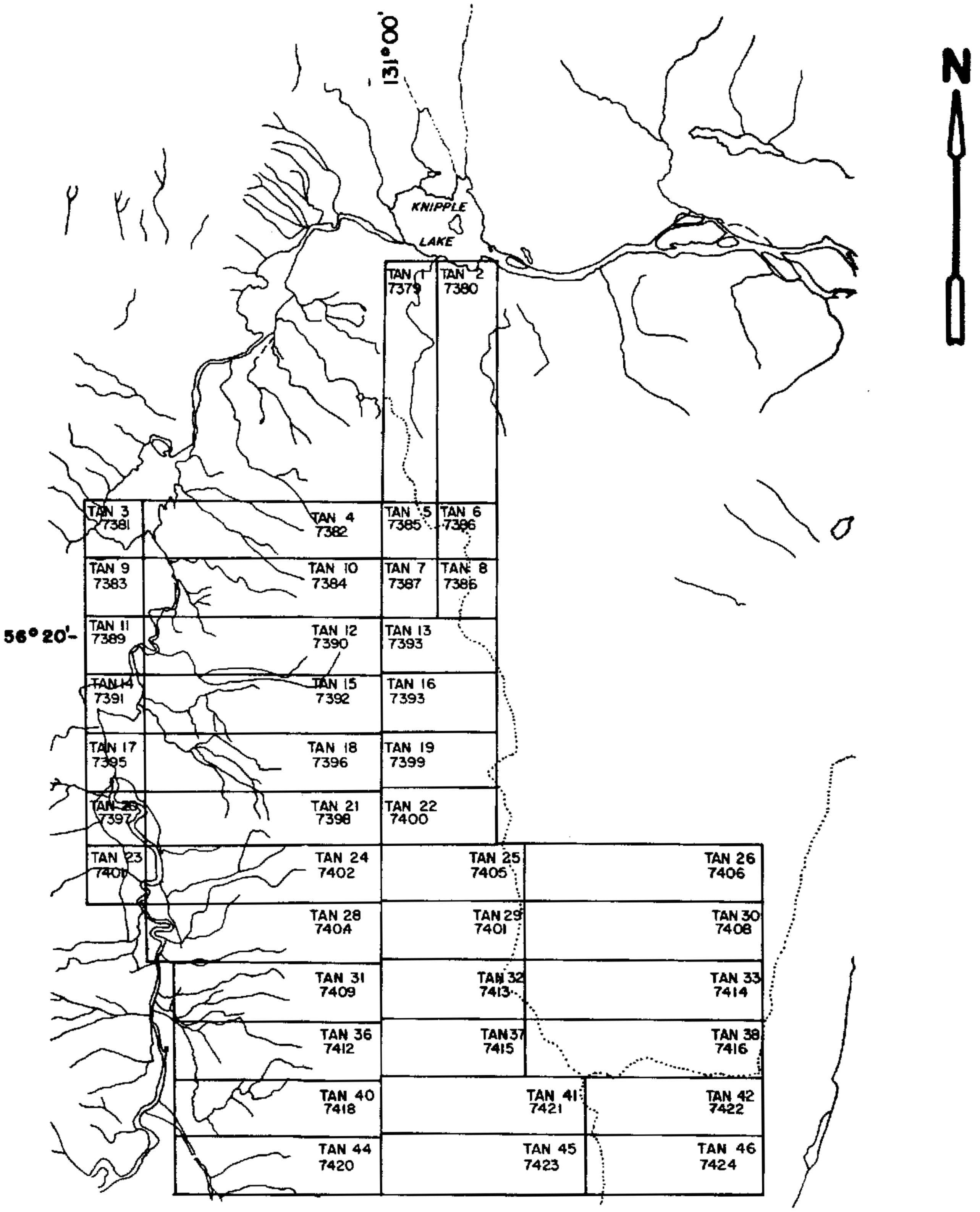
TAN CLAIMS

LOCATION MAP

N.T.S. 104A/5W & 12W

SCALE=1:2 000 000

FIG.1



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TAN CLAIMS

CLAIMS MAP

SCALE = 1:100 000

N.T.S. 104B/8E & 104A/5W

FIG. 2

A computer records readings of the magnitude of the earth's magnetic field and of the fields induced by two powerful VLF-EM transmitters (located in Annapolis, Maryland and Seattle, Washington). This data, the time and date it was observed, radar altimeter values, and survey fiducial points are all superimposed on the video image and recorded on both video cassettes and 3.5 inch computer diskettes.

Data quality is assured by the survey operator monitoring a real-time display of direct and unfiltered recordings of all the geophysical output signals while a navigator directs the helicopter pilot from an air photograph.

Magnetic (Figures 4 & 5) data is useful for mapping the position and extent of regional and local geological structures which have varying concentrations of magnetically susceptible minerals. Many lithological changes correlate with a change in magnetic signature.

VLF-EM data is useful for mapping conductive zones. These zones usually consist of argillaceous graphitic horizons, conductive clays, water-saturated fault and shear zones, or conductive mineralized bodies. The VLF-EM data is presented as contoured total field data overlain by quadrature (out-of-phase component) profiles. Conductors are located at inflection points or a change in sign (cross-over) of the quadrature component over a local total field VLF-EM high.

In a typical VLF-EM survey, satisfactory conductor coupling and imaging occurs only within 45° of the primary field selected (in the direction of the transmitter). For maximum coupling, and in turn, imaging, a transmitter should be selected in the same direction as geologic strike.

DATA PROCESSING:

The video image, with superimposed line and fiducial identification, recording times, and the recorded data, is correlated with both the navigator's and operator's field notes and topographic features observed from an air photograph. The "recovered" flight paths are digitized to obtain relative x and y positions which are then combined with the data. Subsequently, all geophysical data is filtered to remove spurious noise bursts and chatter, and then plotted as flight path profiles and contour maps for each of the sensors.

Both the total field magnetometer signal and the total field and quadrature components of VLF-EM signal are sensitive to topographic changes and bird oscillations. Short wavelength (less than 200 meters) oscillations, are attenuated by filtering the VLF-EM data with a digital low-pass filter. Long wavelength effects (anomalies greater than 2000 metres), attributed to broad topographic features, are also removed from both the VLF-EM channels by high-pass filtering.

DISCUSSION OF RESULTS:

The **Tan claims** were surveyed on March 3 and 7, 1990. Over 310.3 line kilometers of airborne magnetic and VLF-EM survey data have been recorded and evaluated for this property. Survey lines were flown approximately east-west on a Hughes 500D helicopter with an average spacing of 300 metres. The geophysical survey data were recorded on average three times per second for an effective sample interval of 15 metres. The sensors were towed below the helicopter with an average terrain clearance of 30 metres where possible.

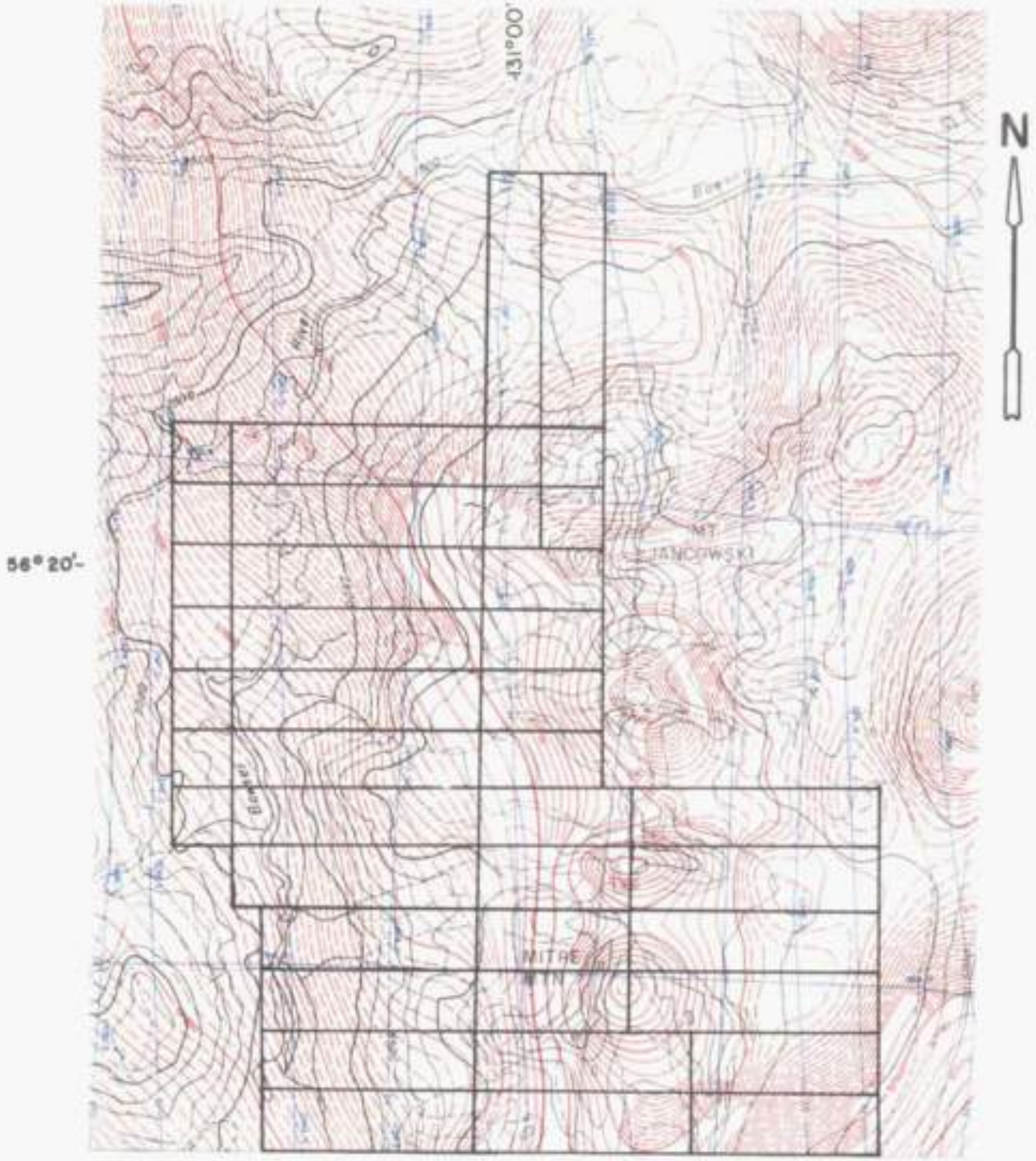
The abrupt topographic changes due to the erosional effects of creeks on the property contribute up to an additional 190 metres of ground-to-sensor separation in places. In any airborne geophysical survey an increase in the ground-to-sensor distance by five metres is noteworthy and by ten metres is significant. The effect of separation increases of this magnitude upon the magnetic and VLF-EM responses is a marked reduction in measured intensity. Increased sensor-ground separation attenuates the geophysical response and results in the appearance of a mappable magnetic or VLF-EM low. In many geological settings the location of creeks and rivers correspond to the surface expression of fault and shear zones, or lithological contacts and are likely areas to observe significant VLF-EM conductors. In part, the VLF-EM response, and to a less extent the magnetometer response, may have been "over-printed" or attenuated in these areas by increased separation effects thus masking conductors that might be observed on a ground survey.

VLF-EM conductors corresponding to Seattle and Annapolis transmitters have been interpreted and numbered on the Geophysical Interpretation Map (Figures 10). The intensity of the conductors imaged by the Seattle, Washington transmitter (Figures 6 & 7) are greater than those induced by the Annapolis, Maryland transmitter (Figure 8 & 9). The Seattle VLF-EM total field contours (Figure 7) have a contour interval of 2.0 per cent whereas the Annapolis data is contoured at an interval of 1.0 per cent. The better Seattle response is more likely the result of a shorter transmission distance rather than improved geological coupling.

Good conductors exhibit strong in-phase crossovers, the quadrature usually lags by up to 90 degrees or mirrors the in-phase response, and the total field is a local high. Conversely, for poor conductors, the quadrature response nearly mimics the in-phase and there are no strong in-phase crossovers and, in some cases, no associated total field anomalies. Poor conductors may be associated with conductive overburden, weathered bedrock, and conductive effects in swampy areas. In airborne surveys the in-phase component is not recorded therefore conductors must be interpreted with only to total field and quadrature responses.

The profiled and contoured magnetic data (Figures 4 & 5) show considerably more detail than the magnetic map of the area published GSC magnetic data (Figure 3). The magnetic detail on the contour display (Figure 5) is dramatic; the **Tan claims** can be divided into two distinct areas of contrasting magnetic signatures. On the west ends of Lines 22 to 45 the magnetic response is relatively low and featureless compared to the steep magnetic gradients and high magnetic levels which characterize the rest of the property. North of Line 22 and on the east ends of Lines 22 to 44 the magnetic levels step dramatically up in distinct blocks. A geological contact has been interpreted along the steep magnetic gradients which rise from the central area of low magnetic relief. This geological contact is interpreted as the western boundary of a sequence of highly magnetic, volcanic and pyroclastic flows. The area containing the weak magnetic response may correspond to an area of marine sediments rather than volcanics. Two small outlying magnetic highs located on the east ends of Lines 21 to 24 and 28 to 32, in the vicinity of Brightwell Glacier, may be sourced in a more mafic unit. North and east of the interpreted flow boundary the elevated magnetic response shows the effects of topographic "over-printing"; local magnetic relief correlates with changes in elevation. For example: east of the interpreted geologic contact/flow boundary there is a marked magnetic increase along the east side **Tan 41 and 45** associated with VLF-EM conductor pairs S3-A4 and the north-south trending ridge line. East of this ridge there is large icefield correlating with an attenuated magnetic response. The reduced magnetic level encountered in areas of thick ice cover is more probably due to an increase in the effective sensor to ground separation rather than a change in the underlying lithology. In the middle of **Tan 4** three geological contacts have been interpreted from the local magnetic response.

The VLF-EM responses resulting from abrupt topographic changes,



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TAN CLAIMS

AEROMAGNETIC MAP

N.T.S. 104B/8E & 104A/5W

SCALE = 1:100 000

FIG. 3

are as expected. The resulting relatively narrow conductors are primarily sourced in topographic effects. The correlation is apparent when the conductors and orthophoto are compared. Areas of low measured VLF-EM total field correspond to areas covered by ice. The ice cover results in an increased ground-sensor separation and thus lower VLF-EM total field intensities. The conductors trend predominantly NNW. Many are over six kilometres in length. There are a number of weak conductors which cut across ice fields. These usually correlate to crevassed areas and reflect a subglacial topographic change and therefore are likely sourced in this topographic effect. One area where the VLF-EM response does not correspond to topographic features is the area spanning Lines 52 to 62, over **Tan 17, 20, and 23.** Here conductors S22-A24, and A25 parallel the west side of Bowser River and are adjacent to a local magnetic high. This local magnetic response has been interpreted as a geological contact. The geophysical response over **Tan 17, 20, and** 23 may be sourced in a contact between a volcanic unit and a deltaic sedimentary unit or in a fault with replacement vein mineralization.

CONCLUSIONS AND RECOMMENDATIONS

The **Tan claims** are located in an area where the dominant lithology is a Middle Jurassic pyroclastic - epiclastic sequence which corresponds to the Betty Creek Formation (Grove, 1986). There is significant magnetic relief on the property. A number of geologic contacts, parallel to magnetic contours, have been interpreted in the area of magnetic relief. The region of steep magnetic gradients between areas of low and elevated magnetic levels have been interpreted as a geological contact between epiclastic and the more magnetic pyroclastic rocks. These potential contacts may also represent a pyroclastic flow boundary with lateral differences in magnetic minerals concentration. In the southern portion of the survey the transition between low and high magnetic levels step northeast in distinct blocks. Faults have been interpreted where magnetics change abruptly, and in some instances where VLF-EM conductors correspond to lineations shown on the orthophoto.

Overall, the VLF-EM conductors recorded on the survey correspond to topographical highs. VLF-EM lows typically correlate to areas covered by glaciers. There are a number of conductors which trend at oblique angles to topographic features. The structural and lithological characteristics of these "cross-cutting" conductors should be evaluated.

A ground examination must be made to verify the geophysical interpretations presented in this report. A more complete picture of the local geology is necessary to interpret the geophysical data. It is recommended that a follow-up search of all sources for additional geological information and any descriptions of past work on these and adjacent claims be undertaken. Subsequent to this search effort a program of geological mapping should be undertaken in the following areas: 1. The region of "cross-cutting" conductors on the **Tan 17, 20, and 23.** 2. The conductors on the west side of Bowser River. 3. The conductors group. 4. All postulated geological contacts.

A follow-up program of ground geophysical surveying should be completed over those airborne geophysical anomalies which are found to be located in a promising geological setting.

Respectfully submitted,

Jeffrey C. Murton, B.Sc., P.Geoph.(APEGGA)

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Alldrick, D.J., and Britton, J.M., 1988, Geology and Mineral Deposits of the Sulphurets Area, Open File Map 1988-4, BCMEMPR

Grove, E.W., 1986, Geology and Mineral Deposits of the Unuk River - Salmon River - Anyox Area, B.C., Bulletin 63, BCMEMPR

STATEMENT OF QUALIFICATIONS

NAME:	MURTON, Jeff C.
PROFESSION:	Geophysicist
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PROFESSIONAL ASSOCIATIONS:	Society of Exploration Geophysicists Association of Professional Engineers, Geologists, and Geophysicists of Alberta
EXPERIENCE:	1984-88 - Geophysicist, Interactive Graphics with Western Geophysical Company of Canada Ltd. in Calgary, Alberta. 1988 - Geophysicist with White Geophysical Inc.

INSTRUMENT SPECIFICATIONS

BARRINGER AIRBORNE MAGNETOMETER

Model:	M 1041
Type:	Proton Precession
Range:	20,000 to 100,000 gammas
Accuracy:	+ 1 gamma at 24 V d.c.
Sensitivity:	1 gamma throughout range
Cycle Rates:	Manual: Pushbutton single cycle External: Actuated by a contact closure (short) longer than 10 microseconds Continuous: 1.114 seconds with external pins shorted Internal: 1 second to 3 minutes in 1 second steps
Outputs:	Analogue: 2 channels, 0 to 99 gammas or 0 to 990 gammas at 1 m.a. or 100 mV full scale deflection Digital: Parallel output 5 figure 1248 BCD, TTL compatible Visual: 5 digit numeric display directly in gammas
Size:	Instrument set in console 19" x 3.5" x 10"
Weight:	10.6 lbs.
Power Requirements:	28 ± 5 volts dc, @ 1.5 amps - polarizing 4 amps
Detector:	Noise cancelling torroidal coil installed in air foil

INSTRUMENT SPECIFICATIONS

HERZ TOTEM - 2A VLF-EM SYSTEM

Primary Source:	Magnetic field component radiated from VLF radio transmitters (one or two simultaneously)
Parameters Measured:	Total field, vertical quadrature, horizontal quadrature and gradient
Frequency Range:	15 kHz to 25 kHz; front panel selectable for each channel in 100 Hz steps
Sensitivity Range:	130 µV m to 100 mV at 20 kHz, 3 dB down at 14 kHz and 24 kHz
VLF Signal Bandpass:	-3 dB at +/- 80 Hz; < 4% variation at ±50 Hz
Adjacent Channel Rejection:	300 to 800 Hz = 20 to 32 dB; 800 to 1500 Hz = 32 to 40 dB; > 1500 Hz > 40 dB (for < 2% noise envelope)
Out of Band Rejection:	10 kHz to 2.5 Hz = 5 x 10^{-4} Am to 5 x 10^{-1} Am < 2.5 kHz rising at 12 dB octave 30 kHz to 60 kHz = 5 x 10^{-4} Am to 8 x 10^{-3} Am > 60 kHz rising at 6 dB octave (for no overload condition)
Output Span:	±100% = ±1.0 V
Output Filter:	Time constant 1 sec. for 0% to 50% or 10% to 90% noise bandwidth 0.3 Hz (second order LP)
Internal Noise:	1.3 µV m rms (ambient noise will exceed this)
Sferics Filter:	Reduces noise contribution of impulse filter
Electric Field Rejection:	<0.5% error for 20 m tow cable
Controls:	Power switch, frequency selector switches (Line and Ortho), meter switch (Total Quad), and sferics filter switch
Displays:	Meters (Line and Ortho), sferics light, overhead light

HERZ TOTEM - 2A VLF-EM SYSTEM - PAGE 2

Inputs:	Power: 23 to 32 V DC; fused 0.5 Amps
	Signal: Sensor upper; sensor lower
Outputs	Total, quad, gradient, multiplexed (line and ortho)
	Audio monitor, stereo line and ortho
Dimensions and Weight:	Console: 480 mm wide x 45 mm high x 340 mm deep, 3.8 kg
	Sensor and Preamplifier Assembly: 150 mm diameter x 460 mm long, 1.5 kg

INSTRUMENT SPECIFICATIONS

DATA ACQUIISITION UNIT

Model:	HP-3852A	
Mainframe Supports:	Eight function module slots	
	Data acquisition operating system	
	System timer	
	Measurement pacer	
	Full alphanumeric keyboard, command and result displays	
Number of Channels:	20 channel relay multiplexer HP44708A/H	
Voltmeter:	5½ to 3½ digit intergrating voltmeter HP44701A measures:	
	DC voltage	
	resistance	
	AC voltage	
	Range ±30V, ±0.008%, +300uV	
	Intergration Time 16.7 msec	
	Number of converted digits	6½
	Reading rate (readings/ sec)	57
	Min-Noise rejection (dB) Normal Mode Rejection at 60 Hz ±0.09%	60
	DC Common Mode Rejection with 1 KΩ in low lead	120
	Effective Common Mode Rejection at 60 Hz ±0.09% with 1 KΩ in low lead	150
Communication:	HPIB interface with Compaq	
Power Requirements:	110/220 Volts AC at 60/50 Hz	
Dimensions:	45.7 cm x 25.4 cm x 61.0 cm	
Weight:	9.5 kg.	

INSTRUMENT SPECIFICATIONS

CONTROLLER AND RECORDING SYSTEM - SPECIFICATIONS

Type:	Compaq Portable II An 80286 microprocessor 640 Kbytes of RAM 2 three and a half inch 720 Kbyte drives one 20-Megabyte fixed disk drive Monochrome, dual-mode, 9-inch internal monitor Asynchronous communications interface Parallel interface Composite-video monitor interface RGB monitor interface RF modulator interface Two expansion slots Real-time clock An 80287 coprocessor A HPIB Interface Card
Data Storage:	3 1/2 inch diskettes in ASCII Roland 1012 printer for printed output Beta I video cassettes
Power Requirements:	115 Volt AC at 60 Hz
Weight:	11 kg
Dimensions:	45 cm x 25 cm x 30 cm

INSTRUMENT SPECIFICATIONS

FLIGHT PATH RECOVERY SYSTEM

T.V. Camera:	Model: RCA TC2055 Vidicon Power Supply: 12 volt DC Lens: Variable, selected on basis of expected terrain clearance Mounting: Gimbal and shock mounted in housing, mounted on helicopter skid
Video Recorder:	Model: Sony SLO-340 Power Supply: 12 volt DC / 120 volt AC (60Hz) Tape: Betamax ½" video cassette - optional length Dimensions: 30 cm X 13 cm X 35 cm Weight: 8.8 Kg Audio Input: Microphone in - 60 db low impedance microphone Video Input: 1.0 volt P-P, 75 unbalanced, sync negative from camera
Altimeter:	Model: King KRA-10A Radar Altimeter Power Supply: 0-25 volt (1 volt/1000 feet) DC signal to analogue meter, 0-10 v (4mv/ft) analogue signal to data acquisition unit Mounting: Fixed to T.V. camera housing, attached to helicopter skid

COST BREAKDOWN:

DESCRIPTION	TOTAL
Tan claims survey totals	
Mobilization and demobilization, 2 men, Brent Robertson and Gerald MacKenzie	$ 1 400.00
Airborne geophysical surveying (March 3,7 1990) (310.3 km @ $50.15/km)	$15 560.00
Data processing and report charges	$14 175.00
Subtotal	$31,135.00