BC Geological Survey Assessment Report 32327

ASSESSMENT REPORT ON GEOPHYSICAL WORK ON THE FOLLOWING CLAIMS

667309-10 INCL. # 667324 # 667703 # 667725-27 INCL. # 667663 # 667683 # 670383 # 668145-147 INCL. # 668165-167 INCL. # 668170-71 INCL. # 668173 # 668183

COLLECTIVELY THE "RED CHRIS SOUTH" PROPERTY"

COLLECTIVELY THE "YELLOW CHRIS" PROPERTY

STATEMENT OF WORK: #4807732 and #4807734

LOCATED 22 KM SOUTHEAST AND 6.5 KM EAST OF ISKUT, BC LIARD MINING DISTRICT

57 degrees 39 minutes latitude 129 degrees 39 minutes longitude 57 degrees 51 minutes latitude 129 degrees 52 minutes longitude

N.T.S. Nos: 104H.011 and 104H.012

PROJECT PERIOD: October 8th to October 19th, 2010

ON BEHALF OF TEUTON RESOURCES CORP. VANCOUVER, B.C.

REPORT BY

D. Cremonese, P. Eng. #202-2187 Oak Bay Avenue Victoria, B.C. V8R 1G1

Date: April 29th, 2011

TABLE OF CONTENTS

	Page
1. INTRODUCTION	
A. Property, Location, Access and Physiography	2
B. Status of Property	2
C. History	4
D. References	5
E. Summary of Work Done	6

2. TECHNICAL DATA AND INTERPRETATION

A. Geology & Mineralization	6
B. Geophysics	7
C. Discussion	7
E. Conclusions	8

APPENDICES

- II Certificate of Qualification
- III Report on a Helicopter-Borne Versatile Time Domain Electromagnetic (VTEM) and Aeromagnetic Geophysical Survey; Geotech Project #10217, Area 1 & Area 2 [Geotech Limited of North Aurora, Ontario]

ILLUSTRATIONS

Fig. 1	Location Map	Report Body
Fig. 2	Claim Map	Report Body
Fig. 3	Geotech Survey Grids Relative to Claim Boundaries	Report Body
Fig. 4	Regional Geology Map	Report Body
Fig. 5	Total Magnetic Intensity (TMI) Results Relative	Report Body
	To Regional Geology	
Fig. 6	VTEM Survey Results Relative to Regional Geology	Report Body



1. INTRODUCTION

A. Property, Location, Access and Physiography

The Red Chris South property is located in northwest British Columbia (see Figure 1), approximately 22km southeast of the village of Iskut, 80km south of Dease Lake, and 12km east of the Stewart-Cassiar Highway (Highway 37). The Yellow Chris Property is located approximately 12 kilometres to the northwest, 6.5 kilometres to the east of Iskut, BC.

The nearest gravel airstrip is located in Iskut. Northern Thunderbird Air currently has scheduled service on Monday, Wednesday and Friday to the Dease Lake airport and the Bob Quinn airstrip, located 111km south of Iskut along Highway 37.

Access to the Yellow Chris claims is obtainable by truck or car using Highway 37 which passes along the western boundary of the property. Access to the upper portions of the area as well as to the Red Chris South property can be gained by helicopter from one of the seasonal helicopter bases stationed in Iskut.

The claims are situated on the eastern portion of the Todagin upland plateau which forms a subdivision of the Klastine Plateau along the northern margin of the Skeena Mountains. Elevations on the property are typically $1,500 \pm 30$ m with relatively flat topography broken by several deep creek gullies. Bedrock exposure is confined to the higher-relief drainages and along mountainous ridges. The majority of the ground in this area is covered by a thin layer of glacial till. Vegetation on the plateau consists of scrub birch and willow, grasses and mosses. Within the creek valleys are several varieties of conifer and deciduous trees including balsam, fir, cedar, spruce, and aspen.

The climate in the area is northern temperate with moderately warm summers and cold dry winters. Typical daytime temperature ranges are from the mid to upper 20°' s Celsius in summer and -20° to -30° Celsius in winter. Precipitation averages about 100 cm. per year. Thick accumulations of snow are common in winter.

B. Status of Property

Red Chris South			
Tenure Number	Claim Name	Area in hectares	Present Anniversary Date
667309	IMP 7	415.47	Nov.10, 2013
667310	IMP 8	415.37	Nov.10, 2013
667324	IMP 9	415.3	Nov.10, 2013
667663	RED DOG1	346.29	Nov.10, 2013

The properties are comprised of claims as summarized below:

667683	RED DOG 2	86.54	Nov.10, 2013
667703	RED DOG 3	415.5	Nov.10, 2013
667723	RED DOG 4	415.31	Nov.10, 2013
667724	RED DOG 5	432.6	Nov.10, 2013
667725	RED DOG 6	433.05	Nov.10, 2013
667726	RED DOG 7	433.02	Nov.10, 2013
667727	RED DOG 8	433.08	Nov.10, 2013
667728	RED DOG 9	415.5	Nov.10, 2013
667729	RED DOG 10	432.85	Nov.10, 2013
667730	RED DOG 12	433.08	Nov.10, 2012
667743		173.26	Nov.10, 2012
667763	RED DOG 13	415.68	Nov.10, 2012
670284	RED CAT 1	432.27	Nov.17, 2012
670285	RED CAT 2	415.15	Nov.17, 2012
670287	RED CAT 3	432.6	Nov.17, 2012
670303	RED CAT 4	415.44	Nov.17, 2012
670323	RED CAT 5	415.58	Nov.17, 2012
670325	RED CAT 6	415.71	Nov.17, 2012
670326	RED CAT 7	415.85	Nov.17, 2012
670328	RED CAT 8	432.16	Nov.17, 2012
670329	RED CAT 9	432.4	Nov.17, 2012
670343	RED CAT 10	415.32	Nov.17, 2012
670363	RED CAT 11	415.51	Nov.17, 2012
670365	RED CAT 12	415.7	Nov.17, 2012
670366	RED CAT 13	415.89	Nov.17, 2012
670368	RED CAT 14	432.7	Nov.17, 2012
670369	RED CAT 15	432.95	Nov.17, 2012
670370	RED CAT 16	433.2	Nov.17, 2012
670383	RED MOUJSE 1	433.1	Nov.17, 2012

Yellow Chris			
Tenure Number	Claim Name	Area in hectares	Present Anniversary Date
668144	YELLOW CHRIS 1	430.79	Nov.11, 2013
668145	YELLOW CHRIS 2	430.73	Nov.11, 2013
668146	YELLOW CHRIS 3	430.71	Nov.11, 2013
668147	YELLOW CHRIS 4	430.72	Nov.11, 2013
668163	YELLOW CHRIS 5	430.74	Nov.11, 2013
668164	YELLOW CHRIS 6	430.6	Nov.11, 2012
668165	YELLOW CHRIS 7	430.57	Nov.11, 2012



668166	YELLOW CHRIS 8	430.5	Nov.11, 2012
668167	YELLOW CHRIS 9	430.47	Nov.11, 2012
668168	YELLOW CHRIS 10	413.5	Nov.11, 2012
668169	YELLOW CHRIS 11	413.53	Nov.11, 2012
668170	YELLOW CHRIS 13	430.36	Nov.11, 2012
668171	YELLOW CHRIS 14	430.31	Nov.11, 2012
668172	YELLOW CHRIS 15	430.14	Nov.11, 2012
668173	YELLOW CHRIS 16	430.12	Nov.11, 2012
668183	YELLOW CHRIS 16	430.18	Nov.11, 2012

Claim locations are shown on Figure 2. The claims are wholly owned by Teuton Resources Corp. of Victoria, British Columbia.

C. History

The Yellow Chris and Red Chris South properties are located in the Stikine River area of northwestern British Columbia, a region well known for its sub-alkalic to alkalic plutons, associated porphyry copper-gold mineralization and peripheral gold-silver bearing quartz veins. The area was subjected to very little exploration until the 1960's and 1970's when extensive exploration for porphyry copper deposits took place. In particular, Texasgulf Inc. carried out an intensive exploration program throughout the area and discovered a number of significant prospects including the Red-Chris and Rok.

The Red Chris South property sits to the immediate south of Imperial Metals, Red- Chris porphyry copper-gold deposit. This deposit was first discovered in the 1960's and has since received sporadic yet continuous exploration. The drill programs undertaken by Texasgulf Inc. during the 1974,1975,1976,1978 and 1980 field seasons, outlined two coalescing, east-north-easterly trending zones of porphyry-style copper gold mineralization hosted by the 'Red' stock, a weakly to intensely altered feldspar hornblend porphyry intrusion. These were later named the Main and East Zones. Current total proven and probable reserves at the Red-Chris deposit are estimated at over 300 million tonnes grading 0.359% copper and 0.274 g/t gold (Estimates for 2010 at website: http://www.imperialmetals.com/s/Development_RedChris.asp).

In 1976, Great Plans Development Company of Canada Ltd. carried out prospecting and geological mapping (Minfile #104H/15, 18) on the Kitty, Fife and Drum claims. These expired claims are within the area presently covered by the Yellow Chris property. The Drum claim was located in between the Zechtoo and Thatue Mountains. The Kitty and Fife claims were situated on the south and west side of Zechtoo Mountain, respectively. No significant mineralized occurrences were discovered during this program.

The area was subsequently staked by West Pride Industries Corp in 1990 to form the Railway-Zetu property. In July and August, 1990, Reliance Geological Services Inc. carried out a program of reconnaissance prospecting and silt sampling (Kidlark, 1990a and 1990b). In June, 1991, Placer Dome Inc. conducted an examination of the property and collected 99 soil samples from several traverses near Zechtoo and Thatue Mountains. Fifty-five rock samples were also collected, mainly from the "Main Trench" area. A sample location map and the analytical results were made available to West Pride Industries Corp. but a report was not submitted.

The Railway-Zetu property was optioned in 1991 to Hyder Gold Inc. who commissioned Keewatin Engineering Inc. to carry out a reconnaissance soil, silt, and rock sampling program (DuPre, 1990) to evaluate the porphyry Cu/Au and shear vein Au/Ag potential of the claim group. The samples returned inconsistent results with spotty low-grade Cu-Au anomalies.

A historically investigated showing referred to as KLASTINE PLATEAU (MINFILE Number 104H 018) lies within the south-eastern portion of the Yellow Chris claim block and comprises limestone lenses included in the unnamed Carboniferous and older basement exposed along the southern flank of the Stikine arch.

Until the present 2010 geophysical program the Red Chris South property has seen no documented work. Teuton acquired the claims in November, 2009, after examination of Imperial Metals' Red Chris drilling results, in particular, hole RC09-350 which ran 152.5m of 4.12% copper and 8.83 g/t gold, said to be one of the richest in terms of length and grade to be drilled in British Columbia since the Eskay Creek discovery in 1989. Teuton's Red Chris South Claims adjoin within 3km of this high grade zone.

D. References

- Ash, C. H. and Fraser, T. M., 1994: 1994 Geological Mapping of the Tatogga Lake Project; An Ongoing Four-Year Geological Mapping Project for the B.C. Ministry of Energy, Mines and Petroleum Resources, Geological Survey Branch.
- Ash, C., Macdonald, R., Stinson, P. et al, 1997. Geology and Mineral Occurrences of the Tatogga Lake Area. B.C. Geological Survey Branch Open File 1997-3
- British Columbia Ministry of Energy, Mines and Petroleum Resources, MINFILE Public Website. April 15, 2011. http://www.em.gov.bc.ca/Mining/Geolsurv/minfile/
- DuPre, D.G., 1990. Geological report on the ROK property. Private company report for Carina Minerals Resources Corp.
- Geological Survey of Canada, 1987. Geology of Klastline River, Ealue Lake, Cake Hill and Stikine Canyon, Open File 1080.
- Kidlark, R.G., 1990. Geological and geochemical report on the Railway Property, Liard Mining Division, private company report for West Pride Industries Corp.



- Kidlark, R.G. (1991). Geological and geochemical report on the Zetu Creek Property, Liard Mining Division, private company report prepared for West Pride Industries Corp.
- MacIntyre, D.G., Villeneuve, M.E., Schiarizza, P., 2001: Timing and tectonic setting of Stikine Terrane magmatism , Babine-Takle lakes area, central British Columbia. Canadian Journal of Earth Sciences, v. 28, p. 579-601.
- Melner, Dave, MSc. (2010): Ground Magnetic, IP Geophysical Surveying and Soil and Rock Geochemistry Of the Coyote Grid and Area, On the Rok-Coyote Property. (#31462), on file with BCEMPR.
- Schiarizza, P., MacIntyre, D.G., 1999: Geology of the Babine-Takla lakes area, central British Columbia. British Columbia Ministry of Energy and Mines, Paper 1999-1, p. 33-68.

E. Summary of Work Done.

A helicopter borne geophysical survey was carried out by Geotech Limited of Aurora, Ontario over parts (see Figure 3) of the Yellow Chris and Red Chris South properties on behalf of Teuton Resources Corp. between October 8th and October 19th, 2010. A total of 530 line-kms was flown during the Project. Of this amount, 328.9 line-kms are attributable to the southernmost portion of the Project, namely the Red Chris South property. The remaining 201.1 line-kms were flown over the northernmost survey grid, within Teuton's Yellow Chris claims.

The helicopter and crew were stationed out of Iskut, BC during the acquisition phase of the survey. Full particulars of the survey are attached to this report as Appendix III, entitled "Report on a Helicopter-Borne Versatile Time Domain Electromagnetic (VTEM) and Aeromagnetic Geophysical Survey; Geotech Project #10217, Area 1 & Area 2" by Geotech Limited of North Aurora, Ontario.

2. TECHNICAL DATA AND INTERPRETATION

A. Geology and Mineralization

The properties lie within the Intermontane Belt of the Canadian Cordillera. More specifically, the claims lay within the northeastern half of the Stikine Arch- dominated by Carboniferous to Middle Jurassic island-arc volcanic and sedimentary rocks, and associated plutonic suites (Schiarizza and MacIntyre, 1999). Stikine Terrane is considered to have developed in the eastern Pacific of the Northern Hemisphere and migrated northwards to accrete with ancestral North America in Middle Jurassic (MacIntyre et al., 2001).

The primary lithologies of the project area include Paleozoic marine sedimentary and volcanic rocks of the Stikine Assemblage, and Lower to Middle Jurassic arc-related, calc- alkaline,



volcano sedimentary rocks of the Hazelton Group, as shown on Figure 4. Middle Jurassic Bowser Lake Group marine clastic sedimentary rocks underlay majority of the Red Chris South property.

The Devonian to Permian Stikine Assemblage (DPSsv) is the oldest lithology in the Stikine Terrane and makes up about 60% of the Yellow Chris property geology. This Paleozoic basement comprises moderately metamorphosed marine sedimentary and volcanic rocks (MacIntyre et al., 2001). A north-west striking body of Lower Permian Stikine Assemblage (IPSIm) comprised of limestone, marble, and other calcareous sedimentary rocks occurs within the south-eastern portion of the Yellow Chris claim block. Early Jurassic (195 to 205Ma) stocks and dykes of hornblende quartz diorite to quartz monzodiorite also occur throughout the northern project area. Major east-northeasterly regional normal faulting affects local strata and alteration (Figure 4).

B. Geophysics

Geophysical data related to the 2010 helicopter-borne EM and Mag survey over the Yellow Chris and Red Chris South properties is present herein in Appendix III: "Report on a Helicopter-Borne Versatile Time Domain Electromagnetic (VTEM) and Aeromagnetic Geophysical Survey; Geotech Project #10217, Area 1 & Area 2" by Geotech Limited of North Aurora, Ontario.

It should be noted that survey areas, Area 1 and Area 2, refered to in Geotech's report, correspond to the Red Chris South and Yellow Chris property surveys, respectively.

C. Discussion

The author concurs with the presentation of results by Geotech geophysicist Alexander Prikhodko, P.Geo as detailed in the Geotech report in Appendix III.

The Geotech Total Magnetic Intensity (TMI) data show a north-west trending group of three discrete, circular to ovate magnetic anomalies along the eastern edge of the Yellow Chris survey grid, coincident with the Hazelton Group volcanic intrusive. The most prominent feature of the TMI map is a large, discrete, roughly oblate magnetic high in immediate sharp contact with a strong magnetic low in the southern part of the survey area.

On the Red Chris South property, two large half-circle magnetic highs were discovered truncated by the edge of the survey area. One of these highs extends north into Imperial Metals' ground and the other west (still within Teuton's ground) into an unsurveyed area. Both anomalies correlate with topographic highs which could be a result of variations in equipment height relative to the ground. Two discrete, moderately high magnetic responses were also detected within the south eastern quadrant of the survey area.

Five electromagnetic (EM) anomalies running in an east-west direction were detected along the eastern part of the Yellow Chris survey area, none of which seem to correlate with the elevated





magnetic responses. Refer to Figure 6 for EM axis orientations. For discussion purposes they have been identified by numbers, with no significance attached to the order.

Upon inspection of the TEM Resistivity Depth Imaging (RDI) profiles, results for the lower anomaly (A-1) best fit the calculated response model for a thick, steeply dipping conductive plate. The time constant for this conductor is variable reaching a maximum at 5.333 msec, a level indicative of significant mineralization. The profile shape for A-2 suggests the source is thin and steeply dipping to the north. A-3 strikes 45 meters to the north-east and represents a shallow skewed thick conductive body. The profile shapes for A-4 and A-5 are indicative of shallowly dipping thick conductors.

Electromagnetic B-field profiles from the southern grid are relatively subdued and broad, suggesting that they are caused by large-scale lithological variations. Possible exceptions are the two multi-line EM anomalies, A-9 and A-10, that coincide with areas of elevated, discrete magnetic intensity in the south-eastern corner of the survey grid.

D. Conclusions

Preliminary interpretation of magnetic data from the Red Chris South grid shows that most areas of elevated magnetic response are topographic highs. There is, however, two pronounced, unexplained, oval shaped magnetic highs, located within the south-eastern corner of the grid which warrant further work.

An aggressive exploration program consisting of extensive geochemical sampling and geological mapping is recommended in the southern portion of the Yellow Chris claim block, covering the contact area between the discrete mag high and mag low, to test for porphyry style copper-gold mineralization. Geochemical surveying should also be expanded to the east to test the skarn potential in the vicinity of the outcropping Paleozoic limestone unit of the Stikine Assemblage.

A preliminary interpretation of VTEM survey results delineated the axis of five notable conductors within the eastern portion of the Yellow Chris grid. These responses may be attributable to graphitic sediments within the DPSsv stratigraphic unit. Alternatively, the anomalies may be due to conductive sulphides within local mineralized intrusions. In order to determine the source of the anomalous responses, the author recommends a follow-up program of ground-truthing the various conductors. Favourable targets identified by such work should be mapped, trenched (if possible) comprehensively sampled, and diamond drilled, if warranted.

Respectfully submitted,

D. Cremonese, P.Eng. April 29th, 2011

APPENDIX I - WORK COST STATEMENT

Geotech Limited Geophysical Survey: October 8th-19th, 2010	
Mobilization and Demobilization Charges	\$12,000.00
533.2 line-km @ \$145.00/km	\$77,314.00
Standby Days 7 @ \$3,800.00/ea	\$26,600.00
Fuel	\$3904.64
Fuel positioning	\$1,715.00
10% Handling fee	\$561.96
GST/HST	14,378.15
	\$136,473.75
Report Costs	
Report and map preparation, compilation and research	
D. Cremonese, P.Eng., 2 days @ \$500/day	\$1000.00
Draughting:	\$1200.00
	TOTAL <u>\$138,673.75</u>

Prorated

328.9 line-km, 6 standby days / *Red Chris South Property* / **67%** = **\$92,911.41** 201.1 line-km, 1 standby days / *Yellow Chris Property* / **33%** = **\$45,762.34**

Amount Claimed Per Statement of Work (not including 30% PAC withdrawal add-on):

RED CHRIS SOUTH >	Per SOW #4807732 >	\$89,776.00
YELLOW CHRIS >	Per SOW #4807734 >	\$44,809.00

[Please adjust PAC account accordingly]

APPENDIX II – CERTIFICATE OF QUALIFICATION

I, Dino M. Cremonese, do hereby certify that:

- 1. I am a mineral property consultant with an office at #202-2187 Oak Bay Avenue, Victoria, B.C.
- 2. I am a graduate of the University of British Columbia (B.A.Sc. in metallurgical engineering, 1972, and L.L.B., 1979).
- 3. I am a Professional Engineer registered with the Association of Professional Engineers of the Province of British Columbia as a resident member, #13876.
- 4. I have practiced my profession since 1979.
- 5. This report is based primarily upon the 2010 Geotech airborne survey over the Red Chris South and Yellow Chris properties. Additional information comes from a review of literature concerning the properties.
- 6. I am a principal of Teuton Resources Corp., owner of the Red Chris South and Yellow Chris properties: this report was prepared solely for satisfying assessment work requirements in accordance with government regulations.

Dated at Victoria, B.C. this 29th day of April, 2011.

D. Cremonese, P.Eng.

APPENDIX III

Report on a Helicopter-Borne Versatile Time Domain Electromagnetic (VTEM) and Aeromagnetic Geophysical Survey; Geotech Project #10217, Area 1 & Area 2 [Geotech Limited of North Aurora, Ontario]

November, 2010

REPORT ON A HELICOPTER-BORN VERSATILE TIME DOMAIN ELECTROMAGNETIC (VTEM) AND AEROMAGNETIC GEOPHYSICAL SURVEY

Area 1 & Area 2 Iskut, British Columbia

For: Teuton Resources Corp

By:

Geotech Ltd. 245 Industrial Parkway North

Aurora, Ont., CANADA, L4G 4C4

Tel: 1.905.841.5004

Fax: 1.905.841.0611

www.geotech.ca

Email: info@geotech.ca

Survey flown during October 2010

Project 10217

November, 2010

TABLE OF CONTENTS

Executi	ive Summary	. ii
1. INTR	ODUCTION	.1
1.1	General Considerations	1
1.2	Survey and System Specifications	2
1.3	Topographic Relief and Cultural Features	3
2. DAT	A ACQUISITION	5
2.1	Survey Area	5
2.2	Survey Operations	5
2.3	Flight Specifications	6
2.4	Aircraft and Equipment	6
2.4.	1 Survey Aircraft	6
2.4.	2 Electromagnetic System	6
2.4.	3 Airborne magnetometer	10
2.4.	4 Radar Altimeter	10
2.4.	5 GPS Navigation System	10
2.4.	6 Digital Acquisition System	10
2.5	Base Station	11
3. PER	SONNEL	12
4. DAT/	A PROCESSING AND PRESENTATION	13
4.1	Flight Path	13
4.2	Electromagnetic Data	13
4.3	Magnetic Data	14
5. DELI	VERABLES	15
5.1	Survey Report	15
5.2	Maps	15
5.3	Digital Data	15
6. CON		18
6.1	Conclusions	18
6.2	Recommendations	18

LIST OF FIGURES

Figure 1 - Property Location	1
Figure 2 – survey area location on Google Earth	2
Figure 3 – Flight path over a Google Earth Image for Area 1	3
Figure 4 - Flight Path over aGoogle Earth Image for Area 2	4
Figure 5 - VTEM Configuration, with magnetometer.	7
Figure 6 - VTEM Waveform & Sample Times	7
Figure 7 - VTEM System Configuration	9

LIST OF TABLES

Table 1 - Survey Specifications	5
Table 2 - Survey schedule	5
Table 3 - Decay Sampling Scheme	8
Table 4 - Acquisition Sampling Rates	10
Table 5 - Geosoft GDB Data Format	16

APPENDICES

A. Survey location maps
B. Survey Block Coordinates
C. VTEM Waveform
D. Geophysical Maps
E. Generalized Modelling Results of the VTEM System
F. EM Time Contant (TAU) Analysis
G. TEM Resitivity Depth Imaging (RDI)

REPORT ON A HELICOPTER-BORNE VERSATILE TIME DOMAIN ELECTROMAGNETIC (VTEM) and AEROMAGNETIC SURVEY

Area 1 & Area 2 Iskut, British Columbia

Executive Summary

Durning October 8th to 19th, 2010 Geotech Ltd. carried out a helicopter-borne geophysical survey over Area 1 and Area 2 located about 5km east and 20km southeast respectively of Iskut British Columbia, Canada.

Principal geophysical sensors included a versatile time domain electromagnetic (VTEM) system, and a cesium magnetometer. Ancillary equipment included a GPS navigation system and a radar altimeter. A total of 533 line-kilometres were planned to be flown.

In-field data quality assurance and preliminary processing were carried out on a daily basis during the acquisition phase. Preliminary and final data processing, including generation of final digital data and map products were undertaken from the office of Geotech Ltd. in Aurora, Ontario.

The processed survey results are presented as the following grids:

- Total Magnetic Intensity
- dB/dt Z Component Channel
- Calculated Time Constant (TAU)
- electromagnetic stacked profiles of the B-field Z
- electromagnetic stacked profiles of the dB/dt Z

Digital data includes all electromagnetic and magnetic products, ancillary data and the VTEM waveform.

The survey report describes the procedures for data acquisition, processing, final image presentation and the specifications for the digital data set. No formal Interpretation has been included.

1. INTRODUCTION

1.1 General Considerations

Geotech Ltd. performed a helicopter-borne geophysical survey over Area 1 and Area 2. Area 1 is located 5km east of Iskut while Area 2 is located 20km southeast of Iskut British Columbia, Canada (Figure 1 & 2).

Dino Cremonese represented Teuton Resources Corp. during the data acquisition and data processing phases of this project.

The geophysical surveys consisted of helicopter borne EM using the versatile time-domain electromagnetic (VTEM) system with Z component measurements and aeromagnetics using a cesium magnetometer. A total of 530 line-km of geophysical data were acquired during the survey.

The crew was based out of Inskut located to the west of the survey blocks (Figure 2) in British Columiba for the acquisition phase of the survey. Survey flying started on October 8th and was completed on October 19th, 2010.

Data quality control and quality assurance, and preliminary data processing were carried out on a daily basis during the acquisition phase of the project. Final data processing followed immediately after the end of the survey. Final reporting, data presentation and archiving were completed from the Aurora office of Geotech Ltd. in November, 2010.



Figure 1 - Property Location

1.2 Survey and System Specifications

Area 2 is located approximately 5 kilometres east of Iskut and Area 1 is located approximately 20 kilometres southeast of Iskut (Figure 2).



Figure 2 – survey area location on Google Earth

The blocks were flown in a north to south (N 0° E azimuth) direction with traverse line spacing of 100 metres as depicted in Figure 3. Tie lines were flown perpendicular to the traverse lines at a spacing of 1000 metres (N 90° E azimuth). For more detailed information on the flight spacing and direction see Table 1.

1.3 Topographic Relief and Cultural Features

Topographically, Area 1 exhibits a high relief with an elevation ranging from 1025 to 1913 metres above mean sea level over an area of 29.6 square kilometres (Figure 3). There are numerous rivers and streams running through the survey area which connect various lakes and wetlands. The most notable lakes are Todagin Lake which is located along the southwest corner of the survey area and Kluea Lake which is located a long the northwest corner of the block. There are no visible signs of culture such as roads and trails through out the survey.



Figure 3 – Flight path over a Google Earth Image for Area 1.

Topographically, Area 2 exhibits a high relief with an elevation ranging from 1107 to 1713 metres above mean sea level over an area of 18 square kilometres (Figure 4). There are numerous rivers and streams running through the survey area which connect various lakes and wetlands. The only visible sign of culture is a trail which runs along the south end of the survey area.



Figure 4 - Flight Path over aGoogle Earth Image for Area 2

Both blocks are covered by numerous mining claims, which are shown in Appendix A, and are plotted on all maps. The survey area is covered by NTS (National Topographic Survey) of Canada sheet 104H12 and 104H13.

2. DATA ACQUISITION

2.1 Survey Area

The survey block (see Figure 3 and Appendix A) and general flight specifications are as follows:

Survey block	Traverse Line spacing (m)	Area (Km²)	Planned ¹ Line-km	Actual Line- km	Flight direction	Line numbers
Area 1	Traverse: 100	29.6	299.2	298.9	N 0° E / N 180° E	L1000-L1590
Alea I	Tie: 1000	23.0	30.6	30	N 90° E / N 270° E	T1900-T1960
Area 2	Traverse: 100	18	182.4	179.4	N 0° E / N 180° E	L2000 – L2290
	Tie: 1000	10	21	21.7	N 90° E / N 270° E	T2900 – T2960
TOTAL		47.6	533.2	530		

Table 1 - Survey Specifications

Survey block boundaries co-ordinates are provided in Appendix B.

2.2 Survey Operations

Survey operations were based out of Iskut in British Columbia from October 8th to October19th, 2010. The following table shows the timing of the flying.

Date	Flight #	Block	Crew location	Comments
8-Oct-10			Iskut, BC	Crew arrived
9-Oct-10			Iskut, BC	System assembly and testing
10-Oct-10			Iskut, BC	System assembly and testing
11-Oct-10	1,2	Area2	Iskut, BC	224km flown
12-Oct-10			Iskut, BC	No Production due to weather
13-Oct-10	3,4	Area1	Iskut, BC	251km flown
14-Oct-10			Iskut, BC	No Production due to weather
15-Oct-10			Iskut, BC	No Production due to weather
16-Oct-10			Iskut, BC	No Production due to weather
17-Oct-10	5	Area1	Iskut, BC	10km flown aborted due to weather
18-Oct-10			Iskut, BC	No Production due to weather
19-Oct-10	6	Area1	Iskut, BC	Remaining kms were flown

Table 2 - Survey schedule

¹ Note: Actual Line kilometres represent the total line kilometres in the final database. These line-km normally exceed the Planned line-km, However, for this survey the flight path needed to be clipped to the exact boundary as indicated in the survey NAV files.

2.3 Flight Specifications

During the survey the helicopter was maintained at a mean altitude of 149 metres for Area 1 and 105 metres for Area 2 above the ground with a nominal survey speed of 80 km/hour. This allowed for a nominal EM bird terrain clearance of 114 metres and 70 metresfor Area 1 and Aear 2 respectively, and a magnetic sensor clearance of 136 metres and 92 metres for Area 1 and Area 2.

The on board operator was responsible for monitoring the system integrity. He also maintained a detailed flight log during the survey, tracking the times of the flight as well as any unusual geophysical or topographic features.

On return of the aircrew to the base camp the survey data was transferred from a compact flash card (PCMCIA) to the data processing computer. The data were then uploaded via ftp to the Geotech office in Aurora for daily quality assurance and quality control by qualified personnel.

2.4 Aircraft and Equipment

2.4.1 Survey Aircraft

The survey was flown using a Eurocopter Aerospatiale (Astar) 350 B3 helicopter, registration C-FEDS. The helicopter is owned and operated by Geotech Aviation Ltd. Installation of the geophysical and ancillary equipment was carried out by a Geotech Ltd crew.

2.4.2 Electromagnetic System

The electromagnetic system was a Geotech Time Domain EM (VTEM) system. The configuration is as indicated in Figure 5.

The VTEM Receiver and transmitter coils were in concentric-coplanar and Z-direction oriented configeration. The EM bird was towed at a mean distance of 35 metres below the aircraft as shown in 5 and 7. The receiver decay recording scheme is shown diagrammatically in Figure 6.





Figure 5 - VTEM Configuration, with magnetometer.



Figure 6 - VTEM Waveform & Sample Times

The VTEM decay sampling scheme is shown in Table 3 below. Thirty-two time measurement gates were used for the final data processing in the range from 96 to 7036 μ sec.



VTEM Decay Sampling Scheme				
Index	Middle	Start	End	Window
	Microseconds			
14	96	90	103	13
15	110	103	118	15
16	126	118	136	18
17	145	136	156	20
18	167	156	179	23
19	192	179	206	27
20	220	206	236	30
21	253	236	271	35
22	290	271	312	40
23	333	312	358	46
24	383	358	411	53
25	440	411	472	61
26	505	472	543	70
27	580	543	623	81
28	667	623	716	93
29	766	716	823	107
30	880	823	945	122
31	1,010	945	1,086	141
32	1,161	1,086	1,247	161
33	1,333	1,247	1,432	185
34	1,531	1,432	1,646	214
35	1,760	1,646	1,891	245
36	2,021	1,891	2,172	281
37	2,323	2,172	2,495	323
38	2,667	2,495	2,865	370
39	3,063	2,865	3,292	427
40	3,521	3,292	3,781	490
41	4,042	3,781	4,341	560
42	4,641	4,341	4,987	646
43	5,333	4,987	5,729	742
44	6,125	5,729	6,581	852
45	7,036	6,581	7,560	979

 Table 3 - Decay Sampling Scheme



VTEM system parameters:

Transmitter Section

- Transmitter coil diameter: 17.6 m
- Number of turns: 4
- Transmitter base frequency: 30 Hz
- Peak current: 255 A
- Pulse width: 3.40 ms
- Duty cycle: 20 %
- Wave form shape: trapezoid
- Peak dipole moment: 248,150 nIA
- Nominal EM Bird terrain clearance: 114 metres for Area 1 and 70 metres for

Area 2 above the ground

- Effective coil area: 973 m²

Receiver Section

Z-Coil

- Z-Coil coil diameter: 1.2 m
- Number of turns: 100
- Effective coil area: 113.04 m²



Figure 7 - VTEM System Configuration



2.4.3 Airborne magnetometer

The magnetic sensor utilized for the survey was Geometrics optically pumped cesium vapour magnetic field sensor mounted 13 metres below the helicopter, as shown in Figure 7. The sensitivity of the magnetic sensor is 0.02 nanoTesla (nT) at a sampling interval of 0.1 seconds.

2.4.4 Radar Altimeter

A Terra TRA 3000/TRI 40 radar altimeter was used to record terrain clearance. The antenna was mounted beneath the bubble of the helicopter cockpit (Figure 7).

2.4.5 GPS Navigation System

The navigation system used was a Geotech PC104 based navigation system utilizing a NovAtel's CDGPS (Canada-Wide Differential Global Positioning System Correction Service) enable OEM4-G2-3151W GPS receiver, Geotech navigate software, a full screen display with controls in front of the pilot to direct the flight and an NovAtel GPS antenna mounted on the helicopter tail (Figure 7). As many as 11 GPS and two CDGPS satellites may be monitored at any one time. The positional accuracy or circular error probability (CEP) is 1.8 m, with CDGPS active, it is 1.0 m. The co-ordinates of the block were set-up prior to the survey and the information was fed into the airborne navigation system.

2.4.6 Digital Acquisition System

A Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data is displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. The data type and sampling interval as provided in Table 4.

DATA TYPE	SAMPLING
TDEM	0.1 sec
Magnetometer	0.1 sec
GPS Position	0.2 sec
Radar Altimeter	0.2 sec



2.5 Base Station

A combined magnetometer/GPS base station was utilized on this project. A Geometrics Cesium vapour magnetometer was used as a magnetic sensor with a sensitivity of 0.001 nT. The base station was recording the magnetic field together with the GPS time at 1 Hz on a base station computer.

The base station magnetometer sensor was installed 200 metres from the motel in wooded area (57° 49'1.01 N, 129° 57'39.73 W); away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data were backed-up to the data processing computer at the end of each survey day.



3. PERSONNEL

The following Geotech Ltd. personnel were involved in the project.

Field:

Project Manager:	Darren Tuck (office)
Data QA/QC:	Neil Fiset (office)
Crew chief:	Sam McNeil
System Operators:	Michael Altman

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – Geotech Aviation.

Pilot:	Alex Para
Mechanical Engineer:	Chris Ward
Office:	
Preliminary Data Processing:	Neil Fiset
Final Data Processing:	Gord Smith
Final Data QA/QC:	Neil Fiset
Reporting/Mapping:	Wendy Acorn

Data acquisition phase was carried out under the supervision of Andrei Bagrianski, P. Geo, Chief Operating Officer. Processing phase was carried out under the supervision of Harish Kumar, P.Geo, Assistant Manager of Data Processing. The interpretation phase was under the supervision of Alexander Prikhodko, P. Geo. The customer relations were looked after by Blair Walker.

4. DATA PROCESSING AND PRESENTATION

Data compilation and processing were carried out by the application of Geosoft OASIS Montaj and programs proprietary to Geotech Ltd.

4.1 Flight Path

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the NAD83 Datum, UTM Zone 9 North coordinate system in Oasis Montaj.

The flight path was drawn using linear interpolation between x, y positions from the navigation system. Positions are updated every second and expressed as UTM easting's (x) and UTM northing's (y).

4.2 Electromagnetic Data

A three stage digital filtering process was used to reject major sferic events and to reduce system noise. Local sferic activity can produce sharp, large amplitude events that cannot be removed by conventional filtering procedures. Smoothing or stacking will reduce their amplitude but leave a broader residual response that can be confused with geological phenomena. To avoid this possibility, a computer algorithm searches out and rejects the major sferic events.

The signal to noise ratio was further improved by the application of a low pass linear digital filter. This filter has zero phase shift which prevents any lag or peak displacement from occurring, and it suppresses only variations with a wavelength less than about 1 second or 15 metres. This filter is a symmetrical 1 sec linear filter.

The results are presented as stacked profiles of EM voltages for the time gates, in linear - logarithmic scale for the B-field Z component and dB/dt responses in the Z. B-field Z component time channel recorded at 2.021 milliseconds after the termination of the impulse is also presented as contour color image. Calculated Time Constant (TAU) with anomly contours of Calculated Vertical Deriviative of TMI is presented in Appendix D and F.Tau was calculated using noise level of 0.005 for dB/dt.

VTEM receiver coil orientation Z-axis coil is oriented parallel to the transmitter coil axis and is horizontal to the ground. Generalized modeling results of VTEM data, are shown in Appendix E.

Z component data produce double peak type anomalies for "thin" subvertical targets and single peak for "thick" targets.

The limits and change-over of "thin-tick" depends on dimensions of a TEM system the system's height and depth of a target. For example see Appendix E, Fig.E-16.

Graphical representations of the VTEM transmitter input current and the output voltage of the receiver coil are shown in Appendix C.

4.3 Magnetic Data

The processing of the magnetic data involved the correction for diurnal variations by using the digitally recorded ground base station magnetic values. The base station magnetometer data was edited and merged into the Geosoft GDB database on a daily basis. The aeromagnetic data was corrected for diurnal variations by subtracting the observed magnetic base station deviations.

Tie line levelling was carried out by adjusting intersection points along traverse lines. A micro-levelling procedure was applied to remove persistent low-amplitude components of flight-line noise remaining in the data.

The corrected magnetic data was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of approximately 25 metres at the mapping scale. The Minimum Curvature algorithm was used to interpolate values onto a rectangular regular spaced grid.



5. DELIVERABLES

5.1 Survey Report

The survey report describes the data acquisition, processing, and final presentation of the survey results. The survey report is provided in two paper copies and digitally in PDF format.

5.2 Maps

Final maps were produced at scale of 1:10,000 for best representation of the survey size and line spacing. The coordinate/projection system used was NAD83 Datum, UTM Zone 9 North. All maps show the mining claims, flight path trace and topographic data; latitude and longitude are also noted on maps.

The preliminary and final results of the survey are presented as EM profiles, a late-time gate gridded EM channel, and a color magnetic TMI contour map. The following maps are presented on paper;

- VTEM dB/dt profiles Z Component, Time Gates 0.220 7.036 ms in linear logarithmic scale.
- VTEM dB/dt late time Z Component Channel 42, Time Gate 4.641 ms color image.
- VTEM B-Field profiles Z Component, Time Gates 0.220 7.036 ms in linear logarithmic scale.
- Total magnetic intensity (TMI) color image and contours.
- VTEM dB/dt & B-Field Calculated Time Constant (TAU) with contours of anomaly areas of the Calculated Vertical Derivative of TMI

5.3 Digital Data

- Two copies of the data and maps on DVD were prepared to accompany the report. Each DVD contains a digital file of the line data in GDB Geosoft Montaj format as well as the maps in Geosoft Montaj Map and PDF format.
- DVD structure.

Data	contains databases, grids and maps, as described below.
Report	contains a copy of the report and appendices in PDF format.

Databases in Geosoft GDB format, containing the channels listed in Table 5.


Channel name	Units	Description
X:	metres	UTM Easting NAD83 Zone 9 North
Y:	metres	UTM Northing NAD83 Zone 9 North
Z:	metres	GPS antenna elevation (above Geoid)
Longitude:	Decimal Degrees	WGS 84 Longitude data
Latitude:	Decimal Degrees	WGS 84 Latitude data
Radar:	metres	helicopter terrain clearance from radar altimeter
Radarb:	metres	Calculated EM bird terrain clearance from radar altimeter
DEM:	metres	Digital Elevation Model
Gtime:	Seconds of the day	GPS time
Mag1:	nT	Raw Total Magnetic field data
Basemag:	nT	Magnetic diurnal variation data
Mag2:	nT	Diurnal corrected Total Magnetic field data
Mag3:	nT	Levelled Total Magnetic field data
SFz[14]:	$pV/(A*m^4)$	Z dB/dt 96 microsecond time channel
SFz[15]:	$pV/(A*m^4)$	Z dB/dt 110 microsecond time channel
SFz[16]:	$pV/(A*m^4)$	Z dB/dt 126 microsecond time channel
SFz[17]:	$pV/(A*m^4)$	Z dB/dt 145 microsecond time channel
SFz[18]:	$pV/(A*m^4)$	Z dB/dt 167 microsecond time channel
SFz[19]:	$pV/(A*m^4)$	Z dB/dt 192 microsecond time channel
SFz[20]:	$pV/(A*m^4)$	Z dB/dt 220 microsecond time channel
SFz[21]:	$pV/(A*m^4)$	Z dB/dt 253 microsecond time channel
SFz[22]:	$pV/(A*m^4)$	Z dB/dt 290 microsecond time channel
SFz[23]:	$pV/(A*m^4)$	Z dB/dt 333 microsecond time channel
SFz[24]:	$pV/(A*m^4)$	Z dB/dt 383 microsecond time channel
SFz[25]:	$pV/(A*m^4)$	Z dB/dt 440 microsecond time channel
SFz[26]:	$pV/(A*m^4)$	Z dB/dt 505 microsecond time channel
SFz[27]:	$pV/(A*m^4)$	Z dB/dt 580 microsecond time channel
SFz[28]:	pV/(A*m ⁴)	Z dB/dt 667 microsecond time channel
SFz[29]:	pV/(A*m ⁴)	Z dB/dt 766 microsecond time channel
SFz[30]:	pV/(A*m ⁴)	Z dB/dt 880 microsecond time channel
SFz[31]:	pV/(A*m ⁴)	Z dB/dt 1010 microsecond time channel
SFz[32]:	pV/(A*m ⁴)	Z dB/dt 1161 microsecond time channel
SFz[33]:	pV/(A*m ⁴)	Z dB/dt 1333 microsecond time channel
SFz[34]:	$pV/(A*m^4)$	Z dB/dt 1531 microsecond time channel
SFz[35]:	pV/(A*m ⁴)	Z dB/dt 1760 microsecond time channel
SFz[36]:	$pV/(A*m^4)$	Z dB/dt 2021 microsecond time channel
SFz[37]:	$pV/(A*m^4)$	Z dB/dt 2323 microsecond time channel
SFz[38]:	$pV/(A*m^4)$	Z dB/dt 2667 microsecond time channel
SFz[39]:	$pV/(A*m^4)$	Z dB/dt 3063 microsecond time channel
SFz[40]:	$pV/(A*m^4)$	Z dB/dt 3521 microsecond time channel
SFz[41]:	pV/(A*m ⁴)	Z dB/dt 4042 microsecond time channel
SFz[42]:	pV/(A*m ⁴)	Z dB/dt 4641 microsecond time channel
SFz[43]:	pV/(A*m ⁴)	Z dB/dt 5333 microsecond time channel
SFz[44]:	$pV/(A*m^4)$	Z dB/dt 6125 microsecond time channel
SFz[45]:	$pV/(A*m^4)$	Z dB/dt 7036 microsecond time channel
BFz	$(pV*ms)/(A*m^4)$	Z B-Field data for time channels 14 to 45
PLM:		60 Hz power line monitor
TauSF	milliseconds	Time Constant (Tau) calculated from dB/dt data
CVG	nT/m	Calculated Magnetic Vertical Gradient

Table 5 - Geosoft GDB Data Format



Electromagnetic B-field and dB/dt Z component data is found in array channel format between indexes 14 - 45.

• Database of the VTEM Waveform "10217_waveform_final.gdb" in Geosoft GDB format, containing the following channels:

Time:	Sampling rate interval, 5.2083 microseconds
Rx_Volt:	Output voltage of the receiver coil (Volt)
Tx_Current:	Output current of the transmitter (Amp)

• Grids in Geosoft GRD format, as follows:

MAG_bb: Total magnetic intensity (nT) SFz42_bb: dB/dt Z Component Channel 42 (Time Gate 4.641 ms) TAUSFz_bb: dB/dt Calculated Time Constant (TAU)

Where bb respresents the block name (ie MAG_Area1)

A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 25 metres was used.

• Maps at 1:10,000 in Geosoft MAP format, as follows:

10217_10k_dBdt_bb:	dB/dt profiles Z Component, Time Gates 0.220 – 7.036
	ms in linear – logarithmic scale.
10217_10k_bfield_bb:	B-field profiles Z Component, Time Gates 0.220 – 7.036
	ms in linear – logarithmic scale.
10217_10k_SFz42_bb:	dB/dt late time Z Component Channel 42, Time Gate
	4.641 ms color image.
10217_10k_TMI_bb:	Total magnetic intensity (TMI) color image and contours.
10217_10K_TAUSFz_CV	'G_contours: dB/dt Calculated Time Contant (TAU) with
	contours of anomaly areas of the Calculated Vertical
	Derivative of TMI

Where bb respresents the block name (ie 10217_10K_TMI_Area1)

Maps are also presented in PDF format.

1:50,000 topographic vectors were taken from the NRCAN Geogratis database at; <u>http://geogratis.gc.ca/geogratis/en/index.html</u>.

• A Google Earth file *10217_Teuton.kml* showing the flight path of the block is included. Free versions of Google Earth software from: <u>http://earth.google.com/download-earth.html</u>



6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

A helicopter-borne versatile time domain electromagnetic (VTEM) geophysical survey has been completed over Area 1 & Area 2 near Iskut, British Columbia.

The total area coverage is 47.6 km^2 . Total survey line coverage is 530 line kilometres. The principal sensors included a Time Domain EM system and a magnetometer. Results have been presented as stacked profiles, and contour color images at a scale of 1:10,000. No formal Interpretation has been included.

6.2 Recommendations

Based on the geophysical results obtained, a number of interesting EM anomalies that were identified across the property. The magnetic results may also contain worthwhile information in support of exploration targets of interest. We therefore recommend a detailed interpretation of the available geophysical data, in conjunction with the geology. It should include 2D - 3D inversion modeling analyses and magnetic derivative analysis prior to ground follow up and drill testing.

Respectfully submitted⁶,

Neil Fiset Geotech Ltd.

Harish Kumar, P.Geo. Geotech Ltd.

Alexander Prikhodko, P. Geo **Geotech Ltd.**

November 2010

⁶Final data processing of the EM and magnetic data were carried out by Neil Fiset, from the office of Geotech Ltd. in Aurora, Ontario, under the supervision of Harish Kumar, Assitant Manager of Data Processing and Alexander Prikhodko, P.Geo., PhD, Senior Geophysicist, VTEM Interpretation Supervisor.



APPENDIX A

SURVEY BLOCK LOCATION MAP





Mining Claims for Area 1





Mining Claims for Area 2



APPENDIX B

SURVEY BLOCK COORDINATES

(WGS 84, UTM Zone 9 North)

Area 1				
Х	Y			
457742.9	6394586.9			
455139.1	6394586.2			
455139.1	6392760			
451861.3	6392760			
451861.3	6390804.3			
451773.4	6390804.3			
451772.1	6387804.3			
455234	6387804.3			
455234	6389557.8			
457742.9	6389557.8			

Area 2

Х	Y
446993.1	6409986.7
446993.1	6416067.4
449959	6416067.4
449959	6409986.7

APPENDIX C

VTEM WAVEFORM





APPENDIX D

GEOPHYSICAL MAPS¹



Area 1 - VTEM B-Field Profiles, Time Gates 0.220 to 7.036 ms

¹Full size geophysical maps are also available in PDF format on the final DVD





Area 1 - VTEM dB/dt Profiles, Time Gates 0.220 to 7.036 ms





Area 1 - VTEM dB/dt Channel 42, Time Gate 4.641 ms (De-corrugation Filter Applied)



Area 1 - Total Magnetic Intensity (TMI)



Area 1 - VTEM dB/dt Calculated Time Constant (TAU) with contours of anomaly areas of the Calculated Vertical Derivative of TMI



Area 2 - Total Magnetic Intensity (TMI)





Resistivity Depth Image (RDI) MAPS











APPENDIX E

GENERALIZED MODELING RESULTS OF THE VTEM SYSTEM

Introduction

The VTEM system is based on a concentric or central loop design, whereby, the receiver is positioned at the centre of a 17.6 metres diameter transmitter loop that produces a dipole moment up to 248,150 nIA at peak current. The wave form is a bi-polar, modified square wave with a turn-on and turn-off at each end. With a base frequency of 30 Hz, the duration of each pulse is approximately 3.4 milliseconds followed by an off time where no primary field is present.

During turn-on and turn-off, a time varying field is produced (dB/dt) and an electro-motive force (emf) is created as a finite impulse response. A current ring around the transmitter loop moves outward and downward as time progresses. When conductive rocks and mineralization are encountered, a secondary field is created by mutual induction and measured by the receiver at the centre of the transmitter loop.

Measurements are made during the on and off-time, when only the secondary field (representing the conductive targets encountered in the ground) is present.

Efficient modeling of the results can be carried out on regularly shaped geometries, thus yielding close approximations to the parameters of the measured targets. The following is a description of a series of common models made for the purpose of promoting a general understanding of the measured results.

General Modeling Concepts

A set of models has been produced for the Geotech VTEM® system with explanation notes (see models C1 to C18). The Maxwell TM modeling program (EMIT Technology Pty. Ltd. Midland, WA, AU) used to generate the following responses assumes a resistive half-space. The reader is encouraged to review these models, so as to get a general understanding of the responses as they apply to survey results. While these models do not begin to cover all possibilities, they give a general perspective on the simple and most commonly encountered anomalies. When producing these models, a few key points were observed and are worth noting as follows:

• For near vertical and vertical plate models, the top of the conductor is always located directly under the centre low point between the two shoulders in the classic **M** shaped response.

• As the plate is positioned at an increasing depth to the top, the shoulders of the **M** shaped response, have a greater separation distance.

• When faced with choosing between a flat lying plate and a prism model to represent the target (broad response) some ambiguity is present and caution should be exercised.



• With the concentric loop system and Z-component receiver coil, virtually all types of conductors and most geometries are most always well coupled and a response is generated (see Figures C17 & C18). Only concentric loop systems can map such wide varieties of target geometries.

Variation of Plate Depth

Geometries represented by plates of different strike length, depth extent, dip, plunge and depth below surface can be varied with characteristic parameters like conductance of the target, conductance of the host and conductivity/thickness and thickness of the overburden layer.

Diagrammatic models for a vertical plate are shown in Figures C-1 & C-2 and C-5 & C-6 at two different depths, all other parameters remaining constant. With this transmitter-receiver geometry, the classic **M** shaped response is generated. Figures C-1 and C-2 show a plate where the top is near surface. Here, amplitudes of the duel peaks are higher and symmetrical with the zero centre positioned directly above the plate. Most important is the separation distance of the peaks. This distance is small when the plate is near surface and widens with a linear relationship as the plate (depth to top) increases. Figures C-5 and C-6 show a much deeper plate where the separation distance of the peaks is much wider and the amplitudes of the channels have decreased.

Variation of Plate Dip

As the plate dips and departs from the vertical position, the peaks become asymmetrical. Figures C-3 & C-4 and C-7 and C-8 show a near surface plate dipping 80° at two different depths. Note that the direction of dip is toward the high shoulder of the response and the top of the plate remains under the centre minimum.

As the dip increases, the aspect ratio (Min/Max) decreases and this aspect ratio can be used as an empirical guide to dip angles from near 90° to about 30°. The method is not sensitive enough where dips are less than about 30°. For example, for a plate dipping 45°, the minimum shoulder starts to vanish. In Figures C-9 & C-10 and C-11 & C-12, a flat lying plate is shown, relatively near surface. Note that the twin peak anomaly has been replaced by a symmetrical shape with large, bell shaped, channel amplitudes which decay relative to the conductance of the plate.

In the special case where two plates are positioned to represent a synclinal structure. Note that the main characteristic is that the centre amplitudes are higher (approximately double) compared to the high shoulder of a single plate. This model is very representative of tightly folded formations where the conductors where once flat lying.

Variation of Prism Dip

Finally, with thicker, prism models, another algorithm is required to represent current on the plate. A plate model is considered to be infinitely thin with respect to thickness and incapable of representing the current in the thickness dimension. A prism model is constructed to deal with this problem, thereby, representing the thickness of the body more accurately.

Figures C-13 & C-14 and C-15 & C-16 show the same prism at the same depths with variable dips. Aside from the expected differences asymmetry prism anomalies show a characteristic change from a double-peaked anomaly to single peak signatures.



I. THIN PLATE



Figure C-1: dB/dt response of a shallow vertical thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-2: B-field response of a shallow vertical thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.



Figure C-3: dB/dt response of a shallow skewed thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-4: B-field response of a shallow skewed thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.



Figure C-5: dB/dt response of a deep vertical thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-6: B-Field response of a deep vertical thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment.



Figure C-7: dB/dt response of a deep skewed thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-8: B-field response of a deep skewed thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment.



Figure C-9: dB/dt response of a shallow horizontal thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-10: B-Field response of a shallow horizontal thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.



Figure C-11: dB/dt response of a deep horizontal thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-12: B-Field response of a deep horizontal thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment.

II. THICK PLATE



Figure C-13: dB/dt response of a shallow vertical thick plate. Depth=100 m, C=12 S/m, thickness=20 m. The EM response is normalized by the dipole moment and the Rx area.



Figure C-14: B-Field response of a shallow vertical thick plate. Depth=100 m, C=12 S/m, thickness= 20 m. The EM response is normalized by the dipole moment.



Figure C-15: dB/dt response of a shallow skewed thick plate. Depth=100 m, C=12 S/m, thickness=20 m. The EM response is normalized by the dipole moment and the Rx area.



Figure C-16: B-Field response of a shallow skewed thick plate. Depth=100 m, C=12 S/m, thickness=20 m. The EM response is normalized by the dipole moment.



III. MULTIPLE THIN PLATES



Figure C-17: dB/dt response of two vertical thin plates. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.



Figure C-18: B-Field response of two vertical thin plates. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.



General Interpretation Principals

<u>Magnetics</u>

The total magnetic intensity responses reflect major changes in the magnetite and/or other magnetic minerals content in the underlying rocks and unconsolidated overburden. Precambrian rocks have often been subjected to intense heat and pressure during structural and metamorphic events in their history. Original signatures imprinted on these rocks at the time of formation have, it most cases, been modified, resulting in low magnetic susceptibility values.

The amplitude of magnetic anomalies, relative to the regional background, helps to assist in identifying specific magnetic and non-magnetic rock units (and conductors) related to, for example, mafic flows, mafic to ultramafic intrusives, felsic intrusives, felsic volcanics and/or sediments etc. Obviously, several geological sources can produce the same magnetic response. These ambiguities can be reduced considerably if basic geological information on the area is available to the geophysical interpreter.

In addition to simple amplitude variations, the shape of the response expressed in the wave length and the symmetry or asymmetry, is used to estimate the depth, geometric parameters and magnetization of the anomaly. For example, long narrow magnetic linears usually reflect mafic flows or intrusive dyke features. Large areas with complex magnetic patterns may be produced by intrusive bodies with significant magnetization, flat lying magnetic sills or sedimentary iron formation. Local isolated circular magnetic patterns often represent plug-like igneous intrusives such as kimberlites, pegmatites or volcanic vent areas.

Because the total magnetic intensity (TMI) responses may represent two or more closely spaced bodies within a response, the second derivative of the TMI response may be helpful for distinguishing these complexities. The second derivative is most useful in mapping near surface linears and other subtle magnetic structures that are partially masked by nearby higher amplitude magnetic features. The broad zones of higher magnetic amplitude, however, are severely attenuated in the vertical derivative results. These higher amplitude zones reflect rock units having strong magnetic susceptibility signatures. For this reason, both the TMI and the second derivative maps should be evaluated together.

Theoretically, the second derivative, zero contour or color delineates the contacts or limits of large sources with near vertical dip and shallow depth to the top. The vertical gradient map also aids in determining contact zones between rocks with a susceptibility contrast, however, different, more complicated rules of thumb apply.

Concentric Loop EM Systems

Concentric systems with horizontal transmitter and receiver antennae produce much larger responses for flat lying conductors as contrasted with vertical plate-like conductors. The amount of current developing on the flat upper surface of targets having a substantial area in this dimension, are the direct result of the effective coupling angle, between the primary magnetic field and the flat surface area. One therefore, must not compare the amplitude/conductance of responses generated from flat lying bodies with those derived from near vertical plates; their ratios will be quite different for similar conductances.

Determining dip angle is very accurate for plates with dip angles greater than 30°. For angles less than 30° to 0°, the sensitivity is low and dips can not be distinguished accurately in the presence of normal survey noise levels.

A plate like body that has near vertical position will display a two shoulder, classic **M** shaped response with a distinctive separation distance between peaks for a given depth to top.

It is sometimes difficult to distinguish between responses associated with the edge effects of flat lying conductors and poorly conductive bedrock conductors. Poorly conductive bedrock conductors having low dip angles will also exhibit responses that may be interpreted as surficial overburden conductors. In some situations, the conductive response has line to line continuity and some magnetic correlation providing possible evidence that the response is related to an actual bedrock source.

The EM interpretation process used, places considerable emphasis on determining an understanding of the general conductive patterns in the area of interest. Each area has different characteristics and these can effectively guide the detailed process used.



The first stage is to determine which time gates are most descriptive of the overall conductance patterns. Maps of the time gates that represent the range of responses can be very informative.

Next, stacking the relevant channels as profiles on the flight path together with the second vertical derivative of the TMI is very helpful in revealing correlations between the EM and Magnetics.

Next, key lines can be profiled as single lines to emphasize specific characteristics of a conductor or the relationship of one conductor to another on the same line. Resistivity Depth sections can be constructed to show the relationship of conductive overburden or conductive bedrock with the conductive anomaly.



APPENDIX F

EM TIME CONSTANT (TAU) ANALYSIS

Estimation of time constant parameter¹ in transient electromagnetic method is one of the steps toward the extraction of the information about conductances beneath the surface from TEM measurements.

The most reliable method to discriminate or rank conductors from overburden, background or one and other is by calculating the EM field decay time constant (TAU parameter), which directly depends on conductance despite their depth and accordingly amplitude of the response.

Theory

As established in electromagnetic theory, the magnitude of the electro-motive force (emf) induced is proportional to the time rate of change of primary magnetic field at the conductor. This emf causes eddy currents to flow in the conductor with a characteristic transient decay, whose Time Constant (Tau) is a function of the conductance of the survey target or conductivity and geometry (including dimensions) of the target. The decaying currents generate a proportional secondary magnetic field, the time rate of change of which is measured by the receiver coil as induced voltage during the Off time.

The receiver coil output voltage (e_0) is proportional to the time rate of change of the secondary magnetic field and has the form,

$$e_0 \alpha (1 / \tau) e^{-(t / \tau)}$$

Where,

 $\tau = L/R$ is the characteristic time constant of the target (TAU) R = resistance L = inductance

From the expression, conductive targets that have small value of resistance and hence large value of τ yield signals with small initial amplitude that decays relatively slowly with progress of time. Conversely, signals from poorly conducting targets that have large resistance value and small τ , have high initial amplitude but decay rapidly with time¹ (Fig. F1).

¹ McNeill, JD, 1980, "Applications of Transient Electromagnetic Techniques", Technical Note TN-7 page 5, Geonics Limited, Mississauga, Ontario.



Figure F1 Left – presence of good conductor, right – poor conductor.

EM Time Constant (Tau) Calculation

The EM Time-Constant (TAU) is a general measure of the speed of decay of the electromagnetic response and indicates the presence of eddy currents in conductive sources as well as reflecting the "conductance quality" of a source. Although TAU can be calculated using either the measured dB/dt decay or the calculated B-field decay, dB/dt is commonly preferred due to better stability (S/N) relating to signal noise. Generally, TAU calculated on base of early time response reflects both near surface overburden and poor conductors whereas, in the late ranges of time, deep and more conductive sources, respectively. For example early time TAU distribution in an area that indicates conductive overburden is shown in Figure 2.



Figure F2 – Map of early time TAU. Area with overburden conductive layer and local sources.



Figure F3 – Map of full time range TAU with EM anomaly due to deep highly conductive target.

There are many advantages of TAU maps:

- TAU depends only on one parameter (conductance) in contrast to response magnitude;
- TAU is integral parameter, which covers time range and all conductive zones and targets are displayed independently of their depth and conductivity on a single map.
- Very good differential resolution in complex conductive places with many sources with different conductivity.
- Signs of the presence of good conductive targets are amplified and emphasized independently of their depth and level of response accordingly.

In the example shown in Figure 4 and 5, three local targets are defined, each of them with a different depth of burial, as indicated on the resistivity depth image (RDI). All are very good conductors but the deeper target (number 2) has a relatively weak dB/dt signal yet also features the strongest total TAU (Figure 4). This example highlights the benefit of TAU analysis in terms of an additional target discrimination tool.



Figure F4 – dB/dt profile and RDI with different depths of targets.



Figure F5 – Map of total TAU and dB/dt profile.

The EM Time Constants for dB/dt and B-field were calculated using the "sliding Tau" in-house program developed at Geotech2. The principle of the calculation is based on using of time window (4 time channels) which is sliding along the curve decay and looking for latest time channels which have a response above the level of noise and decay. The EM decays are obtained from all available decay channels, starting at the latest channel. Time constants are taken from a least square fit of a straight-line (log/linear space) over the last 4 gates above a pre-set signal threshold level (Figure F6). Threshold settings are pointed in the "label" property of TAU database channels. The sliding Tau method determines that, as the amplitudes increase, the time-constant is taken at progressively later times in the EM decay. If the maximum signal amplitude falls below the threshold, or becomes negative for any of the 4 time gates, then Tau is not calculated and is assigned a value of "dummy" by default.

² by A.Prikhodko





Figure F6 - Typical dB/dt decays of Vtem data

Alexander Prikhodko, PhD, P.Geo Geotech Ltd.

September 2010



APPENDIX G

TEM Resistivity Depth Imaging (RDI)

Resistivity depth imaging (RDI) is technique used to rapidly convert EM profile decay data into an equivalent resistivity versus depth cross-section, by deconvolving the system or measured waveforms from the EM data. There are many different schemes to get conductivity/resistivity depth sections from time-domain data. The used RDI algorithm of Resistivity-Depth transformation is based on scheme of on the apparent resistivity transform of Maxwell A.Meju (1998)¹ and TEM response from conductive half-space adopted for time-domain data and system configuration. The program is in-house developed at Geotech for VTEM data².

The VTEM Resistivity Depth Sections have checked and proven on several real known targets, results of drilling and synthetic models (Fig. 1-12). Adding individual responses across the profile produces a pseudo 2-dimensional cross-section, called a RDI. RDIs provide reasonable indications of conductor relative depth and vertical extent, as well as accurate 1D layered-earth apparent conductivity/resistivity structure across a VTEM flight line.

Approximate depth of investigation of a TEM system, image of secondary field distribution in half space, effective resistivity, initial geometry and position of conductive targets is the information obtained on base of the RDIs.





Fig. 1 Maxwell plate model and RDI from the calculated response for conductive "thin" plate (depth 50 m, dip 65 degree, depth extend 100 m).

¹ Maxwell A.Meju, 1998, Short Note: A simple method of transient electromagnetic data analysis, Geophysics, **63**, 405–410.

² by A.Prikhodko



Fig. 2 Maxwell plate model and RDI from the calculated response for "thick" plate 18 m thickness, depth 50 m, depth extend 200 m).





Fig. 4 Maxwell plate model and RDI from the calculated response for "thick" vertical target (depth 100 m, depth extend 100 m). 19-44 chan.





Fig. 5 Maxwell plate model and RDI from the calculated response for horizontal thin plate (depth 50 m, dim 50x100 m). 15-44 chan.




m, depth to the target 50 m.



Fig.8 Maxwell plate model and RDI from the calculated response for the long, wide and deep subhorizontal plate (depth 140 m, dim 25x500x800 m) with conductive overburden.



Fig.9 Maxwell plate models and RDIs from the calculated response for "thick" dipping plates (35, 50, 75 m thickness), depth 50 m, conductivity 2.5 S/m.



Fig.10 Maxwell plate models and RDIs from the calculated response for "thick" (35 m thickness) dipping plate on different depth (50, 100, 150 m),, conductivity 2.5 S/m.



Fig. 11 RDI section of the line over Caber deposit ("thin" subvertical plate target and conductive overburden.



Fig.12 RDI section for the real horizontal and slightly dipping conductive layers







3d presentation of RDIs







Alexander Prikhodko, PhD, P.Geo Geotech Ltd. September 2010

Geotech Ltd.





ch Project # 102









