GM 59028

GEOLOGICAL ASSESSMENT REPORT ON HAUT PLATEAU EST PROJECT 151

NTS: 22O/11

GEOLOGICAL ASSESSMENT REPORT ON

Haut Plateau Est Project 151

Sept-Îles, Québec

Ground Staked Claims 5233376 to 5233535 inclusively

Work Performed 1999-2000

Falconbridge Ltd.
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SUMMARY

This assessment report summarizes exploration work carried out by Falconbridge Limited on their Haut Plateau Est properties. Work includes an experimental 3,300 line-km helicopter-borne magnetic and time-domain electromagnetic survey, ground investigation of the interpreted helicopter-borne conductors, and a detailed ground magnetometer survey. A newly discovered Ni-Cu sulphide mineralization returned average grade from three samples of 1.67% Ni, 1.04% Cu, 0.17% with best assay values of 1.98% Ni, 1.17% Cu and 0.22% Co. Mineralization occurs as a massive sulphide breccia within a late gabbronorite intrusion.

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SCOPE

This report summarizes the results of exploration programs carried out between 1998 and 2000 on Haut Plateau Est Project 151, ground staked Licenses 5233376 to 5233535 inclusively, in the Haut Plateau de la Manicouagan area, north of Sept-Îles.

LOCATION, ACCESS AND INFRASTRUCTURE

The property is located 170 km NNW of Sept-Îles and 275 km NNE of Baie-Comeau on the North shore of the St-Lawrence River in the Province of Quebec. The area is located in the township of Villery (NTS 22O/11) at latitude 51°64′N and longitude 67°34′W. The area is part of the mining district of Cote Nord/Nouveau-Quebec administered from Sept-Îles.

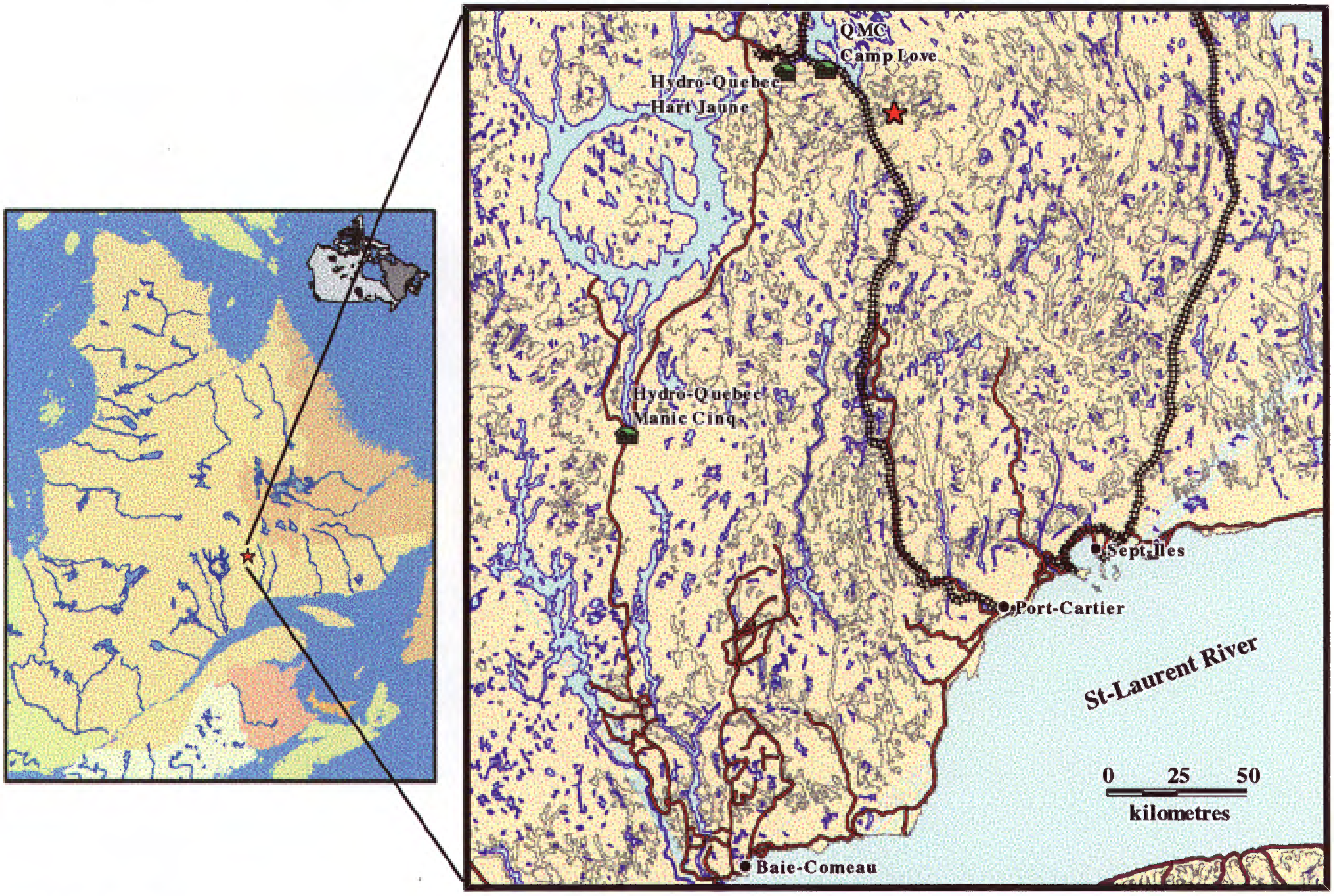

Figure 1: *Project location map.*

Route 389 is an all weather road connecting Baie-Comeau to Fermont to Labrador City. It is paved up to Hydro Quebec Manic 5 power plant. A gravel road maintained by Hydro-Quebec to access their Hart Jaune power station intersects to the East route 389 at kilometre 390. This road extends for 50 km to QMC railway maintenance camp on the West shore of Petit Lac Manicouagan. The Quebec Cartier Mining railroad connecting Fermont to Port-Cartier winds along the West bank of the North-East Toulnustouc River and it is used to haul iron ore from QCM Mount Wright deposits to QMC docking facilities at Port-Cartier. Port-Cartier is a major seaport on the St-Lawrence River. Hydro-Québec Hart Jaune power station is a small power plant located 35km to the NW of the property. The property is only accessible by floatplane and helicopter.

PHYSIOGRAPHY, TOPOGRAPHY AND VEGETATION

The Haut Plateau Est Project is part of the distinctive geographic and topographic feature of the Haut Plateau de la Manicouagan. The Haut Plateau de la Manicouagan forms a rectangular plateau 80 km long by 50 km wide characterized by a series of rounded summits averaging an altitude of 3000 feet. It includes the mountain range of the Monts Groulx with tops culminating over 3000 feet in the property area. The Plateau is dissected by numerous linear valleys at the bottom of which flow rivers and streams. The area is also characterized by a very high number of lakes but with somewhat of smaller dimensions. In the property area, drainage is to the west into the North-East Toulnustouc River to the South of the Petit Lac Manicouagan.

Tundra type vegetation characterizes the tops of the mountain range and taiga type vegetation can be found down in the valleys.

Table I
Summary of Ground Staked Claims
Project 151, Haut Plateau Est, Sept-Îles

Licence No.	Numbers of claims	Total Area (ha)	Issuance Date	Report Due Date	Assessment Year	2001 Requirements	1998-2000 Expenditures	Good Standing
5233376 to 5233535 incl.	160	2560	Oct. 19, 1999	Oct. 18, 2001	1	$80,000	$106,283.21	Oct. 18, 2003

PROPERTY AND OWNERSHIP

The property consists of 160 ground-staked claims held 100% by Falconbridge Ltd. All claims were staked on August 26, 1999 and issued on October 19, 1999. Work report filing dates and information on the claims are summarized in Table I.

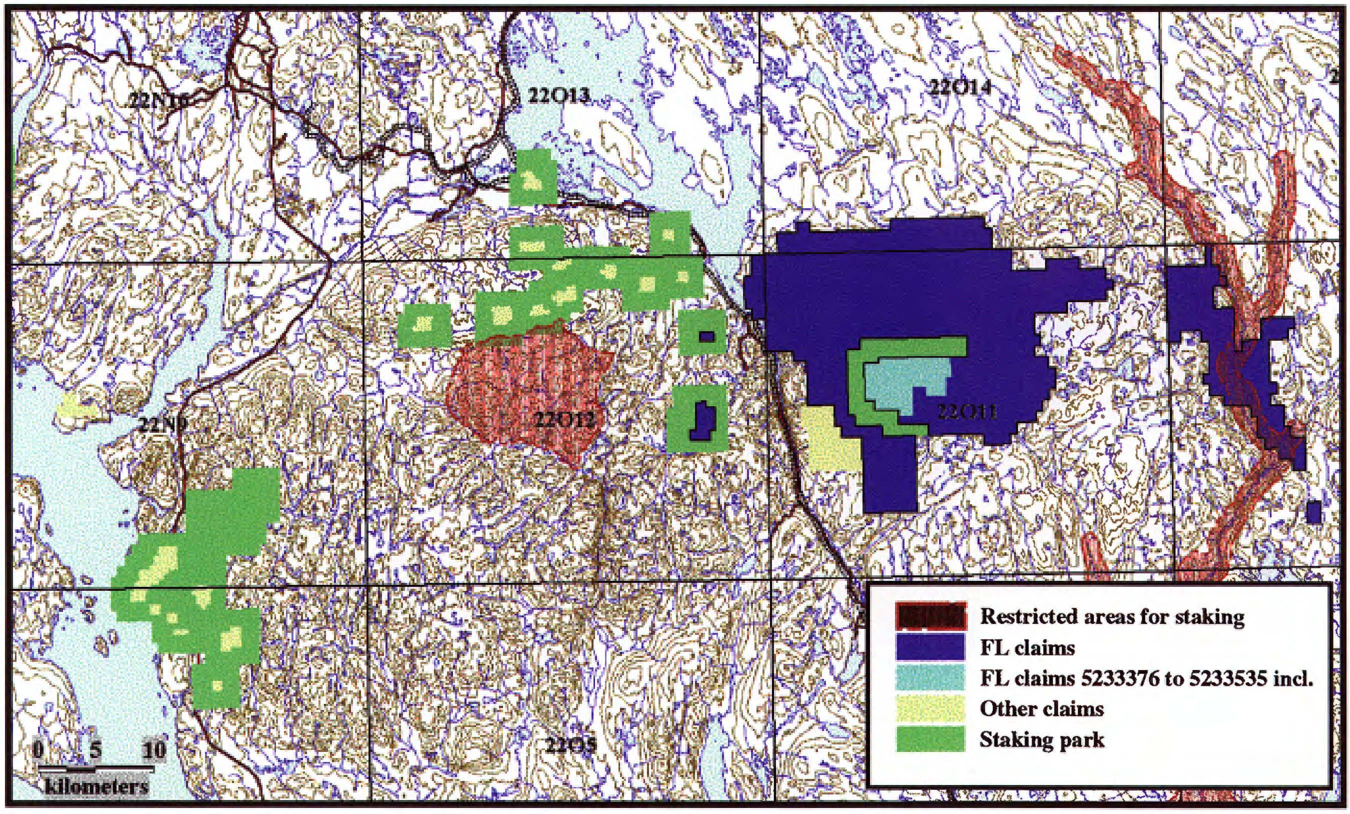

***Figure 2:** Claim map of the Haut Plateau de la Manicouagan area.*

PREVIOUS WORK

The property area has seen very little exploration work except for regional 250 000 and 50 000 scale mapping programs undertaken by the MRNQ. Lake sediment samples were taken on the property in 1977 and 1987 by SOQUEM and MRNQ respectively as part of regional lake sediment sampling programs. SOQUEM ground checked one magnetic anomaly taken from the federal aeromagnetic compilation.

In 1992 Falconbridge Limited undertook detailed compilation work over the entire Haut Plateau de la Manicouagan area. Reconnaissance mapping was completed over the entire Manicouagan metamorphic complex. More the 800 km of geological traverses were completed and some 25 geophysical airborne anomalies were ground investigated. Lithogeochemical sampling of the entire gabbroic granulite and gabbroic intrusions was also carried out in order to establish stratigraphical relationship and geological environment. More than 12 intrusive bodies were of gabbroic types were identifies, including Haut Plateau Est.

EXPLORATION PROGRAM

Table II
Summary of exploration programs
Project 151, Haut Plateau Est, Sept-Îles

Line cutting (line-km)	Magnetometer survey (line-km)	Helicopter-borne THEM survey (line-km)	Economic samples	Prospecting traverses (line-km)	Ground checked anomalies
83	55	3,300	68	150	37

1999 A helicopter-borne magnetic and time-domain electromagnetic survey was carried out during the period from November 8, 1998 to April 22, 1999. This experimental 3,300 line-km survey was conducted by T.H.E.M. Geophysics Inc. from Chelsea, Quebec and CGI Controlled Geophysics Inc. of Thornhill, Ontario carried out data processing and presentation. The survey was financed in part by the MRNQ under the *"Programme d'assistance financière à la realization d'études technico-économiques et à l'innovation technologique"*, project ÉTÉ&IN 1998-05. Continuous bad whether, repeated technical problems and a bird crash caused extended delays to complete the survey. Maps and reports from CGI are appended verbatim to this report.

Follow-up prospecting and sampling of THEM conductors was undertaken by Falconbridge personnel from August 2 to August 17, 1999. Prospecting was conducted using Geonics VLF EM-16 and GDD Instrumentation BeepMat. Several trenches were manually excavated by Falconbridge crew over three (3) newly discovered showings.

Personnal were based of Relais Gabriel outfitters, 62 km SW of the claim block. Transportation to and from the property was via an A-Star 350D helicopter contracted for the project from Les Hélicoptères Canadiens Ltd, Sept-Îles.

Table III

Personnel and Contractors employed on HPE claims
Project 151, Haut Plateau Est, Sept-Îles

FALCONBRIDGE PERSONNEL

Name	*Address*	*Dates Worked*	*Total man-days*	*Work Done*
Jean Laforest	Laval, Qc	Aug. 02 to Aug. 17. 1999	16	Plan & Supervision
Yves Boulianne	Chicoutimi, Qc	Aug. 02 to Aug. 17. 1999	16	Mapping and Prospecting
Pietro Costa	Chibougamau, Qc	Aug. 02 to Aug. 17. 1999	16	Mapping and Prospecting
Christian Blanchette	St-George, Qc	Aug. 02 to Aug. 17. 1999	16	Mapping and Prospecting
Richard Osmond	Laval, Qc	Nov. 08 to Nov. 22 1998	16	Geophysical Interpretation
		Total	**74 man-days**	

CONTRACTORS

Name	*Address*	*Dates Worked*	*Work Done*
T.H.E.M. Geophysics Ltd.	Chelsea, Qc	Nov. 1998 to Apr. 1999	Helicopter-borne survey
Les Hélicoptères Canadien Ltée	Sept-Îles, Qc	Nov. 1998 to Apr. 1999; Aug 1999	Air Charters
Michel Allard	Rouyn-Noranda, Qc	Jan. to Apr. 1999	Geophysical Consultant
CGI Controlled Geophysics Inc.	Thornhill, Ont	Nov. 1998 to Apr. 1999	Data processing and presentation
Intertek Testing Services (Chimitec)	Val d'Or, Qc	Aug. 1999	Analytical Services
Ressources Manicor Inc.	Baie-Comeau, Qc	Jun. to Jul. 2000	Line-cutting
Mckeown Exploration Services	Courtice, Ont.	Aug. to Sept. 2000	Magnetometer survey

A total of 74 man-days of work were performed on the property to conduct the prospecting program with a total expenditure of $52 438.97. 4.39% of the entire T.H.E.M. survey is eligible on 160 claims for total expenditures of $15,933.59 (Table IV).

2000 Line cutting and a ground magnetometer survey were conducted on the property from August 20 to September 9, 2000. Ressource Manicor Inc. was contracted to cut an 83 line-km grid and McKeown Exploration Services were retained to conduct a Mag survey on the grid.

A fly camp was set-up in the center of the grid area for contractors. Logistic to the camp was provided via an A-Star 350D helicopter contracted for the project from Les Hélicoptères Canadiens Ltd, Sept-Îles.

Table IV
Statement of Expenditures
Project 151, Haut Plateau Est, Sept-Îles

General & Geology (1999)		
Salaries		$10,410.00
Field Expenses		$2,572.24
Groceries/Food/Lodging		$6,558.33
Assays		$1,948.95
Helicopter/Air Chater costs		$28,987.45
Truck rental		$1,245.00
Report		$717.00
	Total:	***$52,438.97***
Geophysics (1999)		
Salaries		$2,300.00
Contract Payments (T.H.E.M.+CGI)		$343,100.00
Contract Payments (Geophysicist)		$9,300.00
Transport		$2,808.71
Food/Lodging		$2,791.44
Field Expenses		$2,651.81
	Total:	***$362,951.96***
	Allowed Expenditures (4.39%):	***$15,933.59***
Geophysics (2000)		
Contract Payments (Line-cutting)		$35,006.40
Contract Payments (Ground Mag)		$2,904.25
	Total:	***$37,910.65***
Project Expenditures (1999 + 2000)		**$106,283.21**

Total expenditures of $106,283.21 have been incurred on the 160 claims, sufficient to hold them in good standing until October 18th, 2003 (Table IV).

GEOLOGY

Regional Geology

The Haut Plateau de la Manicouagan comprises all of the Hart Jaune terrane that is zone is located within the Allotochtonous Belt of the Grenville Province. It consists of predominantly granulite-facies metagabbroic rocks and intruded by coronitic Fe-Ti gabbros, with subordinate calc-silicates and metapelites. Rocks of the Hart Jaune terrane experienced an early stage of largely garnet-free, granulite-facies metamorphism and a later granulite-facies overprint in which garnet developed in some rocks. Geochronological studies provided support for their polymetamorphic character, with the earlier metamorphism dated at ca. 1470 Ma (Pinwarian) and the later metamorphic overprint dated at 989 Ma.

Property Geology

The western half of the property is underlain by granulitic gabbronorites. The eastern half is mostly underlain by different types of coronitic gabbronorites intruded in paragneisses. Mafic and ultramafic lithologies were recognized as part of these late intrusive suites. Known Ni-Cu sulphide mineralization found on the property appears to be associated with the late intrusion lithologies.

Mineralization

Mineralization was found in three different localities on the property. Mineralization occurs as concentration of veins, veinlets and breccias of semi- to massive sulphides associated either with graphitic paragneisses or late mafic to ultramafic intrusions.

Table V
Best Assay Results
Project 151, Haut Plateau Est, Sept-Îles

Assay	Rock Facies	Mineralization	Ni ppm	Cu ppm	Co ppm	Au ppb	Pt ppb	Pd ppb	S %	Ni (100%)
QB4048	Gabbro tardif	Po(90) vein+Cp(3) diss	8333	8059	1364	2	-9	66	26.77	1.20
QB4068	Gabbro	Po(90)+Cp(3) breccia	19804	11765	2225	20	-9	22	32.54	2.34
QB4069	Gabbro	Po(70)+Cp(2) breccia	14850	10432	1344	42	5	68	17.36	3.26
QB4070	Gabbro	Po(90)+Cp(3) breccia	15490	9020	1569	10	-9	12	33.06	1.81
QB4086	Gabbro/paragneiss	Po(70) breccia	7642	652	1415	5	-9	33	24.57	1.21
QB4504		Po(43)+Cp(1)	5867	9306	985	20	-9	18	19.47	1.16
QB4505		Po(55)+Cp(2)	4286	1485	859	5	-9	10	14.16	1.17
QB4506		Po(60)	4144	1102	1008	3	-9	17	15.68	1.02

A massive sulphide horizon was found in the southern portion of the claim block within the paragneiss. It coincides with 2,400 m long formational conductor. Sulphides consist of pyrite and pyrrhotite with no significant nickel mineralization.

A northwest-southeast late gabbronorite is mineralized over 400m. Mineralization occurs as disseminated sulphides or as massive to semi-massive veins or veinlets. Mineralization coincides with an 800m long T.H.E.M. conductor. Mineralization appears to be related to the presence of partially to totally digested inclusions of paragneisses within a late gabbronoritic intrusion. Assay values vary from 0.20 to 0.76% Ni and 0.10 to 0.93% Cu along the whole length of the conductor.

A massive sulphide breccia loaded with mafic to ultramafic inclusions was found in a late gabbronorite intrusion. Three samples taken from the bottom of a 1 meter deep hand dug hole returned an average value of 1.67% Ni, 1.04% Cu, 0.17% Co, 34 ppb Pd and 24 ppb Au with best assay values of 1.98% Ni, 1.17% Cu and 0.22% Co. Mineralization coincides with a strong T.H.E.M. conductor. The overall context of the mineralization is still unclear but ultramafic rocks have been observed in the vicinity.

CONCLUSIONS AND RECOMMENDATIONS

Massive sulphide mineralization was found on the Haut Plateau property. Average grade from three samples returned values of 1.67% Ni, 1.04% Cu, 0.17% with best assay values of 1.98% Ni, 1.17% Cu and 0.22% Co. Mineralization occurs as a massive sulphide breccia within a late gabbronorite intrusion and it coincides with a T.H.E.M. airborne conductor.

Further ground geophysics and detailed mapping is recommended over the newly discovered mineralization.

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APPENDIX A

ROCK DESCRIPTION

Table VI

Sample location and description
Project 151, Haut Plateau Est, Sept-Îles

Assay	Easting	Northing	Type	Rock_Facies	Mineralization
QB4041	612228.28	5724005.9	EC	Gabbro	15%podiss-.2%cpdiss
QB4042	612322.71	5724035.4	EC	Gabbro	8%po-.5%py-.2%cp-1%gpdiss
QB4043	612366.29	5724101.3	EC	Gabbro	20%po-.5%cp-3%gpdiss
QB4044	614180.33	5722926.6	EC	Gabbro	5%po-3%py-15%gpdiss
QB4045	614839.36	5722576.9	EC	Gneiss graphitique	5%po-20%gpdiss
QB4046	614414.11	5723717.2	EC	Gneiss gabbroique?	6%podiss
QB4047	616519.00	5723200.0	EC	Gabbro	6%podiss/.1%cpdiss
QB4048	616682.03	5723337.3	EC	Gabbro tardif	povein90%/cpdiss3%
QB4049	616680.52	5723333.3	EC	Gabbro tardif	podiss15%/cpdiss.5%
QB4050	617170.94	5723179.9	EC	Gabbro tardif	podiss4%
QB4051	616644.08	5723221.1	EC	Gabbro tardif	podiss7%
QB4052	615936.25	5723698.4	EC	Paragneiss	gpdiss10%/pydiss1%
QB4053	617899.64	5722822.7	EC	Gabbro tardif	povlts/2%
QB4054	617709.20	5722825.8	EC	Gabbro	podiss1%
QB4055	616472.70	5723178.8	EC	Gneiss siliceux	gpdiss3%/podiss2%
QB4056	616417.19	5723193.6	EC	Gneiss siliceux	podiss2%
QB4057	616540.56	5723252.4	EC	Gabbro	podiss10%/cpdiss.5%
QB4058	615447.66	5724584.3	EC	Paragneiss	gpdiss15%
QB4059	615838.29	5724613.9	EC	Paragneiss	gp20%/py2%po1%diss
QB4068	614986.19	5722482.3	EC	Gabbro	poMSS90%/cpdiss3%
QB4069	614986.19	5722482.3	EC	Gabbro	podiss70%/cpdiss2%
QB4070	614986.19	5722482.4	EC	Gabbro	poMSS90%/cpdiss3%
QB4071	614906.56	5722592.8	EC	Gabbro	podiss1%/cpdiss.1%/gpdiss.1%
QB4072	615847.38	5722321.5	EC	Gabbro	podiss.2%
QB4073	615116.09	5721015.2	EC	Paragneiss	PO(tr),GP(10) sur 60 cm
QB4074	615116.70	5721015.7	EC	Paragneiss	PO(15),CP(3) sur 24 cm
QB4075	615117.32	5721016.1	EC	Paragneiss	GP(15) sur 46 cm
QB4076	615120.10	5721018.6	EC	Paragneiss	GP(12) sur 40 cm
QB4077	615120.72	5721018.9	EC	Paragneiss	PO(23),GP(2) sur 35 cm
QB4080	614971.29	5721161.7	EC	Paragneiss	PO(6),GP(2) sur 50 cm
QB4081	614971.97	5721162.5	EC	Paragneiss	PO(75),CP(0.5) sur 50 cm
QB4082	614972.50	5721163.3	EC	Paragneiss	PO(35),CP(0.5) sur 50 cm
QB4083	614973.56	5721165.5	EC	Paragneiss	PO(55),CP(tr) sur 35cm
QB4086	612644.80	5722423.0	EC	Gabbro/paragneiss	poMSS70%
QB4501	613474.17	5721649.4	EC	Gabbro	80%Po, trCp
QB4502	613528.65	5721573.0	EC	Gabbro	12%Po, trCp
QB4503	613561.21	5721547.4	EC	Gabbro	17%Po
QB4504	613559.15	5721346.5	EC	Gabbro	43%Po, 1%Cp
QB4505	613597.85	5721494.5	EC	Gabbro	55%Po, 2%Cp
QB4506	613618.01	5721521.4	EC	Gabbro	60%Po, trCp

Table VI (Cont'd)

Sample location and description
Project 151, Haut Plateau Est, Sept-Îles

Assay	Easting	Northing	Type	Rock_Facies	Mineralization
QB4507	613792.64	5721505.6	EC	Paragneiss	22%Po-Py
QB4508	613746.82	5721526.7	EC	Gabbro	55%Po
QB4509	613746.82	5721526.7	EC	Gabbro	40%Po, 5%Py
QB4510	613682.19	5721549.7	EC	Gabbro	15%Po, trCp
QB4511	613654.34	5721562.7	EC	Gabbro	35%Po, 1%Cp
QB4512	613629.52	5721567.3	EC	Gabbro	8%Po
QB4513	613628.97	5721530	EC	Gabbro	50%Po, 2%Cp
QB4514	615484.32	5720707.1	EC	Paragneiss	3%Po-Py
QB4515	615250.27	5720839.7	EC	Paragneiss	10%Po-Py
QB4516	615115.8	5721021.9	EC	Gabbro	17%Po-Py, trCp
QB4517	614998.52	5721127.5	EC	Gabbro	17%Po, 3%Py, trCp
QB4518	614972.53	5721162	EC	Gabbro	30%Po, 1%Cp
QB4519	614972.53	5721162	EC	Gabbro	85%Po, trCp
QB4520	614973.79	5721201	EC	Paragneiss	20%Po, trPy, trCp
QB4521	614325.85	5722096.6	EC	Paragneiss	20%Po, 5%Py, 2%Cp
QB4523	613115.1	5721956.4	EC		12%Po
QB4524	613090.81	5721949.9	EC		8%Po
QB4525	613410.54	5721686.7	EC		35%Po
QB4526	612996.74	5722023.6	EC		5%Po
QB4527	613412.08	5721695.3	EC		25%Po, 3%Cp
QB5004	613760	5721245	EC	Paragneiss	6%Po, tr Gp
QB5006	615160	5721245	EC	Paragneiss	3%Po
QB5345	612957.07	5722070	EC	Paragneiss?	2%Po
QB5346	613146.14	5721927.5	EC	Metasediment	30%Po, 3%Cp
QB5347	613238.48	5721816.8	EC	Paragneiss	20%Po, 1%Cp
QB5348	613310.17	5721738.3	EC	Gabbro?	10%Po, trCp
QB5349	613440.87	5721677.2	EC	Gabbro	3%Po, 1%Cp
QB5350	613474.17	5721649.4	EC	Gabbro?	45%Po, trCp

APPENDIX B

WHOLE ROCK ANALYSIS AND ASSAY RESULTS

INTERTEK TESTING SERVICES (CHIMITEC)

Samples for economic analysis (including Ni, Cu, Co, Au, Pt, Pd) were crushed (<10mm), split, pulverized to -150 mesh. The Ni, Cu, Co group was digested by HF-HNO_3-$HClO_4$-HCl and analyzed by atomic absorption (AA). The Au, Pt, Pd group was determined by fire assay. Sulfur was measured by LECO fusion.

Station ID	Sample No.	Easting	Northing	Rock_Facies	Type	Mineralization	Ni ppm	Cu ppm	Co ppm	Au ppb	Pt ppb	Pd ppb	S %
S-JL99-0234A01	QB4041	612228.28	5724005.9	Gabbro	EC	Po(15)+Cp(1) diss	2210	3230	390	2	-9	4	5.22
S-JL99-0235A01	QB4042	612322.71	5724035.4	Gabbro	EC	Po(8)+Py(.5)+Cp(1)+Gp(1) diss	2300	3865	328	-9	-9	4	5.07
S-JL99-0236A01	QB4043	612366.29	5724101.3	Gabbro	EC	Po(20)+Cp(1)+Gp(3) diss	2938	3317	647	-9	-9	12	9.58
S-JL99-0237A01	QB4044	614180.33	5722926.6	Gabbro	EC	Po(5)+Py(3)+Gp(15) diss	1325	799	230	-9	-9	8	4.26
S-JL99-0239A01	QB4045	614839.36	5722576.9	Gneiss graphitique	EC	Po(5)+Gp(20) diss	211	511	46	-9	-9	10	5.57
S-JL99-0241A01	QB4046	614414.11	5723717.2	Gneiss gabbroique?	EC	Po(6) diss	74	152	47	-9	-9	-9	0.92
S-JL99-0243A01	QB4047	616519.00	5723200.0	Gabbro	EC	Po(6)+Cp(1) diss	922	559	339	2	-9	6	5.58
S-JL99-0244A01	QB4048	616682.03	5723337.3	Gabbro tardif	EC	Po(90) vein+Cp(3) diss	8333	8059	1364	2	-9	66	26.77
S-JL99-0245A01	QB4049	616680.52	5723333.3	Gabbro tardif	EC	Po(15)+Cp(5) diss	2965	1414	538	4	-9	8	9.95
S-JL99-0247A01	QB4050	617170.94	5723179.9	Gabbro tardif	EC	Po(4) diss	965	550	133	2	-9	2	1.43
S-JL99-0248A01	QB4051	616644.08	5723221.1	Gabbro tardif	EC	Po(7) diss	1096	678	268	4	-9	10	3.62
S-JL99-0249A01	QB4052	615936.25	5723698.4	Paragneiss	EC	Gp(10)+Py(1) diss	102	218	5	-9	-9	2	2.39
S-JL99-0250A01	QB4053	617899.64	5722822.7	Gabbro tardif	EC	Po(2) vnlts	183	173	104	-9	6	-9	1.72
S-JL99-0251A01	QB4054	617709.20	5722825.8	Gabbro	EC	Po(1) diss	108	86	49	-9	-9	-9	0.85
S-JL99-0252A01	QB4055	616472.70	5723178.8	Gneiss siliceux	EC	Gp(3)+Po(2) diss	192	186	69	-9	-9	4	2.4
S-JL99-0253A01	QB4056	616417.19	5723193.6	Gneiss siliceux	EC	Po(2) diss	95	125	35	-9	-9	-9	2.14
S-JL99-0254A01	QB4057	616540.56	5723252.4	Gabbro	EC	Po(10)+Cp(5) diss	1064	473	217	4	-9	4	4.16
S-JL99-0255A01	QB4058	615447.66	5724584.3	Paragneiss	EC	Gp(15) diss	50	61	11	-9	-9	-9	0.7
S-JL99-0256A01	QB4059	615838.29	5724613.9	Paragneiss	EC	Gp(20)+Py(2)+Po(1) diss	281	754	23	-9	-9	8	8.28
S-JL99-0268A01	QB4068	614986.19	5722482.3	Gabbro	EC	Po(90) +Cp(3) MS	19804	11765	2225	20	-9	22	32.54
S-JL99-0269A01	QB4069	614986.19	5722482.3	Gabbro	EC	Po(70)+Cp(2) diss	14850	10432	1344	42	5	68	17.36
S-JL99-0270A01	QB4070	614986.19	5722482.4	Gabbro	EC	Po(90) +Cp(3) MS	15490	9020	1569	10	-9	12	33.06
S-JL99-0271A01	QB4071	614906.56	5722592.8	Gabbro	EC	Po(1)+Cp(1)+Gp(1) diss	712	275	81	12	14	8	0.5
S-JL99-0272A01	QB4072	615847.38	5722321.5	Gabbro	EC	Po(2) diss	135	108	47	1	-9	-9	0.41
S-CB99-0279b02	QB4073	615116.09	5721015.2	Paragneiss	EC	Gp(10) sur 60 cm	74	71	24	2	-9	2	0.75
S-CB99-0279b03	QB4074	615116.70	5721015.7	Paragneiss	EC	Po(15)+Cp(3) sur 24 cm	211	2911	34	4	-9	7	6.64
S-CB99-0279b04	QB4075	615117.32	5721016.1	Paragneiss	EC	Gp(15) sur 46 cm	62	248	-9	2	-9	2	1.27
S-CB99-0279b05	QB4076	615120.10	5721018.6	Paragneiss	EC	Gp(12) sur 40 cm	81	243	7	2	-9	3	1.54
S-CB99-0279b06	QB4077	615120.72	5721018.9	Paragneiss	EC	Po(23)+Gp(2) sur 35 cm	182	308	24	2	-9	3	5.38
S-CB99-0282a02	QB4080	614971.29	5721161.7	Paragneiss	EC	Po(6)+Gp(2) sur 50 cm	119	754	24	17	-9	71	6.75
S-CB99-0282a03	QB4081	614971.97	5721162.5	Paragneiss	EC	Po(75)+Cp(0.5) sur 50 cm	279	581	64	5	-9	6	18.17
S-CB99-0282a04	QB4082	614972.50	5721163.3	Paragneiss	EC	Po(35)+Cp(0.5) sur 50 cm	249	1048	54	13	-9	11	16.39
S-CB99-0282a05	QB4083	614973.56	5721165.5	Paragneiss	EC	PO(55),CP(tr) sur 35cm	349	958	81	56	-9	18	23.07
S-JL99-0274A01	QB4086	612644.80	5722423.0	Gabbro/paragneiss	EC	Po(70) MS	7642	652	1415	5	-9	33	24.57

Station ID	Sample No.	Easting	Northing	Rock_Facies	Type	Mineralization	Ni ppm	Cu ppm	Co ppm	Au ppb	Pt ppb	Pd ppb	S %
S-CB99-0262A01	QB4501	613474.17	5721649.4	Gabbro	EC	Po(80)+Cp(TR) MS	3071	1298	669	4	-9	10	10.36
S-CB99-0263A01	QB4502	613528.65	5721573.0	Gabbro	EC	Po(12)+Cp(TR)	1766	1041	456	4	-9	2	6.86
S-CB99-0264A01	QB4503	613561.21	5721547.4	Gabbro	EC	Po(17)	3661	1076	787	7	-9	13	11.5
S-CB99-0265A01	QB4504	613559.15	5721346.5	Gabbro	EC	Po(43)+Cp(1)	5867	9306	985	20	-9	18	19.47
S-CB99-0266A01	QB4505	613597.85	5721494.5	Gabbro	EC	Po(55)+Cp(2)	4286	1485	859	5	-9	10	14.16
S-CB99-0267A01	QB4506	613618.01	5721521.4	Gabbro	EC	Po(60)+Cp(TR)	4144	1102	1008	3	-9	17	15.68
S-CB99-0271A01	QB4507	613792.64	5721505.6	Paragneiss	EC	Po-Py(22)	2217	1225	453	3	-9	9	6.34
S-CB99-0272A01	QB4508	613746.82	5721526.7	Gabbro	EC	Po(55)	3217	1327	756	6	-9	14	12.07
S-CB99-0272A01	QB4509	613746.82	5721526.7	Gabbro	EC	Po(40)+Py(5)	1863	1311	456	6	-9	9	7.23
S-CB99-0273A01	QB4510	613682.19	5721549.7	Gabbro	EC	Po(15)+Cp(TR)	1333	600	312	3	-9	3	4.98
S-CB99-0274A01	QB4511	613654.34	5721562.7	Gabbro	EC	Po(35)+(Cp(1)	3496	1533	717	14	-9	8	11.82
S-CB99-0275A01	QB4512	613629.52	5721567.3	Gabbro	EC	Po(8)	1115	1057	278	4	-9	2	3.32
S-CB99-0276A01	QB4513	613628.97	5721530.0	Gabbro	EC	Po(50)+Cp(2)	2291	3834	428	5	-9	10	7.28
S-CB99-0277A01	QB4514	615484.32	5720707.1	Paragneiss	EC	Po-Py(3)	37	282	7	7	-9	6	0.83
S-CB99-0278A01	QB4515	615250.27	5720839.7	Paragneiss	EC	Po-Py(10)	201	611	39	15	-9	11	6.18
S-CB99-0279A01	QB4516	615115.80	5721021.9	Gabbro	EC	Po-Py(17)+Cp(TR)	370	735	66	5	-9	17	11.49
S-CB99-0281A01	QB4517	614998.52	5721127.5	Gabbro	EC	Po(17)+Py(3)+CP(TR)	181	918	62	37	-9	14	9.93
S-CB99-0282A01	QB4518	614972.53	5721162.0	Gabbro	EC	Po(30)+Cp(1)	293	1350	70	16	-9	77	18.39
S-CB99-0282A01	QB4519	614972.53	5721162.0	Gabbro	EC	Po(85)+Cp(TR)	443	440	99	11	-9	3	28.48
S-CB99-0283A01	QB4520	614973.79	5721201.0	Paragneiss	EC	Po(20)+Py-Cp(TR)	173	810	25	4	-9	3	8.98
S-CB99-0284A01	QB4521	614325.85	5722096.6	Paragneiss	EC	Po(20)+Py(5)+Cp(2)	188	1643	54	6	-9	5	6.85
S-CB99-0318A01	QB4523	613115.10	5721956.4		EC	Po(12)	2578	861	562	-9	-9	7	6.95
S-CB99-0319A01	QB4524	613090.81	5721949.9		EC	Po(8)	1310	562	322	2	7	9	4.5
S-CB99-0373A01	QB4525	613410.54	5721686.7		EC	Po(35)	1316	976	351	2	17	11	3.55
S-CB99-0303A01	QB4526	612996.74	5722023.6		EC	Po(5)	1457	681	298	5	-9	7	3.94
S-CB99-0372A01	QB4527	613412.08	5721695.3		EC	Po(25)+(Cp(3)	1494	1652	358	1	-9	3	4.97
PC99-104	QB5004	613760.00	5721245.0	Paragneiss	EC	Po(6)+Gp(TR)	181	175	57	-9	-9	3	0.52
PC99-106	QB5006	615160.00	5721245.0	Paragneiss	EC	Po(3)	216	745	41	5	-9	11	8.18
S-CB99-0256A01	QB5345	612957.07	5722070.0	Paragneiss?	EC	Po(2)	125	277	45	-9	-9	8	0.93
S-CB99-0258A01	QB5346	613146.14	5721927.5	Metasediment	EC	Po(30)+Cp(3)	3730	1552	889	3	-9	19	12.62
S-CB99-0259A01	QB5347	613238.48	5721816.8	Paragneiss	EC	Po(20)+Cp(1)	2754	2831	605	6	-9	8	8.91
S-CB99-0260A01	QB5348	613310.17	5721738.3	Gabbro?	EC	Po(10)+Cp(TR)	3071	1375	768	4	-9	14	11.46
S-CB99-0261A01	QB5349	613440.87	5721677.2	Gabbro	EC	Po(3)+(Cp(1)	1538	797	362	2	61	5	5.6
S-CB99-0262A01	QB5350	613474.17	5721649.4	Gabbro?	EC	Po(45)+Cp(TR)	3688	1647	967	2	-9	10	14.73

Intertek Testing Services
Chimitec Bondar Clegg

Certificat D'Analyse
Assay Lab Report

RAPPORT: C99-62149.0 (COMPLET) RÉFÉRENCE: 170981

CLIENT: FALCONBRIDGE LTD. SOUMIS PAR: J. LAFOREST
PROJET: 110 DATE RECU: 18-AUG-99 DATE DE L'IMPRESSION: 1-SEP-99

DATE APPROUVÉ	COMMANDE	ÉLÉMENT		NOMBRE D'ANALYSES	LIMITE INFÉRIEURE DE DETECTION	EXTRACTION	MÉTHODE
990901	1	Ni	Nickel	51	1 PPM	HF-HNO3-HCLO4-HCL	ABSORPTION ATOMIQUE
990901	2	Cu	Cuivre	51	1 PPM	HF-HNO3-HCLO4-HCL	ABSORPTION ATOMIQUE
990901	3	Co	Cobalt	51	3 PPM	HF-HNO3-HCLO4-HCL	ABSORPTION ATOMIQUE
990901	4	Au	Or - Pyro Analyse	51	1 PPB	PYRO ANALYSE	PYROANALYSE-DCP
990901	5	Pt	Platine	51	5 PPB	PYRO ANALYSE	PYROANALYSE-DCP
990901	6	Pd	Palladium	51	1 PPB	PYRO ANALYSE	PYROANALYSE-DCP
990901	7	S Tot	Soufre (Total)	51	0.02 PCT		LECO

TYPES D'ÉCHANTILLONS	NOMBRE	FRACTION UTILISÉE	NOMBRE	PRÉP. DE L'ÉCHAN.	NOMBRE
ROCHE	51	-150	51	CONCASSER, PULVERISE	51

COPIES DU RAPPORT À: M. JEAN LAFOREST FACTURE À: M. JEAN LAFOREST

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Ce rapport ne doit être reproduit que dans sa totalité. Les données présentées dans ce rapport sont exprimées sur base sèche sauf indication contraire et ne concernent que les échantillons reçus, identifiés par le numéro d'échantillon.

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M Berger TP

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Certificat D'Analyse
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CLIENT : FALCONBRIDGE LTD. PROJET: 110
RAPPORT: C99-62149.0 (COMPLET) DATE RECU: 18-AUG-99 DATE DE L'IMPRESSION: 1-SEP-99

NUMÉRO DE L'ÉCHANTILLON	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT	
QB4041		2210	3230	390	2	<5	4	5.22	
QB4042		2300	3865	328	<1	<5	4	5.07	
QB4043		2938	3317	647	<1	<5	12	9.58	
QB4044		1325	799	230	<1	<5	8	4.26	
QB4045		211	511	46	<1	<5	10	5.57	
QB4046		74	152	47	<1	<5	<1	0.92	
QB4047		922	559	339	2	<5	6	5.58	
QB4048		8333	8059	1364	2	<5	66	26.77	
QB4049		2965	1414	538	4	<5	8	9.95	
QB4050		965	550	133	2	<5	2	1.43	
QB4051		1096	678	268	4	<5	10	3.62	
QB4052		102	218	5	<1	<5	2	2.39	
QB4053		183	173	104	<1	6	<1	1.72	
QB4054		108	86	49	<1	<5	<1	0.85	
QB4055		192	186	69	<1	<5	4	2.40	
QB4056		95	125	35	<1	<5	<1	2.14	
QB4057		1064	473	217	4	<5	4	4.16	
QB4058		50	61	11	<1	<5	<1	0.70	
QB4059		281	754	23	<1	<5	8	8.28	
QB4060		170	130	39	<1	<5	4	4.83	
QB4061		98	97	23	<1	<5	2	3.05	
QB4062		89	79	18	<1	<5	2	3.00	
QB4063		61	55	17	<1	<5	<1	1.78	
QB4064		408	810	59	<1	<5	14	13.57	
QB4065		224	482	40	<1	<5	10	7.23	
QB4066		331	416	54	<1	<5	2	2.10	
QB4067		20	136	8	16	<5	2	0.81	
QB4068		19804	11765	2225	20	<5	22	32.54	(2.22)
QB4069		14850	10432	1344	42	5	68	17.36	(3.66)
QB4070		15490	9020	1569	10	<5	12	33.06	(1.69)
QB4071		712	275	81	12	14	8	0.50	
QB4072		135	108	47	1	<5	<1	0.41	
QB4073		74	71	24	2	<5	2	0.75	
QB4074		211	2911	34	4	<5	7	6.64	
QB4075		62	248	<3	2	<5	2	1.27	
QB4076		81	243	7	2	<5	3	1.54	

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NUMÉRO DE L'ÉCHANTILLON	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
QB4077		182	308	24	2	<5	3	5.38
QB4078		336	764	60	3	<5	13	11.04
QB4080		119	754	24	17	<5	71	6.75
QB4081		279	581	64	5	<5	6	18.17
QB4082		249	1048	54	13	<5	11	16.39
QB4083		349	958	81	56	<5	18	23.07
QB4084		4128	3469	1463	2	<5	17	31.66
QB4085		3093	4466	1433	9	<5	30	27.39
QB4086		7642	652	1415	5	<5	33	24.57
QB4087		2774	3029	721	10	<5	26	12.11
QB4088		37	63	9	1	<5	<1	0.70

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# MESURE / STANDARD	ÉLÉMENT / UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
BLANC		<1	<1	<3	<1	<5	<1	-
BLANC		<1	1	<3	<1	<5	<1	-
BLANC		-	-	-	<1	<5	<1	-
Nombre d'analyses		2	2	2	3	3	3	-
Valeur de moyenne		0.5	0.8	1.5	0.5	2.5	0.5	-
Écart-type		0.00	0.35	0.00	0.00	0.00	0.00	-
Valeur acceptee		1	1	1	5	5	5	<0.01
STANDARD DCP		-	-	-	77	77	77	-
STANDARD DCP		-	-	-	78	78	77	-
Nombre d'analyses		-	-	-	2	2	2	-
Valeur de moyenne		-	-	-	77.5	77.3	77.0	-
Écart-type		-	-	-	0.64	1.06	0.00	-
Valeur acceptee		-	-	-	83	83	83	-
STD GEOCHIMIQUE 4		48	297	7	-	-	-	-
Nombre d'analyses		1	1	1	-	-	-	-
Valeur de moyenne		48.0	297.0	7.0	-	-	-	-
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		42	-	9	-	-	-	-
UTS-1		-	-	-	-	-	-	0.98
Nombre d'analyses		-	-	-	-	-	-	1
Valeur de moyenne		-	-	-	-	-	-	0.980
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		-	-	-	-	-	-	1.00
CANMET LAKE-SED 2		27	41	16	-	-	-	-
Nombre d'analyses		1	1	1	-	-	-	-
Valeur de moyenne		27.0	41.0	16.0	-	-	-	-
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		26	37	17	-	-	-	-
UTS-2		-	-	-	-	-	-	3.20
Nombre d'analyses		-	-	-	-	-	-	1
Valeur de moyenne		-	-	-	-	-	-	3.200
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		-	-	-	-	-	-	3.23

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RAPPORT: C99-62149.0 (COMPLET) DATE RECU: 18-AUG-99 DATE DE L'IMPRESSION: 1-SEP-99

# MESURE STANDARD	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
WPR-1		-	-	-	48	258	201	-
Nombre d'analyses		-	-	-	1	1	1	-
Valeur de moyenne		-	-	-	48.0	258.0	201.0	-
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		-	-	-	42	285	235	-

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NUMÉRO DE L'ÉCHANTILLON	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
QB4037		53	37	40	<1	<5	<1	0.89
Duplicata								0.92
QB4046		74	152	47	<1	<5	<1	0.92
Duplicata		72	150	46	<1	<5	<1	0.94
QB4051		1096	678	268	4	<5	10	3.62
Duplicata								3.75
QB4056		95	125	35	<1	<5	<1	2.14
Duplicata								2.15
QB4061		98	97	23	<1	<5	2	3.05
Duplicata								2.99
QB4063		61	55	17	<1	<5	<1	1.78
Duplicata		61	56	14				
QB4066		331	416	54	<1	<5	2	2.10
Duplicata								2.13
QB4068		19804	11765	2225	20	<5	22	32.54
Duplicata					16	<5	22	
QB4069		14850	10432	1344	42	5	68	17.36
Prep Duplicata		17883	10493	1715	47	<5	62	
QB4070		15490	9020	1569	10	<5	12	33.06
Duplicata								33.25
QB4078		336	764	60	3	<5	13	11.04
Duplicata								11.10
QB4083		349	958	81	56	<5	18	23.07
Duplicata		346	922	77				
QB4084		4128	3469	1463	2	<5	17	31.66
Duplicata								31.95

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Certificat D'Analyse
Assay Lab Report

RAPPORT: C99-62150.0 (COMPLET) RÉFÉRENCE: 170981

CLIENT: FALCONBRIDGE LTD. SOUMIS PAR: J. LAFOREST
PROJET: 110 DATE RECU: 18-AUG-99 DATE DE L'IMPRESSION: 8-SEP-99

DATE APPROUVÉ	COMMANDE	ÉLÉMENT		NOMBRE D'ANALYSES	LIMITE INFÉRIEURE DE DETECTION	EXTRACTION	MÉTHODE
990908	1	Ni	Nickel	51	1 PPM	HF-HNO3-HCLO4-HCL	ABSORPTION ATOMIQUE
990908	2	Cu	Cuivre	51	1 PPM	HF-HNO3-HCLO4-HCL	ABSORPTION ATOMIQUE
990908	3	Co	Cobalt	51	3 PPM	HF-HNO3-HCLO4-HCL	ABSORPTION ATOMIQUE
990908	4	Au	Or - Pyro Analyse	51	1 PPB	PYRO ANALYSE	PYROANALYSE-DCP
990908	5	Pt	Platine	51	5 PPB	PYRO ANALYSE	PYROANALYSE-DCP
990908	6	Pd	Palladium	51	1 PPB	PYRO ANALYSE	PYROANALYSE-DCP
990908	7	S Tot	Soufre (Total)	51	0.02 PCT		LECO

TYPES D'ÉCHANTILLONS	NOMBRE	FRACTION UTILISÉE	NOMBRE	PRÉP. DE L'ÉCHAN.	NOMBRE
ROCHE	51	-150	51	CONCASSER, PULVERISE	51

COPIES DU RAPPORT À: M. JEAN LAFOREST FACTURE À: M. JEAN LAFOREST

****

Ce rapport ne doit être reproduit que dans sa totalité. Les données présentées dans ce rapport sont exprimées sur base sèche sauf indication contraire et ne concernent que les échantillons reçus, identifiés par le numéro d'échantillon.

****

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NUMÉRO DE L'ÉCHANTILLON	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
QB4501		3071	1298	669	4	<5	10	10.36
QB4502		1766	1041	456	4	<5	2	6.86
QB4503		3661	1076	787	7	<5	13	11.50
QB4504		5867	9306	985	20	<5	18	19.47
QB4505		4286	1485	859	5	<5	10	14.16
QB4506		4144	1102	1008	3	<5	17	15.68
QB4507		2217	1225	453	3	<5	9	6.34
QB4508		3217	1327	756	6	<5	14	12.07
QB4509		1863	1311	456	6	<5	9	7.23
QB4510		1333	600	312	3	<5	3	4.98
QB4511		3496	1533	717	14	<5	8	11.82
QB4512		1115	1057	278	4	<5	2	3.32
QB4513		2291	3834	428	5	<5	10	7.28
QB4514		37	282	7	7	<5	6	0.83
QB4515		201	611	39	15	<5	11	6.18
QB4516		370	735	66	5	<5	17	11.49
QB4517		181	918	62	37	<5	14	9.93
QB4518		293	1350	70	16	<5	77	18.39
QB4519		443	440	99	11	<5	3	28.48
QB4520		173	810	25	4	<5	3	8.98
QB4521		188	1643	54	6	<5	5	6.85
QB4522		180	481	72	<1	<5	6	5.59
QB4523		2578	861	562	<1	<5	7	6.95
QB4524		1310	562	322	2	7	9	4.50
QB4525		1316	976	351	2	17	11	3.55
QB4526		1457	681	298	5	<5	7	3.94
QB4527		1494	1652	358	1	<5	3	4.97
QB4528		169	315	65	<1	<5	3	3.02
QB5004		181	175	57	<1	<5	3	0.52
QB5005		1567	1249	339	2	<5	8	3.72
QB5006		216	745	41	5	<5	11	8.18
QB5007		214	588	48	5	<5	10	7.27
QB5008		33	577	40	2	<5	2	1.56
QB5009		101	402	7	<1	<5	7	11.00
QB5010		2827	1563	147	160	199	328	1.06
QB5011		1925	1942	101	550	172	305	1.13
QB5012		60	99	17	2	<5	11	1.67

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NUMÉRO DE L'ÉCHANTILLON	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
QB5345		125	277	45	<1	<5	8	0.93
QB5346		3730	1552	889	3	<5	19	12.62
QB5347		2754	2831	605	6	<5	8	8.91
QB5348		3071	1375	768	4	<5	14	11.46
QB5349		1538	797	362	2	61	5	5.60
QB5350		3688	1647	967	2	<5	10	14.73

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# MESURE STANDARD	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
BLANC		<1	<1	<3	<1	<5	<1	-
BLANC		<1	<1	<3	<1	<5	<1	-
BLANC		-	-	-	<1	<5	<1	-
Nombre d'analyses		2	2	2	3	3	3	-
Valeur de moyenne		0.5	0.5	1.5	0.5	2.5	0.5	-
Écart-type		0.00	0.00	0.00	0.00	0.00	0.00	-
Valeur acceptee		1	1	1	5	5	5	<0.01
STANDARD DCP		-	-	-	80	80	78	-
STANDARD DCP		-	-	-	78	83	79	-
Nombre d'analyses		-	-	-	2	2	2	-
Valeur de moyenne		-	-	-	79.0	81.5	78.5	-
Écart-type		-	-	-	1.41	2.12	0.71	-
Valeur acceptee		-	-	-	83	83	83	-
STD GEOCHIMIQUE 5		44	110	18	-	-	-	-
Nombre d'analyses		1	1	1	-	-	-	-
Valeur de moyenne		44.4	110.1	17.6	-	-	-	-
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		40	102	18	-	-	-	-
CANMET Certified Std		-	-	-	-	-	-	8.31
Nombre d'analyses		-	-	-	-	-	-	1
Valeur de moyenne		-	-	-	-	-	-	8.310
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		-	-	-	-	-	-	8.23
WPR-1		-	-	-	36	268	220	-
Nombre d'analyses		-	-	-	1	1	1	-
Valeur de moyenne		-	-	-	36.0	268.3	220.0	-
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		-	-	-	42	285	235	-
STD GEOCHIMIQUE 6		147	147	33	-	-	-	-
Nombre d'analyses		1	1	1	-	-	-	-
Valeur de moyenne		146.8	146.8	32.7	-	-	-	-
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		150	148	38	-	-	-	-

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# MESURE STANDARD	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
CANMET CERTIFIED STD		-	-	-	-	-	-	12.78
Nombre d'analyses		-	-	-	-	-	-	1
Valeur de moyenne		-	-	-	-	-	-	12.780
Écart-type		-	-	-	-	-	-	-
Valeur acceptee		-	-	-	-	-	-	12.70

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NUMÉRO DE L'ÉCHANTILLON	ÉLÉMENT UNITÉS	Ni PPM	Cu PPM	Co PPM	Au PPB	Pt PPB	Pd PPB	S Tot PCT
QB4501		3071	1298	669	4	<5	10	10.36
Duplicata		3011	1291	641	7	<5	11	10.63
QB4510		1333	600	312	3	<5	3	4.98
Duplicata								5.12
QB4515		201	611	39	15	<5	11	6.18
Duplicata								6.08
QB4516		370	735	66	5	<5	17	11.49
Prep Duplicata		345	709	60	4	<5	22	10.97
QB4519		443	440	99	11	<5	3	28.48
Duplicata		443	437	103				
QB4520		173	810	25	4	<5	3	8.98
Duplicata								8.96
QB4523		2578	861	562	<1	<5	7	6.95
Duplicata					1	<5	14	
QB4525		1316	976	351	2	17	11	3.55
Duplicata								3.56
QB5002		3587	4326	683	18	<5	17	12.08
Duplicata								12.58
QB5006		216	745	41	5	<5	11	8.18
Duplicata								8.23
QB5010		2827	1563	147	160	199	328	1.06
Duplicata		2862	1570	141				
QB5341		273	1045	100	3	1656	20	1.20
Duplicata								1.19
QB5343		3866	2082	998	23	<5	48	17.17
Duplicata					29	<5	45	
QB5346		3730	1552	889	3	<5	19	12.62
Duplicata								12.53

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APPENDIX C

GEOLOGY AND GEOPHYSICS MAPS

FALCONBRIDGE LIMITED

APPENDIX D

T.H.E.M. HELICOPTER-BORNE EM AND MAG REPORT

CGI CONTROLLED GEOPHYSICS INC.

CGI
Controlled
Geophysics
Inc.

10 Years of Excellence in
Exploration Geophysics

189 Clark Avenue East, Thornhill, Ontario CANADA L3T 1T3
Tel: (905) 881-2059 Fax: (905) 881-9517 E-mail: cgi@visionol.net

A T.H.E.M. HELICOPTER-BORNE EM AND MAGNETIC SURVEY OVER THE RELAIS GABRIEL AND FORGUES PROJECT AREAS, QUEBEC FOR FALCONBRIDGE LIMITED

Distribution:
3 - Falconbridge Limited - Laval, Quebec, CANADA
1 - CGI Controlled Geophysics Inc. - Thornhill, Ontario, CANADA

CGI File: 6165
July, 1999

EXECUTIVE SUMMARY

During the period November 8, 1998 to April 22, 1999 a helicopter-borne magnetic and T.H.E.M. electromagnetic survey was carried out by T.H.E.M. Geophysics Inc. for Falconbridge Limited over the Relais Gabriel and Forgues Project areas centred approximately 75 km east of Lac Manicouagan in Northern Quebec. CGI Controlled Geophysics Inc. of Thornhill, Ontario, CANADA, carried out data processing and presentation.

The objectives of the survey were to map in detail the magnetic and electromagnetic responses to obtain an improved geological interpretation, to identify targets of potential economic value, and to relate the new information to that obtained from prior exploration information acquired in the same area. Including tie lines, a total of approximately 2,995 line kilometres were flown in Relais Gabriel and approximately 151 line kilometres were flown in Forgues.

Flight path recovery was by means of real-time corrected GPS sampled at a minimum of once per second. Helicopter radar altimeter and GPS altitude were also recorded. The geophysical parameters measured during flight were total magnetic field at 10 samples per second (approximately every 3 metres along track) and electromagnetic channels representing the T.H.E.M. transient response from both X-axis and Z-axis receiver coils at 10 samples per second (approximately every 3 metres along track). Data compilation included flight path recovery, electromagnetic data processing, calculation of first vertical magnetic derivative, and preparation and plotting of all map products.

Maps of selected processed T.H.E.M. channels and preliminary anomaly picks were plotted in plan profile format to show all conductive responses in the survey areas. For Relais Gabriel, a map of *OUTPUT* Time Constant was prepared to show the time constants and location of conductors in the areas. The total magnetic field and the computed magnetic first vertical derivative were presented as contoured colour images. Map scales of 1:50,000 for Relais Gabriel and 1:20,000 for Forgues were employed.

This report presents a logistical account of the survey and describes the products produced. A detailed program of ground geophysics is recommended to pinpoint targets before drilling, especially in areas where complex structures appear to be present and conductor axes were not uniquely resolvable.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND

This report describes the execution and results of a helicopter-borne Time Domain EM and magnetic survey carried out during the period November 8, 1998 to April 22, 1999 by T.H.E.M. Geophysics Inc. for Falconbridge Limited. The survey was flown over the Relais Gabriel and Forgues Project areas, both located approximately 75 km east of Lac Manicouagan in Northern Quebec. CGI Controlled Geophysics Inc. of Thornhill, Ontario, CANADA, carried out data processing and presentation.

The survey instrumentation and layout were chosen to maximize the ability to detect buried conductors of potential economic value and to use the electromagnetic data in a mapping mode to compliment the magnetic data mapping abilities. The EM mapping is achieved by examining the conductivity distribution in the area as maps of apparent time constant as derived from the *OUTPUT* processing technique developed by CGI.

T.H.E.M. Geophysics Inc. was responsible for data acquisition, flight path recovery and field processing of the electromagnetic raw data. The electromagnetic data were processed and presented by CGI Controlled Geophysics Inc., who were also responsible for magnetic levelling, calculation of first magnetic vertical derivative and preparation of contoured colour image maps of both magnetic products.

This report presents the logistics of the survey and descriptions of the supporting map products.

2. SURVEY AREA DESCRIPTION

The survey area is centred approximately 75 km east of Lac Manicouagan in Northern Quebec (See Figure 1), and is encompassed within the following geographic co-ordinates:

Relais Gabriel		**Forgues**	
Longitude	Latitude	Longitude	Latitude
-66.89695° W	51.5352° N	-67.6309° W	51.5947° N
-67.389° W	51.7596° N	-67.5334° W	51.6556° N

The co-ordinates used on the maps are expressed in metres north of the Equator and east of a false easting located 500,000 metres west of 69° W longitude for the local UTM grid Zone 19 using North American Datum 1927. The UTM limits enclosing the project are:

Relais Gabriel		**Forgues**	
Easting	Northing	Easting	Northing
611,610 m E	5,710,537 m N	594,710 m E	5,716,671 m N
647,221 m E	5,735,747 m N	601,506 m E	5,723,473 m N

Topographic relief is generally on the order of 250 metres in Forgues and Gabriel. In addition, the eastern portion of Relais Gabriel block includes a large severe 300 m escarpment along Riviere Sainte-Marguerite. The survey lines were terminated along the cliff to maintain optimal terrain clearance on each side of the river. Cultural sources are minimal.

3. FIELD WORK

3.1 Survey Specifications

The survey specifications were set based on a detailed knowledge of the T.H.E.M. system, the project objectives, and some *a priori* knowledge of the regional geological setting.

The nominal line spacing of 200 metres and line direction of N 45°/225 ° E for Relais Gabriel and N 150°/330° E for Forgues were chosen to map the blocks in sufficient detail to resolve the anticipated structures. A series of tie-lines were flown orthogonal to the primary survey direction and/or along the survey boundaries. The nominal flying terrain clearance was approximately 82 m for the helicopter.

The T.H.E.M. system configuration entails a rigid 11 m diameter, vertical axis, circular transmitter loop suspended beneath the helicopter. A two-axis (X and Z) receiver coil system are towed behind the receiver coil within an inflated neutrally buoyant blimp. The transmitter and receiver coils are both approximately 35 m above the ground.

3.2 Survey Operations

The survey was completed in four separate phases in the period from November 10th, 1998 through April 22nd, 1999. Crew included one helicopter pilot and one engineer, one party chief (Bernard Kremer), one electronics engineer, one technician, and one geophysicist.

4. DATA COMPILATION, PROCESSING, AND PRESENTATION

The following covers the preparation and presentation of the products. Each product has been presented on one map sheet at a scale of 1:20,000 for Forgues and one map sheet at a scale of 1:50,000 for Relais Gabriel. Some products have a digital topographic base prepared from 1:50,000 scale NTS topographic maps.

4.1 Flight Path

The flight path recovery was carried out by the T.H.E.M. using a real-time differentially corrected Global Positioning System (GPS) system. The final flight path has been presented on a digital topographic base. Each line is labelled and annotated with fiducial ticks every 100 fids (10 seconds) and fiducial labels every 1000 fids (approximately 100 seconds). The direction of traverse is indicated by arrows at the beginning and end of each line. On all maps, a UTM registration grid has been plotted using 10,000 m intervals.

4.2 Total Magnetic Field

The total magnetic field measured during the survey was edited for spikes and levelled by Controlled Geophysics. The total magnetic field was then minimum curvature gridded with a 50 m cell size and contoured at 5 nT (gamma) intervals. Data are presented as black-line contours on a coloured image with flight path. A Geosoft format total magnetic field grid has been supplied.

4.3 Magnetic Vertical Gradient

The magnetic first vertical derivative (or gradient) operator serves to accentuate shallow magnetic sources and magnetically defined contacts, and to more clearly resolve closely spaced anomalies. The magnetic first vertical derivative 0 nT/metre contour defines contacts between more susceptible rocks (having positive vertical gradients) and less susceptible rocks (having negative vertical gradients).

The first vertical derivative of the total magnetic field was calculated from the total magnetic field data and then 50 m cell minimum curvature gridded and black-line contoured at 0.02 nT/metre intervals. Maps are presented as black-line contours over a coloured imaged. A Geosoft format magnetic first vertical derivative grid has been supplied.

4.4 Electromagnetic Data

The T.H.E.M. data were compiled and processed at Controlled Geophysics. The data needed to be processed to remove noise from known non-geological sources. This section describes each of these procedures.

Figure 2 presents the principles of operation of the T.H.E.M. system. When a conductor is nearby, the receiver measures a transient waveform produced by the decay of the induced secondary field from that conductor. During flight, a set of channel amplitudes measured in a number of time slices through the transient are plotted vs time on analogue chart records. The amplitude of the response grows as the aircraft approaches the conductor and returns to zero or background levels as the aircraft departs. The detailed manner in which the amplitudes vary in the interim (including possible zero crossovers and nulls) provide source type and geometry information. In the T.H.E.M. system, a set of channel amplitudes are recorded ten times per second corresponding to roughly one transient every 3 metres.

In the T.H.E.M. receiver a programmable number of channels are available to represent the transient waveform. Fifteen of these are positioned at intervals throughout the off-time (the period following the transmitter pulse) to obtain a close representation of the transient waveform. The other channels are used to monitor the T.H.E.M. response during the pulse. Additional channels record the primary field at the towed bird and the power line noise. The channel positions measured after the end of the primary pulse are:

- 0.26ms
- 0.39ms
- 0.52ms
- 0.65ms
- 0.78ms
- 1.04ms
- 1.30ms
- 1.56ms
- 1.82ms
- 2.34ms
- 2.86ms
- 3.39ms
- 3.91ms
- 4.95ms
- 5.99ms
- 8.07ms

The T.H.E.M. data were loaded into Geosoft oasis montaj and all processing was carried out. Channel levelling errors due to system drift were trapped and adjusted.

The selection and presentation of EM intercepts was carried out by C. Vaughan. The full suite of off-time channel amplitudes for the Z and X receiver coils were displayed simultaneously in montaj. EM responses exhibiting amplitude above the noise levels and a genuine transient nature were flagged and rated from one to eight, where eight is best quality. It was not necessary for anomalies to appear in both coils simultaneously, however, those that did were considered to have higher confidence.

The EM picks were presented in plan form as colour-coded circles superimposed upon the processed T.H.E.M. Z-coil 0.26 millisecond delay time channel plotted in plan profile at 2 units/mm vertical scale. The flight path and digital topography were also included to facilitate correlation from line to line and to terrain features.

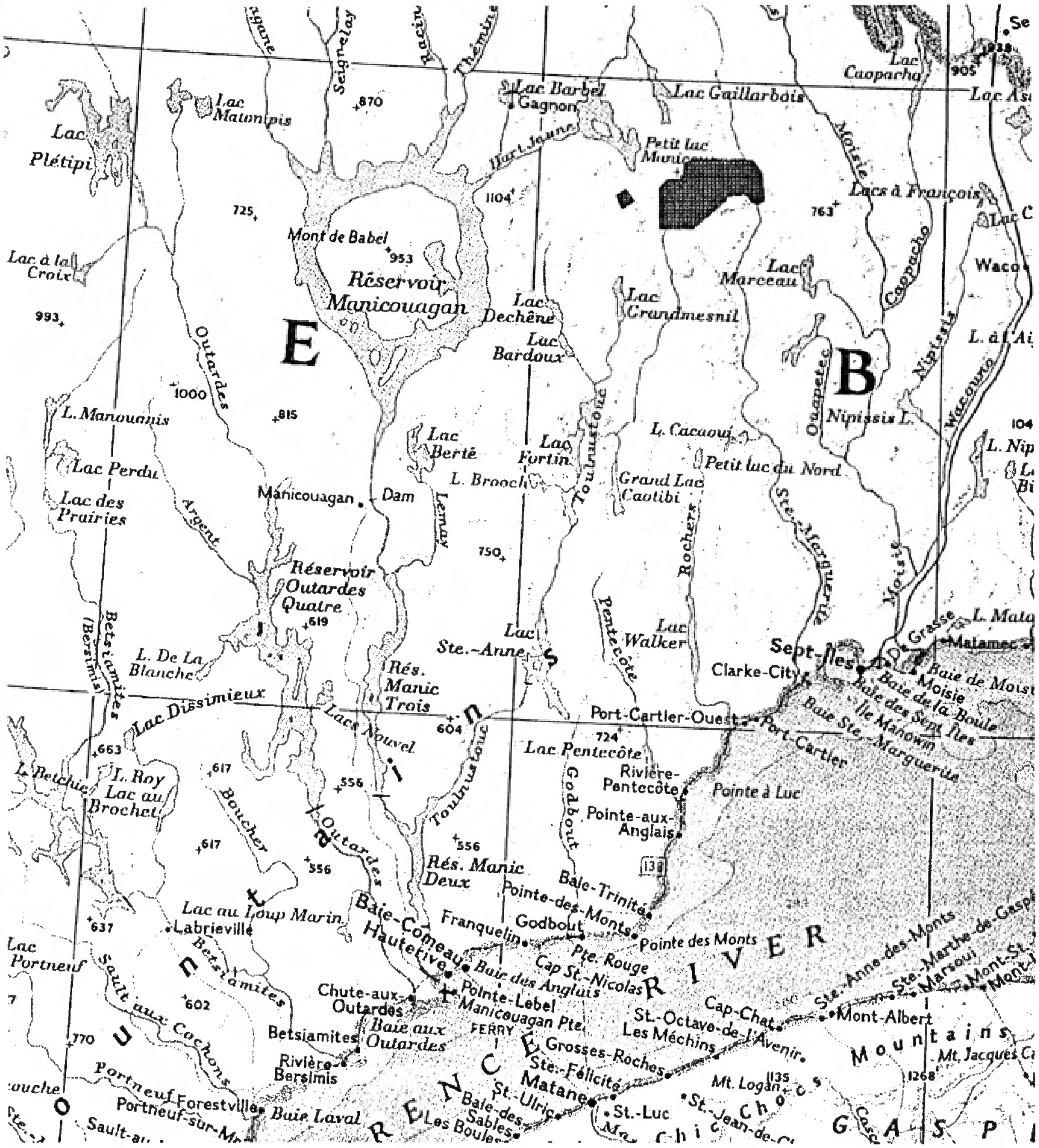
4.5 Data Archiving

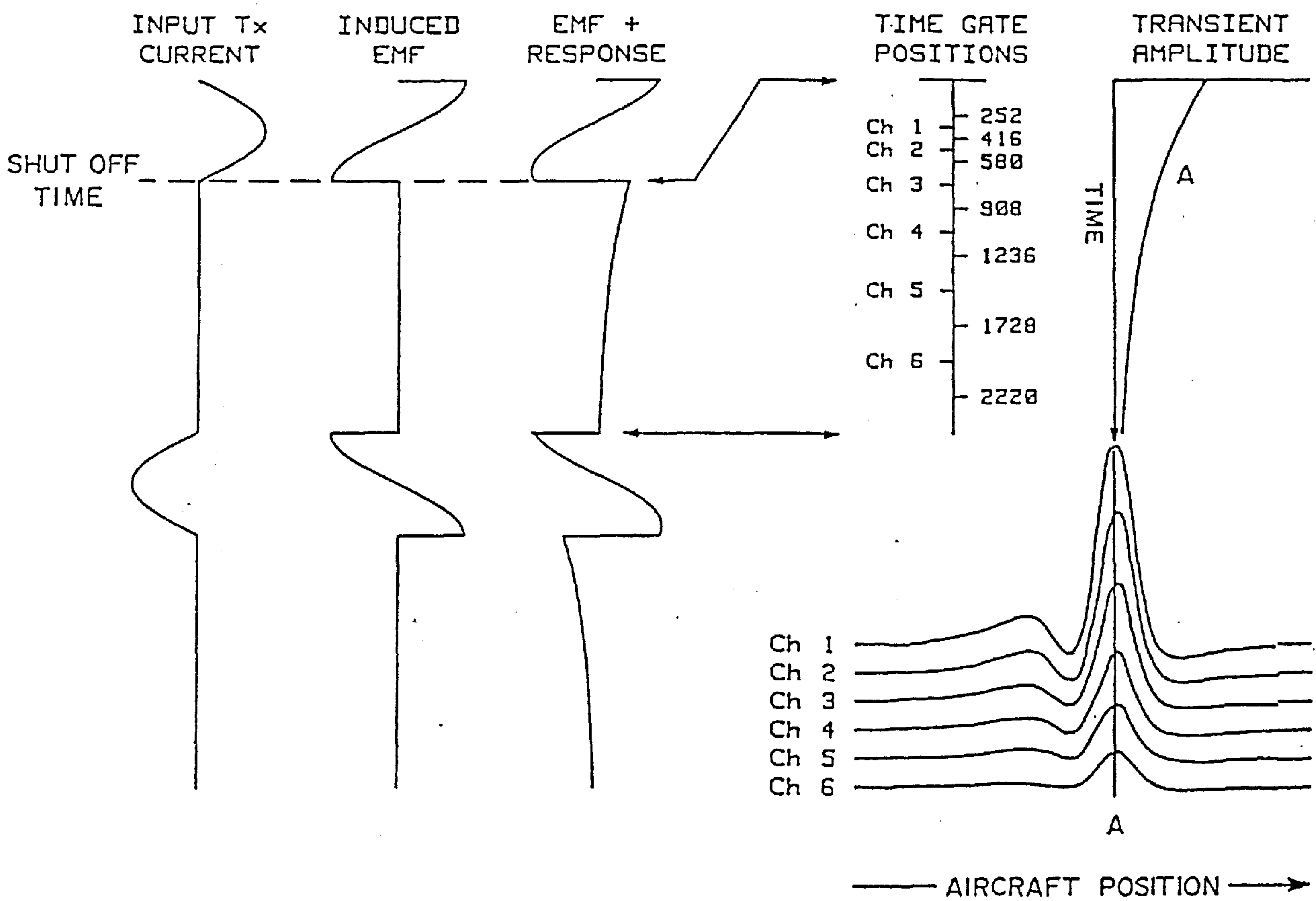
The final located line data have been archived in Geosoft format grids and profile data.

Respectfully submitted,
CGI *Controlled* Geophysics Inc.

Chris Vaughan
Chief Geophysicist

Figure 1 - Survey Area Location Map





Fugure 2 - T.H.E.M. System Principles of Operation

APPENDIX E

RAPPORT SUR LEVÉ EXPÉRIMENTAL T.H.E.M.

MICHEL ALLARD

RAPPORT SUR DES LEVÉS MAGNÉTIQUE ET ÉLECTROMAGNÉTIQUE HÉLIPORTÉS

Effectués dans la région des monts Groulx

Par T.H.E.M géophysique

Pour Falconbridge inc.

soumis au

MINISTÈRE DES RESSOURCES NATURELLES DU QUÉBEC.

mai 1999

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1. INTRODUCTION

Dans le cadre d'un projet d'exploration stratégique, la compagnie Falconbridge Inc. a mandaté T.H.E.M géophysique pour réaliser des levés magnétique et électromagnétique héliportés expérimentaux dans la région des monts Groulx. Cette région est située tout juste à l'est du réservoir Manicouagan.

Le levé s'est effectué dans trois secteurs, le secteur de Forgues, la zone 1 et la zone 2, entre les mois de novembre 1998 et avril 1999.

L'objectif du levé était double. Premièrement, il cherchait à vérifier l'efficacité d'un nouvel appareillage dont le concept est unique et deuxièmement, il visait à déceler des zones anomales qui pourraient indiquer la présence d'une minéralisation conductrice riche en nickel.

Le présent rapport décrit la technique utilisée, discute des résultats obtenus et finalement formule certaines recommandations quant à la poursuite du programme de développement du système utilisé par T.H.E.M.

2. LOCALISATION ET ACCÈS AU SECTEUR PROSPECTÉ

La région à l'étude se trouve à l'est du réservoir Manicouagan à envrion trois heures de route au nord de Baie-Comeau. Elle couvre une bonne partie des Monts Groulx. (figure 1).

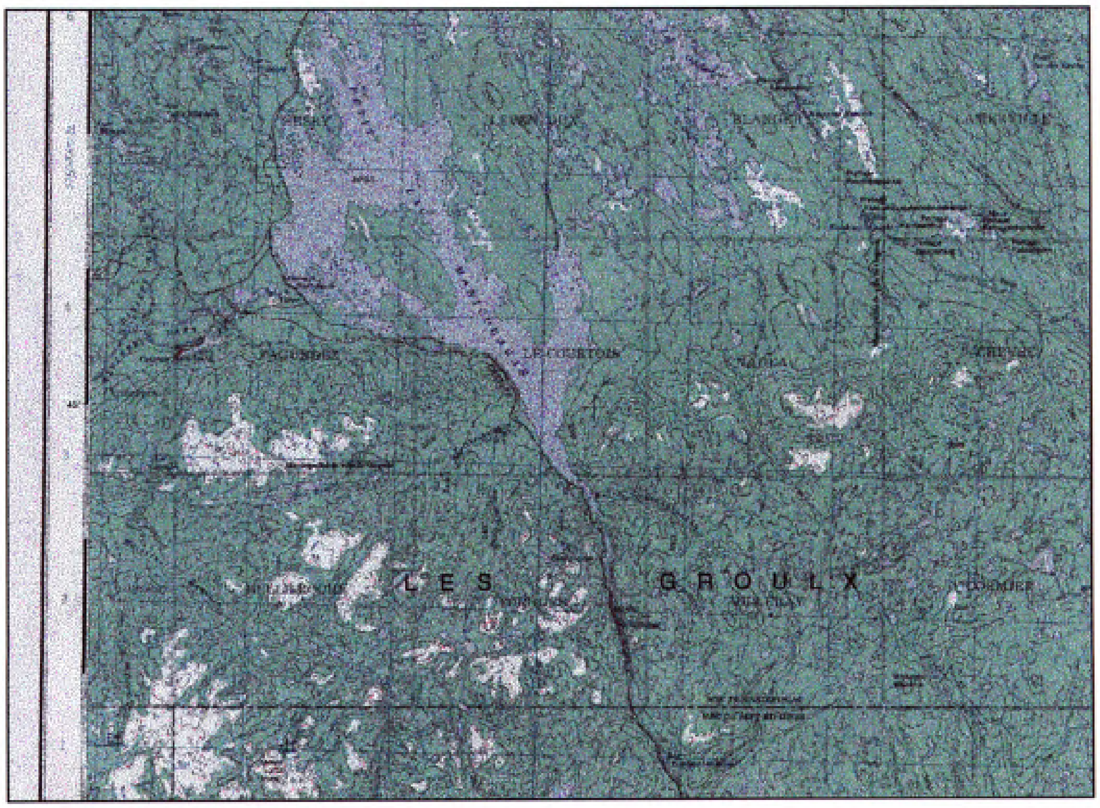


Figure 1 : Localisation générale

3. DESCRIPTION DE LA MÉTHODE ET DE L'APPAREILLAGE

3.1. Description de la méthode

Le système utilisé par T.H.E.M. fait partie des méthodes de prospection aérienne qui utilisent une boucle émettrice et des bobines réceptrices séparées par une grande distance pour mesurer la réponse transitoire du sol après une impulsion électromagnétique (figure 2). Dans ce sens, il fait partie de la même famille que les systèmes GEOTEM de Geoterrex-Dighem, QUESTEM de World geoscience et SPECTREM de Anglo American Corp.

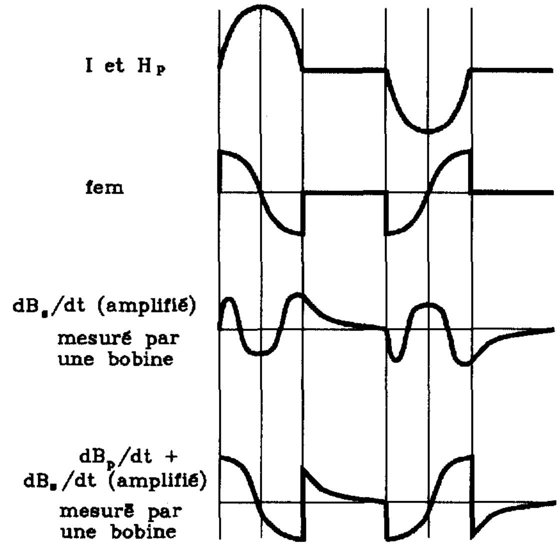


Figure 2 : Courant de l'émetteur, champ primaire reçu, champ secondaire reçu et voltage total mesuré par les bobines.

Toutefois, il diffère de ces trois systèmes par l'utilisation d'un hélicoptère comme plate-forme au lieu d'un avion. De plus, l'usage d'un ballon d'hélium pour porter les bobines réceptrices permet une géométrie qui s'apparente à celle de la configuration moving-loop terrestre (figure 3).

En principe, ces deux différences majeures procurent certains avantages au système T.H.E.M :

- une bobine émettrice plus près du sol pour accroître la puissance effective du champ primaire
- une vitesse plus basse, entre 50 à 60 noeuds (environ 25 m/s ou 90 km/h), ce qui augmente la résolution spatiale du levé;
- des anomalies de formes plus simples à cause de la géométrie horizontale du système;

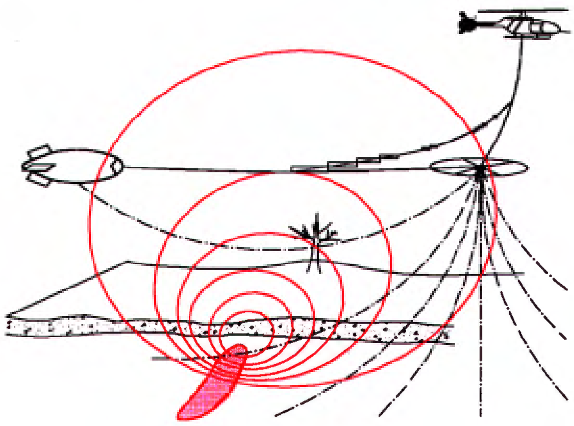


Figure 3 :Représentation schématique du système T.H.E.M.

3.2. Spécifications de l'appareillage utilisé

Lors du levé, la distance entre la boucle et les bobines réceptrices a été maintenue à 65 m. L'hélicoptère volait à une hauteur moyenne de 70 m ce qui place la boucle et les bobines réceptrices à environ 30 m du sol.

Émetteur

- Fréquence fondamentale : 30 Hz
- Largeur de l'impulsion : 2,5 ms
- Moment magnétique : 230 x 10^5 Am^2
- Courant crête : 2500 A
- Diamètre de la boucle : 11 m

Récepteur

- Taux d'échantillonnage : 512 par demi-cycle ou 30,72 kHz ou encore 1 échantillon tout les 32µs.
- Convertisseur A/D : 16 bits sur 4 voies simultanément.
- Composantes mesurées : dBz/dt (verticale) et dBx/dt (horizontale le long de la ligne de vol)
- Durée du temps mort : 14,1 ms

En plus de l'appareillage servant au levé EM, un magnétomètre de vol et un autre fixe au sol pour mesurer les variations diurnes, un système de navigation et de positionnement GPS qui corrige en temps réel et un altimètre complétaient l'instrumentation.

4. SOURCES DE BRUIT

Lors de l'évaluation de l'efficacité d'un système géophysique, on se réfère habituellement à la notion de signal/bruit. Cette notion est cependant très relative. On utilise souvent le rapport entre le niveau de l'enveloppe de bruit divisé par l'amplitude du champ primaire mesuré par les capteurs. Ce signal/bruit dépend évidemment de la configuration géométrique du système, de l'activité géomagnétique, du filtrage etc. Ce rapport ne peut donc être utile que pour comparer le comportement d'un même système d'une journée à l'autre.

Pour juger de l'efficacité des différents systèmes, il faudrait plutôt comparer les réponses, c'est-à-dire les signaux, obtenues au dessus d'une même cible par rapport au bruit de fond.

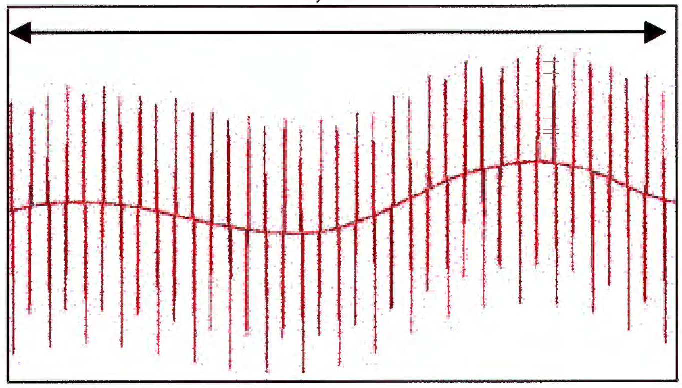
En ce qui concerne le système T.H.E.M., il est assez difficile pour le moment d'en estimer le niveau réel de signal/bruit tant que les routines de traitement de données n'auront pas été mises au point.

4.1. Bruit lié au mouvement des capteurs dans le champ magnétique terrestre.

Comme pour tous les systèmes électromagnétiques, le mouvement des capteurs dans le champ magnétique terrestre produit un signal parasite qui peut être de relativement grande amplitude. Les bobines mesurent ce signal quand le flux magnétique qui les traverse varie en fonction du temps. La tendance actuelle de diminuer la fréquence fondamentale d'opération de 125 Hz à 75 Hz puis à 30 Hz et même à 15 Hz aggrave le problème. Généralement l'amplitude de ce type de bruit surpasse celui des signaux provenant du sol. On observe ce phénomène lorsque :

- le ballon (et les bobines) tournent par rapport à la direction du champ magnétique;
- le ballon (et les bobines) bougent et vibrent dans le vent et dans la turbulence de l'hélicoptère;
- l'hélicoptère change de vitesse, par exemple en montant et en descendant;
- la tension dans le câble n'est pas constante provoquant des à-coups sur le ballon;
- l'amplitude et la direction du champ magnétique changent à cause d'anomalies magnétiques locales.

Les deux exemples suivants (figure 4) montrent comment ce bruit se superpose au signal. Dans le premier cas, le mouvement du ballon crée une ondulation de fréquences beaucoup plus basses que celles du signal recherché. Dans le deuxième cas, l'oscillation est plus rapide et donc plus difficile à filtrer sans affecter aussi le signal.



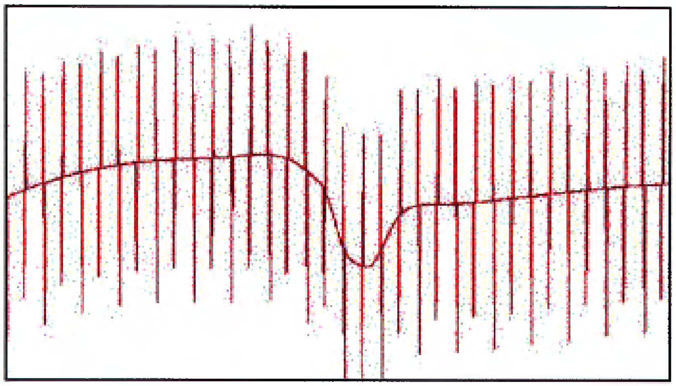


Figure 4 : Bruit dû au mouvement du ballon

À cause de l'utilisation d'un ballon plus léger que l'air, le système développé par T.H.E.M est plus sensible que les autres systèmes AEM à ce type de bruit. Pour le réduire, T.H.E.M

- a conçu un ballon le plus stable possible. Toutefois, les variations de pressions à l'intérieur du ballon en fonction de la température et surtout de l'altitude causent encore certains problèmes qui peuvent affecter la stabilité du vol. Ainsi, à plusieurs reprises, le ballon ou les ailerons ont crevé lors des vols au-dessus des sommets des monts Groulx sous l'effet du froid et de l'augmentation de pression.

- doit effectuer les vols que les jours ou durant les périodes de la journée où les conditions météorologiques sont relativement calmes.

- a confectionné un système d'amortissement pour les bobines en vue de minimiser les vibrations de hautes fréquences, au-dessus de 30 Hz, la fréquence d'opération du système. Le perfectionnement du système d'amortissement a continuellement évolué au cours des intermissions entre les périodes de levé. Un filtre passe-haut peut être ensuite appliqué pour réduire le bruit de basses fréquences qui reste. L'exemple de la figure suivante montre le résultat d'un tel procédé. On voit que l'ondulation n'est pas complètement enlevée. T.H.E.M, travaille présentement à développer et tester d'autres algorithmes qui donneraient un meilleur résultat.

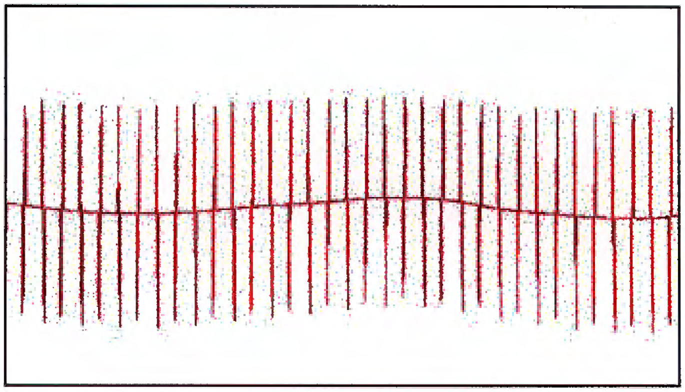


Figure 5 : Atténuation du bruit causé au mouvement du ballon par l'utilisation d'un filtre passe-haut

Enfin, il serait utile de vérifier l'ampleur du bruit causé par le mouvement du ballon lors d'un vol normal en l'absence de champ primaire.

4.2. Bruit lié à la géométrie variable entre l'émetteur-sol-capteurs

En principe, la géométrie entre les trois éléments du système électromagnétique devrait rester constante tout au long du vol, l'émetteur et les capteurs devant se trouver sur un plan parallèle au sol. Si, par exemple, la distance entre le sol et les bobines réceptrices diffère passablement de celle estimée avec l'altimètre de l'hélicoptère ou encore si l'axe de la boucle émettrice s'éloigne de la verticale, les anomalies observées au-dessus des conducteurs auront une signature (amplitude et forme) différente de celle qu'on pourrait s'attendre théoriquement. Il devient alors difficile d'apprécier qualitativement et quantitativement les caractéristiques des conducteurs (pendage, profondeur, etc.). À défaut de bien pouvoir contrôler cette géométrie, une étude théorique pourrait à tout le moins permettre d'en estimer l'importance.

4.3. Bruit lié l'induction dans l'hélicoptère et le reste du système

Dans les systèmes ATEM traditionnels, la boucle émettrice entoure l'avion. Il en résulte de forts courants de Foucault dans l'ensemble de l'avion lesquels induisent un signal dans les bobines réceptrices. Un système de compensation qui tient compte des manoeuvres de l'avion minimise ce bruit. Dans le cas du système de T.H.E.M., la plus grande distance entre la bobine émettrice et l'aéronef réduit la nécessité d'appliquer cette compensation. Des manoeuvres en haute altitude pourraient confirmer la faible amplitude de ce bruit.

4.4. Bruit lié aux ondes électromagnétiques de très basses fréquences (VLF)

Dans la région étudiée, l'intensité des ondes de la station VLF-NAA qui émet à la fréquence 24 kHz à partir de Culter au Maine, est suffisamment forte pour qu'elles puissent être enregistrées comme un bruit de fond par les capteurs. Ce bruit de fond apparaît sur les enregistrements des données comme un faible signal à environ 6000 Hz, ce qui correspond à la différence entre la fréquence d'échantillonnage et la fréquence du signal VLF (figure 6). Ce bruit est facilement éliminé par l'utilisation d'un filtre passe-bas et par tout le processus de stacking.

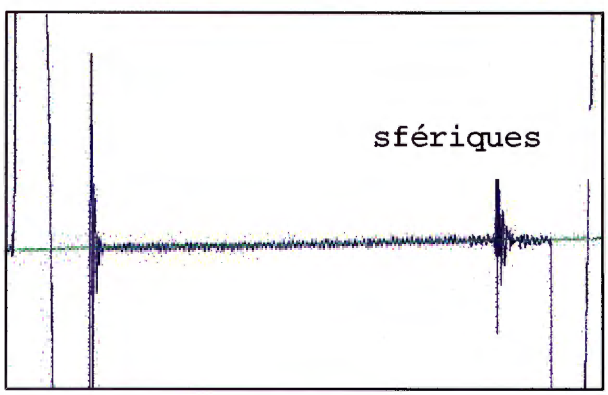


Figure 6 : Bruit causé les ondes VLF et par les sfériques. L'intervalle de temps correspond à un peu plus qu'un demi-cycle.

4.5. Bruit lié aux sphérics

Durant l'hiver, le bruit lié aux sfériques est relativement faible et peut être facilement éliminé. La figure 6 en montre quand même un exemple typique tel qu'on peut le voir sur un enregistrement des données brutes.

5. TRAVAUX EFFECTUÉS

Trois secteurs ont été couverts par le présent levé : la zone de Forgues, la zone 1 et la zone 2. Sauf pour quelques profils au 100 m au-dessus de l'indice connu sur la zone de Forgues, la distance entre les profils a été de 200 m. Au total, 170 km ont été levés sur la zone de Forgues, 1580 sur la zone 1 et 1424 km sur la zone 2 incluant les lignes de rattache.

Les données magnétométriques ont été corrigées pour les variations diurnes sauf pour une journée (22-3-99) où le magnétomètre de base est tombé en panne. La carte de la figure 9 montre une image couleur en relief ombré du champ total corrigé des zones 1 et 2.

En vue d'effectuer une interprétation rapide sur le terrain, les données brutes ont été post-traitées sommairement en utilisant un programme fourni par T.H.E.M. Ce programme applique d'abord un filtre passe-bas pour éliminer les sfériques et les ondes VLF, puis applique un filtre passe-haut pour minimiser l'effet du mouvement du ballon, ensuite effectue des moyennes mobiles de 60 points et 30 points puis regroupe les données en faisant des moyennes sur six cycles (0,1 s ou 2,5m). Finalement les données sont divisées par fenêtres dont la largeur augmente avec le temps. Le tableau suivant liste le temps du centre de ces fenêtres après la fin de l'impulsion.

Fenêtre	Centre(ms)
Ch 1	0,26
Ch 2	0,39
Ch 3	0,52
Ch 4	0,68
Ch 5	0,85
Ch 6	1,04
Ch 7	1,24
Ch 8	1,50
Ch 9	1,76
Ch 10	2,05
Ch 11	2,38
Ch 12	2,78
Ch13	3,19

Tableau 1 : Temps du centre des fenêtres utilisées par rapport à la fin de l'impulsion.

Deux ballons à peu près semblables ont été utilisés lors du levé. La plupart du temps, un ensemble de bobines réceptrices différentes était utilisé avec chaque ballon. Comme les caractéristiques de réponses en fréquences et d'amplification différaient légèrement d'un ensemble à l'autre, une attention particulière devra être portée lors de l'analyse finale des données afin de tenir compte de ces différences.

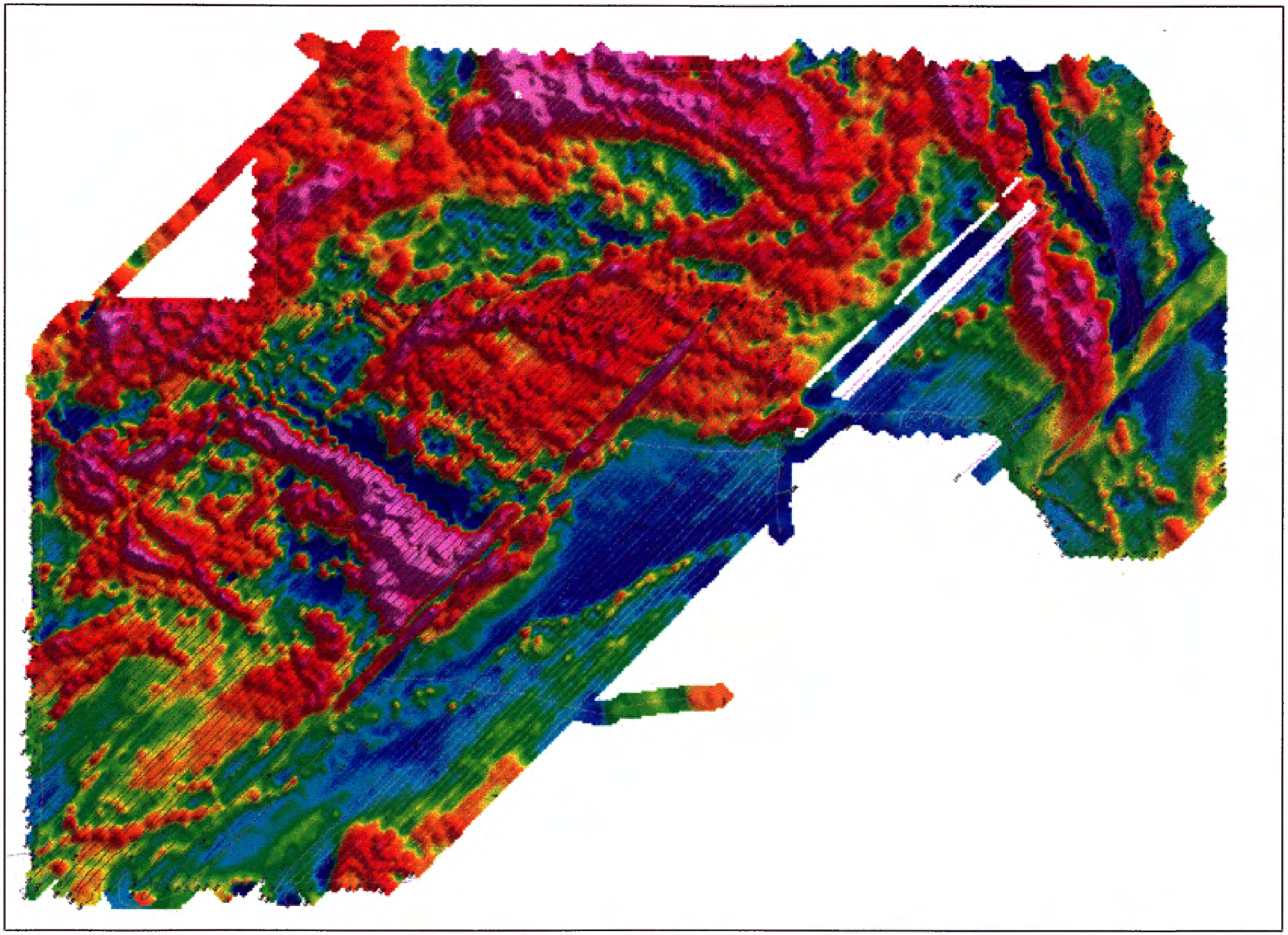


Figure 7 Carte des lignes de vol et du champ magnétique total (préliminaire) des zones 1 et 2

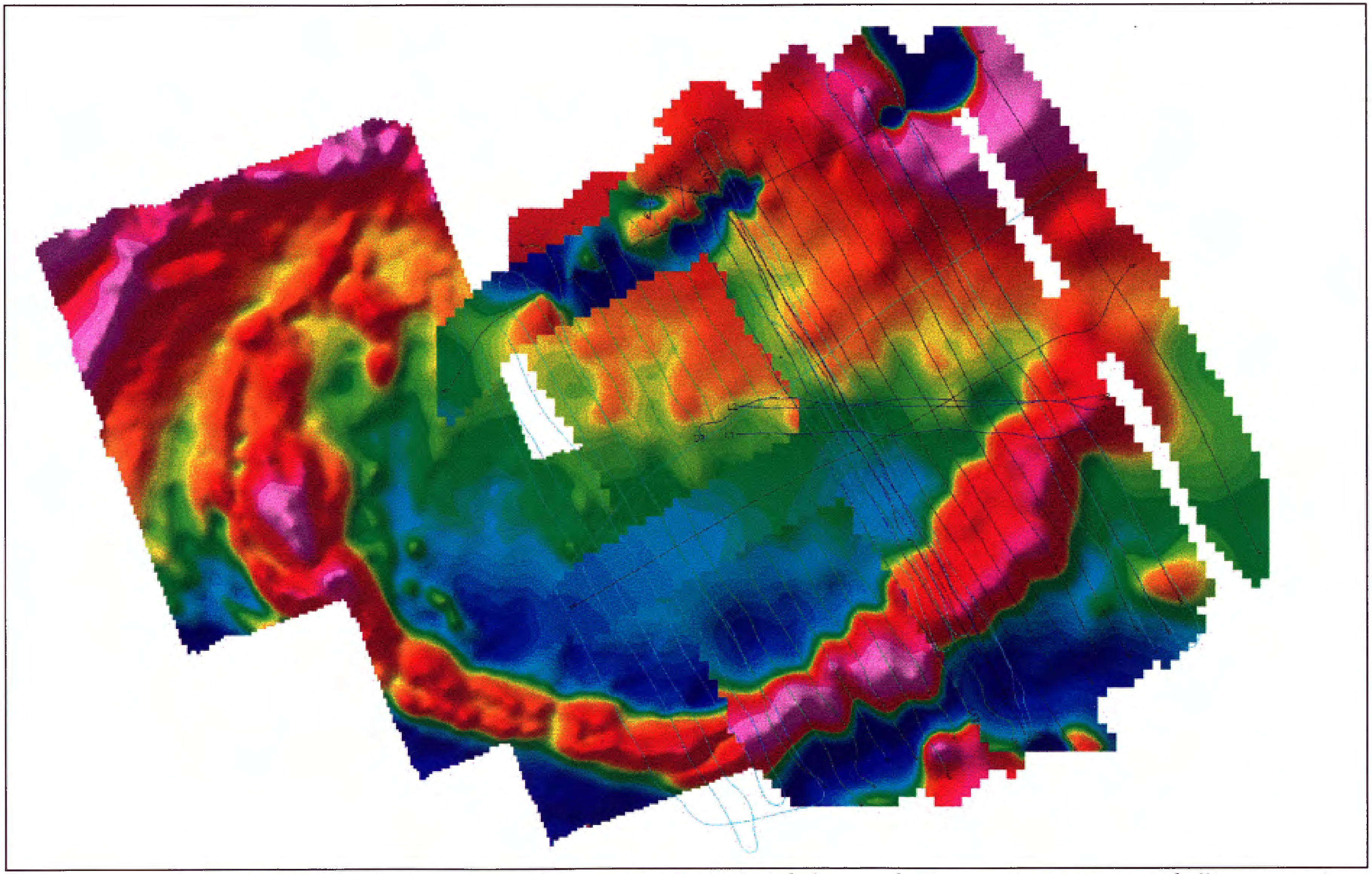


Figure 8 Carte des lignes de vol et du champ magnétique total (préliminaire) de la zone de Forgues, La partie ouest de l'image provient du levé de SIAL en 1996.

6. DISCUSSION DES RÉSULTATS

6.1. Modélisation synthétique

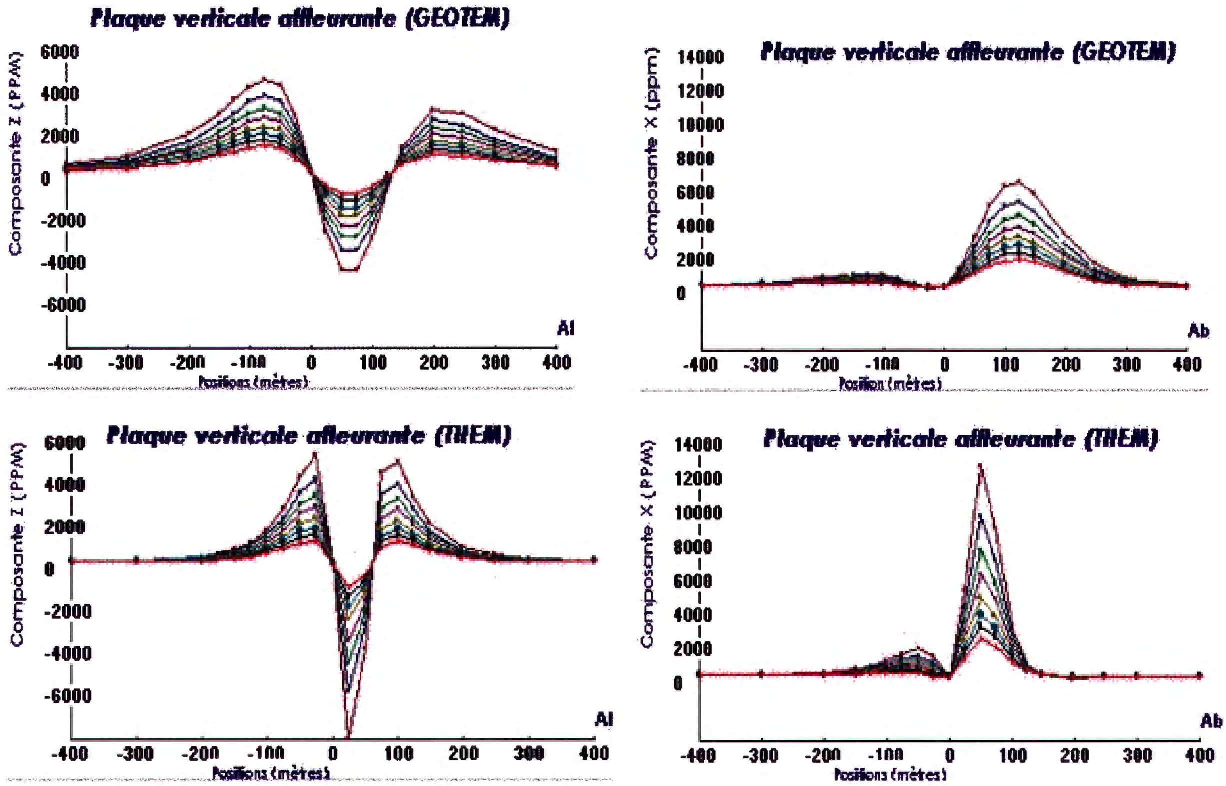
En raison du traitement de signal encore sommaire, les profils ont été interprétés qualitement en recherchant des signatures typiques. Au préalable, il importait de déterminer la forme réelle des anomalies évidemment différentes de celle des anomalies « GEOTEM » en raison de la géométrique différente. Pour ce faire, quelques modèles comparatifs furent calculés parmi lesquels on a choisi de montrer les résultats du modèle d'une plaque verticale mince de 600 m d'extension latérale par 300 m d'extension en profondeur ayant une conductance de 20 mhos (figure 9). Dans un premier cas, le sommet de la plaque affleure et dans le second, le sommet est à 150 m de profondeur. La ligne de vol passe au-dessus du centre de la plaque et l'aéronef se dirige vers la droite. Les valeurs calculées du champ secondaire sont exprimées en PPM du champ primaire et reportées vis-à-vis de la position de l'émetteur. Seul les huit premières fenêtres ont été mises en profils. Le centre de ces fenêtres est 0.31, 0.41, 0.52, 0.62, 0.73, 0.85, 0.99, 1.14 ms.

La géométrie du levé GEOTEM est la suivante :

- Hauteur de l'avion : 105 m
- Séparation horizontal Tx-Rx : 135 m
- Séparation verticale Tx-Rx : 44 m

La géométrie du levé THEM est la suivante

- Hauteur du Tx et Rx : 35 m
- Séparation horizontale Tx-Rx : 60 m



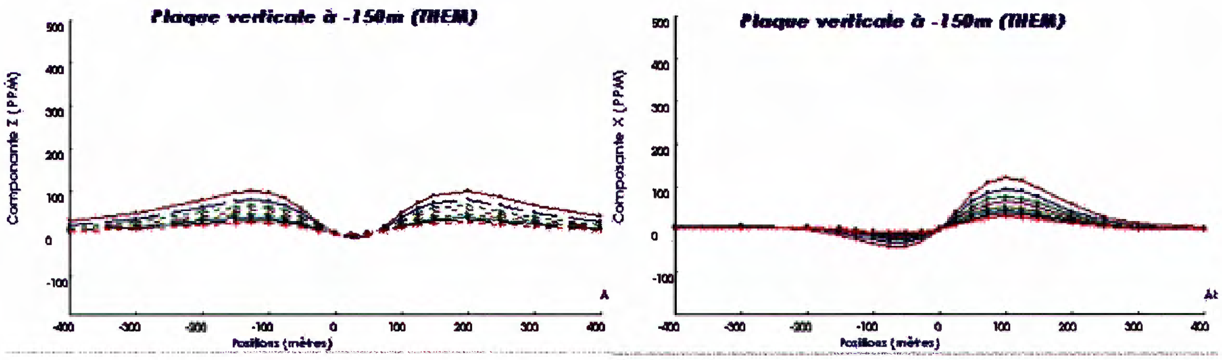


Figure 9 : Anomalies causées par une plaque mince verticale de 300m x 600m de 20 mhos

En observant les profils, on remarque que les principales caractéristiques des anomalies THEM sont les suivantes .

- En général, pour le même corps, la résolution est supérieure avec le système THEM évidemment puisque l'émetteur et le récepteur sont plus près de la surface du sol.
- Sur les profils de la composante Z, les anomalies ont forme symétrique comme celle du MAXMIN, mais contrairement à celle du GEOTEM.
- Sur les profils de la composante Z, les anomalies liées à des sources superficielles ont la forme positive-négative-positive. La partie négative a une largeur équivalente à la distance émetteur-récepteur. Par contre, les anomalies dues à des sources profondes ont une forme positive – zéro – positive. La partie centrale possède en fait une amplitude négative très faible en comparaison aux deux épaules positives.
- Sur les profiles de la composantes X, les anomalies montrent un petit et un gros pic. Le conducteur se trouve entre les deux sur la pente ascendante du plus gros pic.
- En théorie, à 150m de profondeur, la réponse de la plaque est environ deux fois le niveau de bruit moyen noté lors du présent levé.

6.2. Interprétation des anomalies

Sur les enregistrements des données brutes, l'aspect des anomalies ressemble généralement à celui de l'exemple de la figure 10. Sur cette figure, tout juste après l'impulsion, on distingue nettement que les mesures du champ secondaire diffèrent du niveau de base normal. Après un certain temps, ces mesures se rapprochent et se confondent avec ce niveau de base. Encore une fois, par cette figure, on comprend l'importance de bien placer ce niveau de base pour évaluer correctement les anomalies.

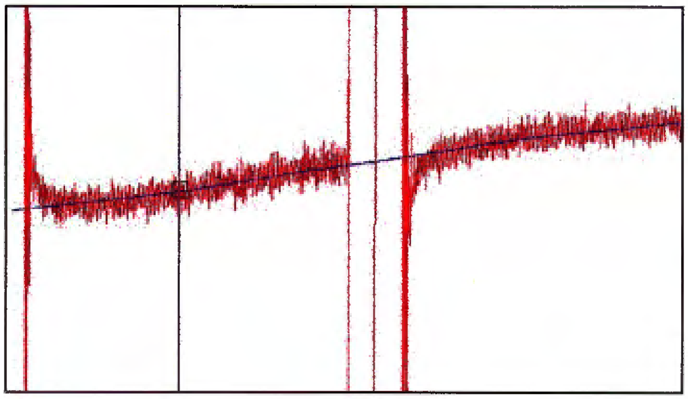


Figure 10 : Anomalie de courte constante de temps observée sur les données brutes d'un cycle.

L'interprétation préliminaire des anomalies s'est accomplie sur chacun des profils par la recherche des patrons typiques définis par la modélisation. On en voit un exemple à la figure 11. L'anomalie de grande amplitude sur la composante X, dans la partie droite du profil fait environ 1400 ppm tandis que la même anomalie sur la composante Z présente une amplitude pic-à-pic de 1000 ppm. Le bruit estimé par l'écart type des variations dans la partie de gauche du profil de la composante Z donne environ 65 ppm.

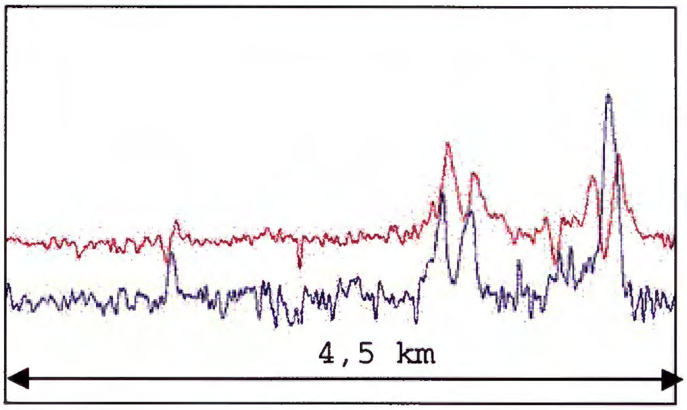


Figure 11 : Anomalies observées dans la première fenêtre des composantes Z(rouge) et X(bleu) sur le profil 12 de la zone de Forgues.

Les anomalies liées aux très bons conducteurs superficiels présentent des formes quasi-théoriques. La figure 12 est un bon exemple d'une anomalie très bien définie. On observe une asymétrie entre les deux épaules ce qui pourrait signifier que la source de l'anomalie est un conducteur ayant un pendage vers la gauche sur le profil.

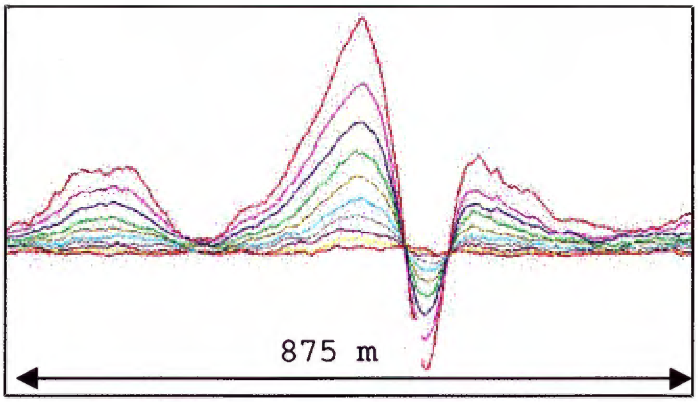


Figure 12 : Anomalies observées avec les 10 premières fenêtres de la composante Z sur le profil 9 de la zone de Forgues. L'amplitude du pic positif maximum de la fenêtre est d'environ 4500 ppm.

6.3. Mesures durant l'impulsion

Il est maintenant reconnu que la détection de très forts conducteurs à l'aide de la mesure du champ secondaire durant le temps mort entre deux impulsions par des capteurs de type bobine (dB/dt) peut s'avérer difficile. On tente plutôt de mesurer leur effet durant l'impulsion avec les mêmes bobines réceptrices ou encore durant le temps mort avec un capteur magnétique (B). La mesure durant l'impulsion ressemble en effet à ce que réalise les systèmes fréquentielles comme le MAXMIN ou le DIGHEM. Pour tous ces systèmes, une contrainte majeure doit être surmontée. Pour isoler le champ secondaire, il faut éliminer le champ primaire. Il n'est possible d'obtenir ou de calculer ce champ que si l'on fixe ou l'on connaît parfaitement la position de l'émetteur par rapport aux bobines réceptrices. Sinon, le seul indice de la présence du champ secondaire que l'on peut mesurer est le déphasage du champ total par rapport au champ primaire seul. Cet effet de déphasage a pu être facilement vérifié en mesurant le signal dans une fenêtre en plein centre de l'impulsion ou normalement le champ primaire est nul, c'est-à-dire qu'il passe par zéro. L'amplitude des valeurs dans cette fenêtre devrait être liée au déphasage et donc à la conductivité des sources. La figure 13 compare les valeurs mesurées au centre de l'impulsion (en rouge) et celle durant le temps mort (fenêtre 3). On remarque généralement une bonne corrélation entre les anomalies. Une analyse plus poussée des différences permettrait probablement de tirer certaines informations complémentaires.

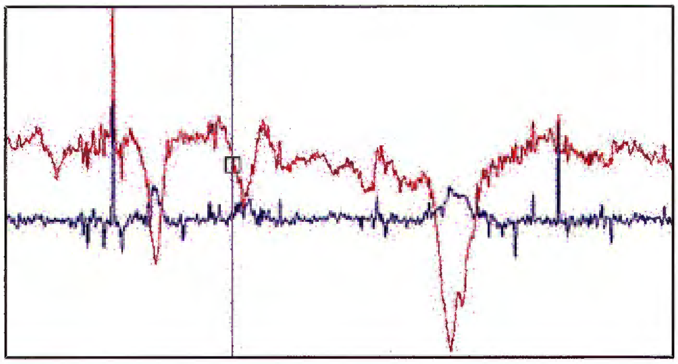


Figure 13 : Mesure dans et après l'impulsion

7. CONCLUSION

Le levé expérimentale TEM héliporté a démontré que la méthode fonctionne relativement bien. La majorité des composantes du système ont fait preuve de fiabilité : l'émetteur, le système d'acquisition et d'enregistrement (malgré quelques pannes), le système de positionnement et les bobines réceptrices. Ainsi plusieurs anomalies ont pu être détectées et méritent une interprétation et évaluation rigoureuse.

Cependant plusieurs détails techniques restent à être améliorés pour que ce succès technique puisse devenir un succès commercial. Par exemple, il faudra améliorer la fiabilité du ballon lors de changement de pression ou de température atmosphérique. On a aussi pu constater la fragilité du matériel du ballon lors de température froide sous les –20°C. Par ailleurs, un traitement des données brutes plus performant permettrait d'accroître le niveau du signal/bruit considérablement. Finalement, en raison même de l'utilisation du ballon d'hélium, la mise en oeuvre des levés sera toujours plus sensible aux conditions atmosphériques que les autres types de levés. Ce désavantage pourra être relativement peu important si la qualité des données traitées (signal/bruit, résolution spatiale et profondeur d'investigation) surpasse celle des autres systèmes.

Respectueusement soumis,

Michel Allard, ing. M.Sc.
Géophysicien

APPENDIX F

GROUND MAGNETOMETER REPORT

MCKEOWN EXPLORATION SERVICES

REPORT ON MAGNETOMETER SURVEY

FOR FALCONBRIDGE LTD.

HAUT PLATEAU PROPERTY

MONTS-GROULX AREA, QUEBEC

AUGUST – SEPTEMBER 2000

MCKEOWN EXPLORATION SERVICES
48 FOXHUNT TRAIL OSHAWA ONTARIO CANADA L1E 1E9
(905) 576-7993 PHONE (905) 576-7339 FAX (416) 706-7040 MOBILE
73711.110@COMPUSERVE.COM

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1 Introduction

On 20 August 2000, a crew was mobilized from Toronto to Falconbridge's Haut Plateau property in the Monts-Groulx area of northern Quebec (200km north of Sept-Iles) to carry out a magnetometer survey over an area of mineralogical interest. The work was done after a GPS survey was carried out on the same property (the results of which are covered in a separate report [1]). The work was carried out by McKeown Exploration Services of Oshawa, Ontario.

2 Background

The Earth's magnetic field (or flux lines) resembles the field of a large bar magnet near it's centre, or the field of a uniformly magnetized sphere (Van Blaricom, 1992). Telford states that "this field is comprised of three parts:

1) The main field which varies relatively slowly and is of internal origin.

2) A small field (compared to the main field), which varies rather rapidly and originates outside the Earth.

3) Spatial variations of the main field, which are usually smaller than the main field, are nearly constant in time and place, and are caused by local magnetic anomalies in the near-surface crust of the earth. These are the targets in magnetic prospecting."

It is believed that the Earth's main field is caused by convection currents of a highly conductive fluid circulating in the liquid outer core (2800 to 5000km depth) (Telford, 1990). The convective motion of the conducting fluid is coupled to the Earth's spin; the Earth's magnetic field has always been roughly along the Earth's spin axis. The intensity of the field (a function of the density of the flux lines) is twice as large in the polar region as in the equatorial region, 60000 nT to 30000 nT respectively.

The small, rapidly changing external field can be attributed to cyclic sunspot activity, solar wind, lunar variations, and magnetic storms, all of which appear to interfere or change electrical currents in the ionized layers of the upper atmosphere.

Local changes in the main field are the result of near-surface variation in the magnetic mineral content of rocks. Such anomalies are typically large enough to double the main field, but do not persist over great distances. The sources of local magnetic anomalies can not be below approximately 40km in depth, roughly the point at which the temperature of the Earth's crust reaches the *Curry point* (550°C), or the temperature at which rocks lose their magnetic properties. (Telford, 1990).

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[1] see "Report on GPS Survey for Falconbridge Ltd., Haut Plateau Property, Monts-Groulx Area, Quebec" McKeown Exploration Services Report, October 2000.

The portable proton magnetometer is capable of measuring the Earth's magnetic field through the use of a proton rich hydrocarbon fluid-filled sensor. The fluid is polarized by passing current through a coil wound around the bottle containing the fluid. A small coil is used to detect and measure the transient voltage build-up and decay caused by the proton precession of the fluid about the Earth's field. The voltage is modulated by the precession frequency, which is proportional to the magnetic field:

$$F = 2\pi v / \gamma_p \qquad \text{(Telford, 1990)}$$

$$\cong 23.487 \text{ +/- } 0.002 \text{ nT/Hz}$$

where:
F = magnetic field
v = precession frequency
γ_p = gyromagnetic ratio of the proton (known quantity)

The Overhauser magnetometer differs from the proton magnetometer in that it's sensor uses a different fluid much richer in protons, and does not employ a polarizing magnetic field, but uses a radio frequency to induce polarization. Readings can be done concurrent to polarization, which allows for very quick readings with higher sensitivity.

Both types of magnetometers employ a portable computer console to control the polarization and record data.

Through the use of two synchronized magnetometers, one recording continuously at a know interval as a base station, and one recording as a mobile unit, the effect of the main field and diurnal variations (see 1 and 2 above) can be removed from the data; any changes in the field can then be attributed to local variations, hopefully those caused by magnetic ore-bodies.

3 Mobilization and Equipment

3.1 Mobilization

On 20 August 2000, a crew was mobilized from Toronto to Falconbridge's Haut Plateau Camp in the Monts-Groulx area of Quebec, approximately 200km north of Sept-Iles.

The camp, located at 51°38'27" N, 067°20'43" W, was at the east end of a small lake in the centre of the grid.

The camp consisted of four "jutland" style tents with seven occupants, including three Falconbridge geologists, a cook, two field workers from Lamontagne Geophysics, and the author. The camp was setup several days prior to the author's arrival. An Aerospatial AS350 was used to sling gear into the camp from a road ~30km west of camp, and was also used to drop off personnel. Food was flown in weekly by helicopter from Sept-Iles. The helicopter was stationed in Sept-Iles and was not used for daily field support.

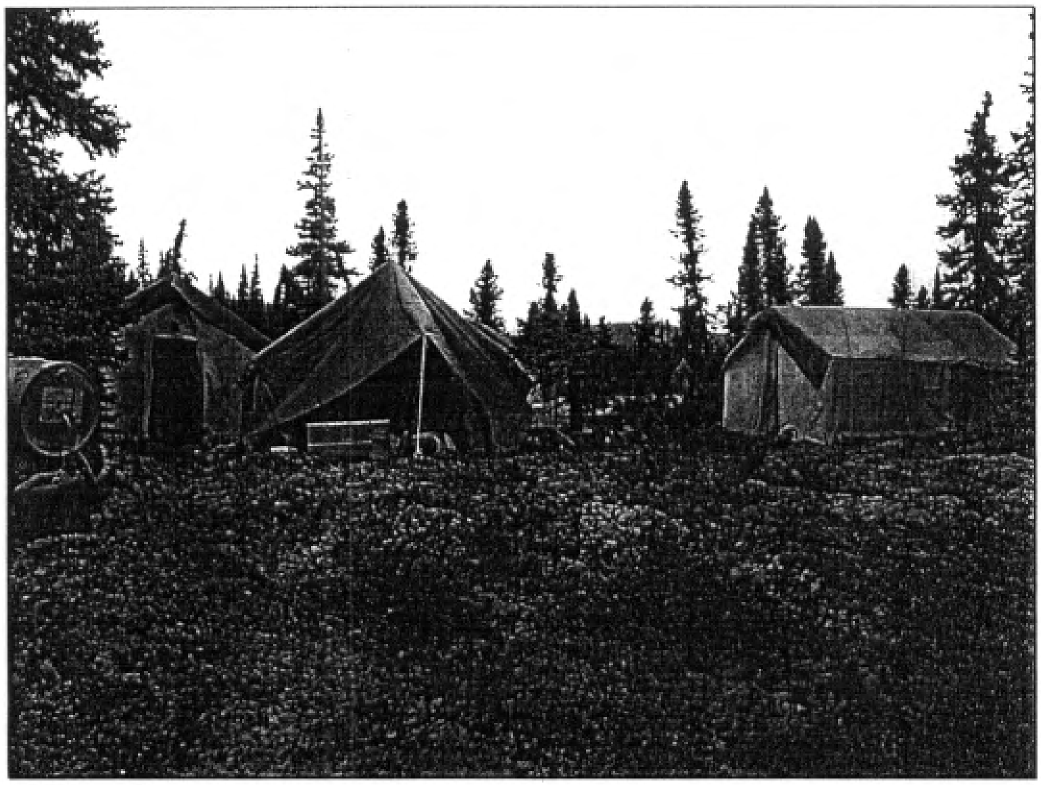


Figure 3.1.1 - Haut Plateau Camp, Quebec

3.2 Equipment

Two GEM Systems GSM-19 Overhauser Magnetometers were employed for the survey. Both sensors were mounted on top of the standard GEM four piece aluminum staff (see Appendix B for Equipment Specifications). A laptop Pentium computer was used to dump and process all data.

4 Survey Procedure

4.1 The Grid

The grid was placed by a local line cutting crew prior to the arrival of field personnel. Lines were cut at either 100m or 200m spacing, 25m stations, lines were oriented 050° true. A local coordinate system was used for grid reference, the grid origin (L 00E, ST 00N) was located approximately 275m grid-south of camp. A baseline (BL00) was cut through the centre of the grid, with tielines bounding the grid to the north and south at 1800N and 1500S respectively. The lines extend westward to 1800W and eastward to 1400E, for a total of approximately 74 line kilometers. There were several lakes, ponds, and cliffs on the property where grid lines could not physically be placed. See Map 6.1.

Lines are a minimum of 100m apart, so the line numbers may be shortened by omitting the last two zeros, i.e. L 16W to L 14E. By convention, lines located west of L 00E may be referred to as negatives (i.e. L 16W = L –16), similarly stations located south of ST 00N may be also be referred to as negatives (ST 1500S = ST –1500).

4.2 The Survey

One magnetometer was setup as a base station 50m east of camp and used to log data at four second intervals for diurnal correction of the mobile data. A datum of 56000 nT was chosen. A 12volt motorcycle-type battery was used to power the base station, the battery was charged nightly. Magnetometers were time-synchronized each morning using a synchronization cable.

The mobile unit was set to auto-tune and auto-initialize due to the high gradients encountered. For the majority of the survey, stations were paced-out between 25m pickets and readings were taken on each line at 6.25 m intervals. Due to time constraints, readings were taken at 12.5m intervals on the final two days of the survey; 08, 09 September 2000. A UTEM survey was running concurrent to the magnetometer survey, magnetometer readings were not obtained for stations within 25m of a live wire.

Where gradients were very high, multiple readings were taken. Readings with low signal quality indicators (<88) were also repeated until a good reading was obtained. All data, including obviously bad readings, and all repeats, were left in the final data set, with the exception of positioning errors which were edited out nightly. Data with signal quality indicators less than 88 were remarked out of the data set with a backslash (/).

Each evening, uncorrected mobile and base station data were transferred via RS232 serial port from the magnetometer to a laptop computer. Magnetometers were then hooked up to each other using a sync cable, the mobile data were then automatically diurnally corrected by the magnetometer and the corrected data transferred to the laptop.

Once transferred, Geosoft Mapping and Processing software was used to merge the magnetic observations with GPS data; a UTM easting and UTM northing were added in the X and Y column respectively (NAD27 Canada Mean). Daily data were appended to the end of a master XYZ file, then the data was imported into MS Excel where a formula was applied to "remark" out readings with a signal quality indicator of less than 88. Data were then exported as an XYZ file for plotting in Geosoft (see Appendix A for Data CD Information).

X and Y positions on Line 200E, from 1500S to 00N were interpolated based on positions obtained while GPSing in UTEM loop corners.

The magnetometer survey was started 02 September 2000 and complete by 09 September 2000. Approximately 55 line kilometers of the grid were surveyed (see Map 6.2).

7 Conclusions and Recommendations

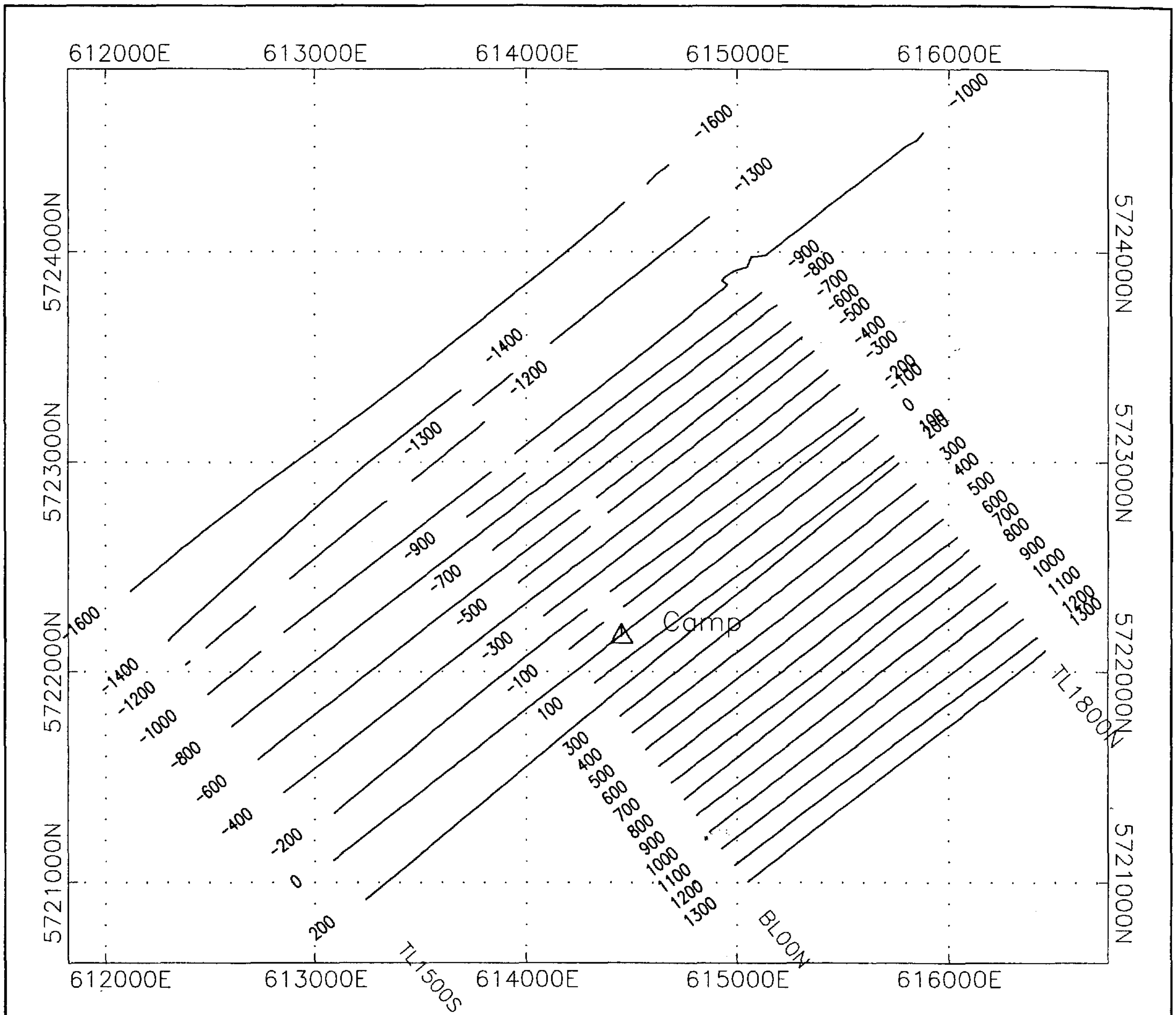
When the survey first began, readings were so erratic due to high gradients that it was believed that there was a problem with the mobile magnetometer or sensor. A section of line 0E, from 300N to 600N was repeated several times and repeatability was excellent (see Map 6.6). Base and mobile units were also switched and data repeated to ensure that the equipment was working properly.

Map 6.6, "Line 0 Repeatability Profile Plot" clearly shows that the magnetometer is capable of both handling and repeating in an area of extremely high horizontal gradient, i.e. 3500nT over 6.25m!

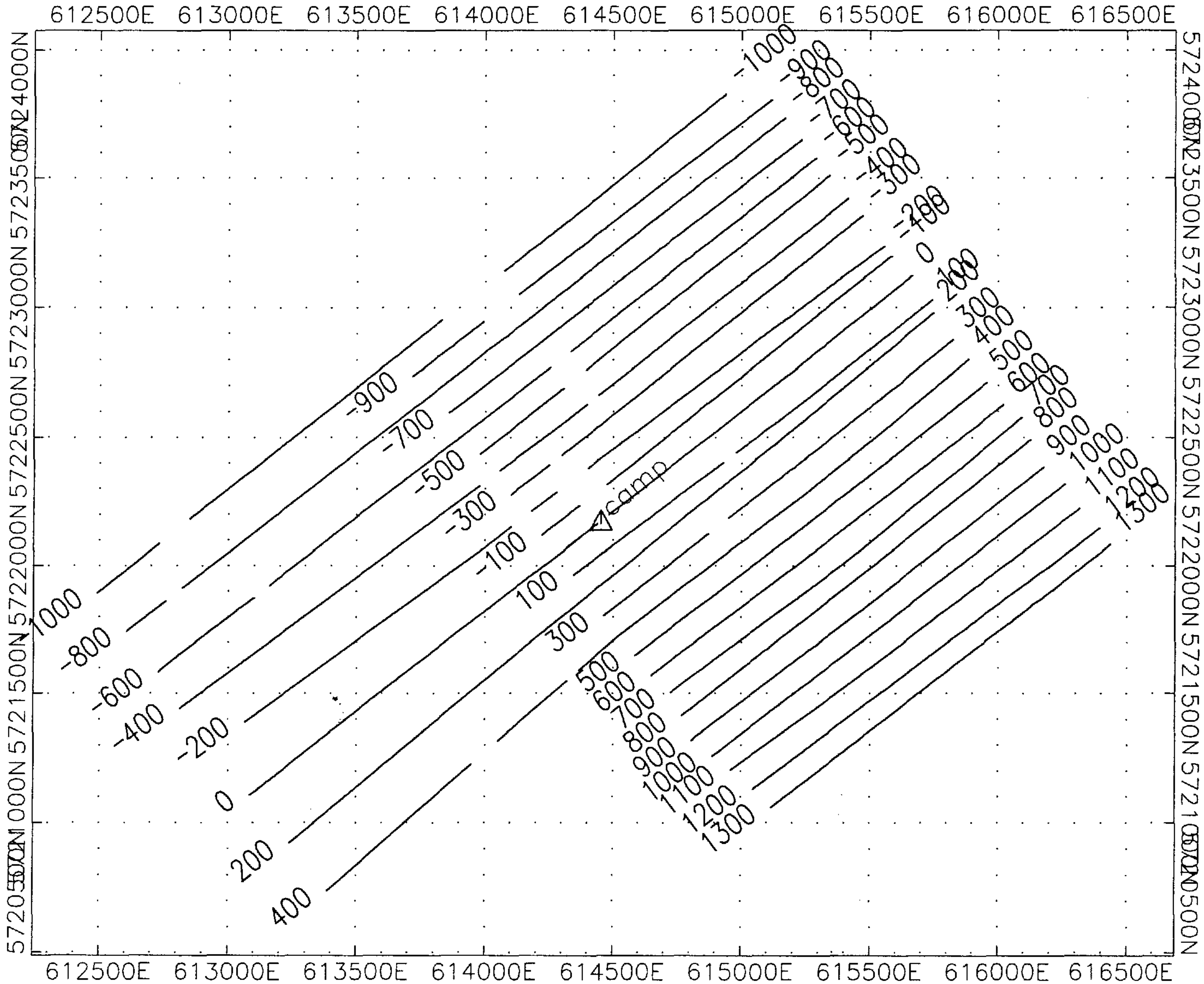
The data, although at first glance looks chaotic and of poor quality, has some unique profile signatures that can be followed line to line (see Map 6.5), which indicates that the data are OK. The high gradients could be caused by semi-massive pyrrhotite stringers and/or magnetite which are prevalent in the area.

The data should be cleaned up, thoroughly filtered, and looked at closer.

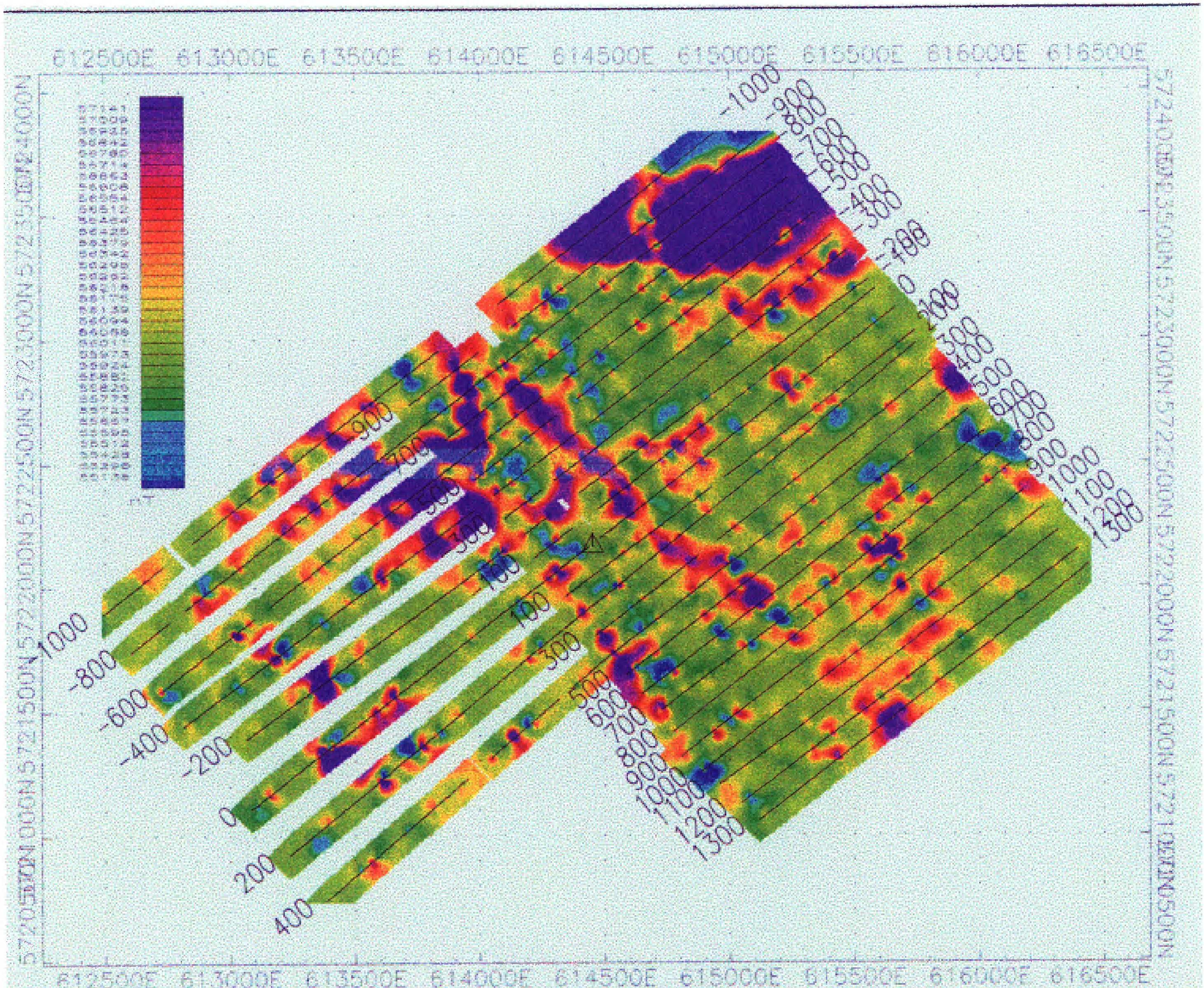
Any future magnetometer surveys over this area could include a cesium or potassium magnetometer, which may be able to handle the high gradients better than the Overhauser magnetometer.



GPS Survey for Falconbridge Ltd.
Haut Plateau, Monts-Groulx, Quebec
Grid Map



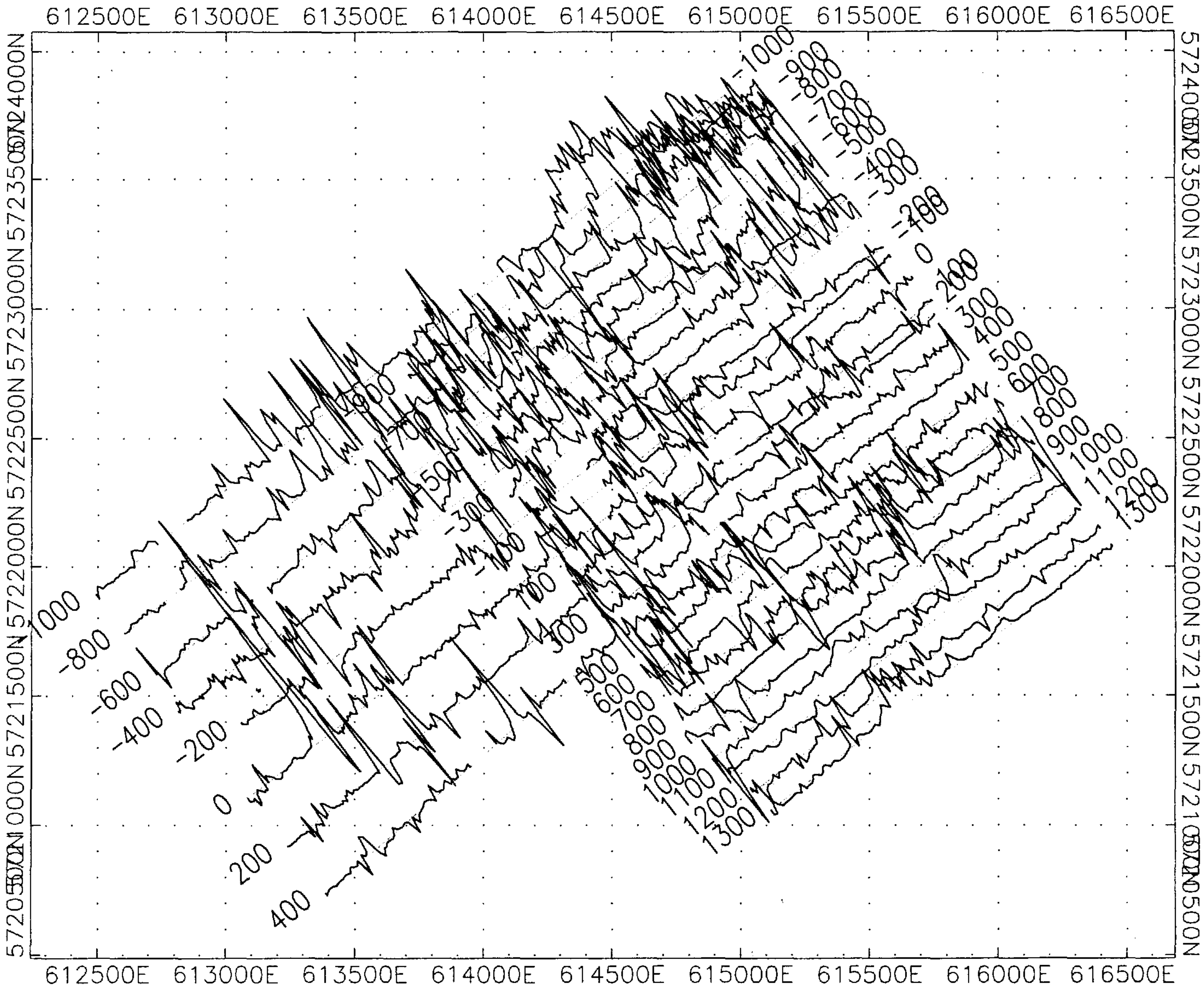
Magnetometer Survey for Falconbridge Ltd.
Haut Plateau, Monts-Groulx, Quebec
Magnetometer Survey Coverage



Magnetometer Survey for Falconbridge Ltd.

Haut Plateau, Monts-Groulx, Quebec

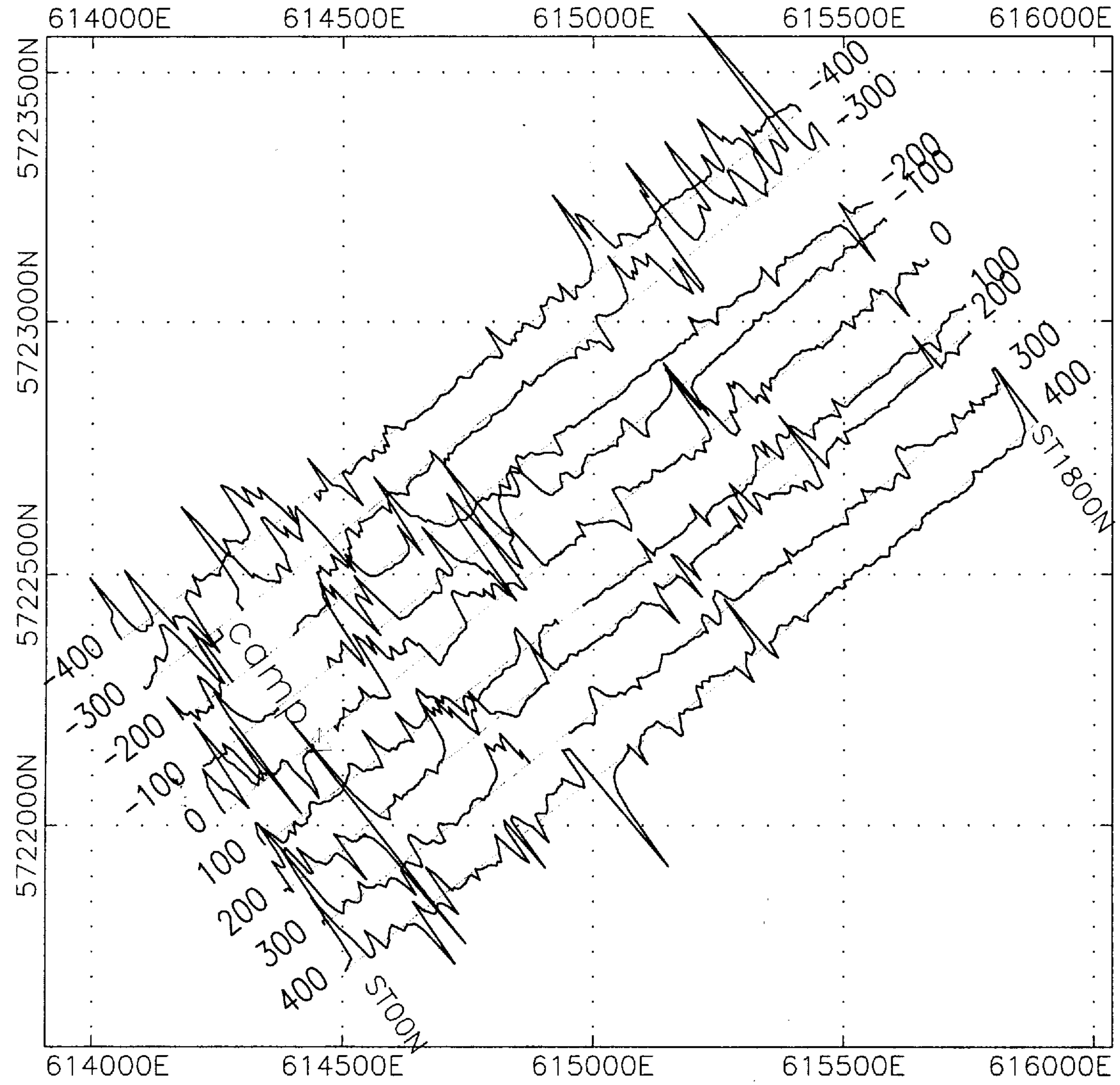
Gridded Total Field / nT



Magnetometer Survey for Falconbridge Ltd.

Haut Plateau, Monts-Groulx, Quebec

Total Field Profile, 2500 nT/cm, Base Level 56000 nT



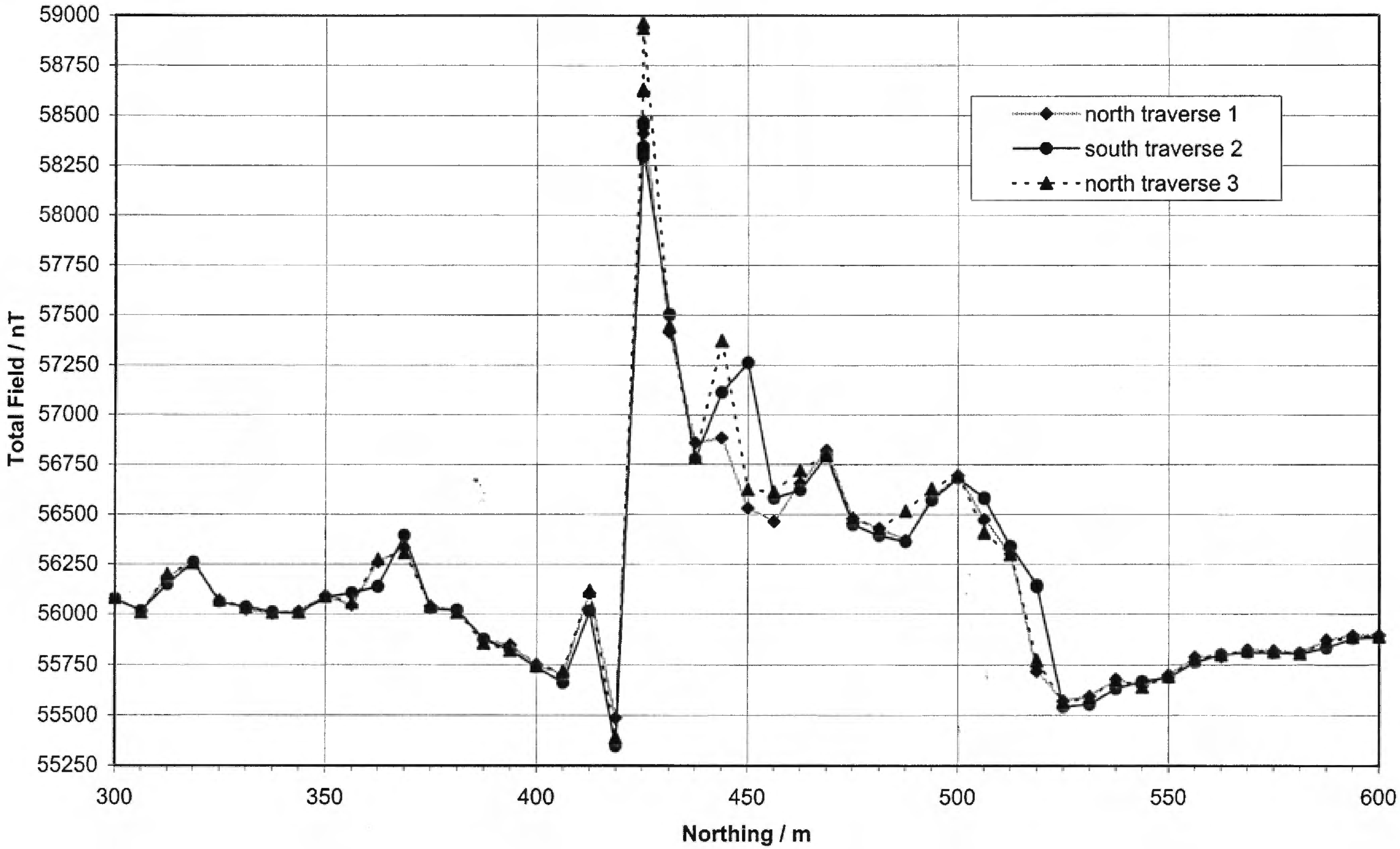
Magnetometer Survey for Falconbridge Ltd.

Haut Plateau, Monts-Groulx, Quebec

Detailed Total Field Profile, 2000 nT/cm, BL 56000

Haute Plateau Magnetometer Survey

Line 0 Repeatability Profile Plot



<u>Appendix A</u> <u>Data CD Information</u>

The attached data CD contains all raw and processed data.

Data from each survey day is located in the day's respective folder. Each day folder contains a "raw" and a "cor" folder. The "raw" folder contains two raw ASCII dump files with the extensions *.bse and *.raw. *.bse files are raw base station data, *.raw files are uncorrected mobile mag files. Each "cor" folder contains a diurnally corrected file with the extension *.cor.

The folder "xyz" contains three files:

1) allmag.xls MS Excel spreadsheet contains final mag data sorted and unsorted
2) magrepeat.xls MS Excel spreadsheet contains repeat section L0, 300N to 600N
3) finalmag.xyz final mag data in Geosoft XYZ format

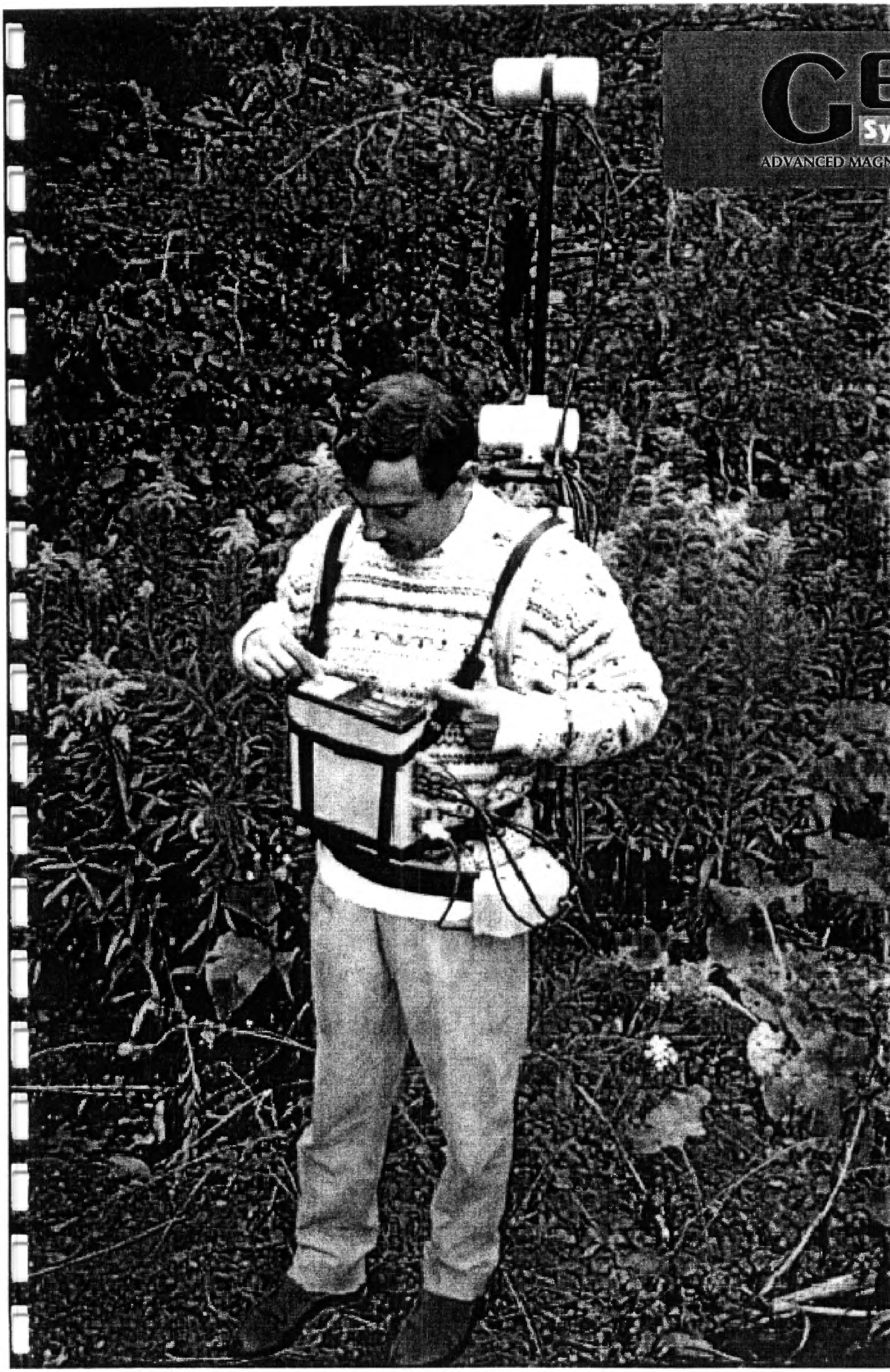
The figure below is a sample of the final data format (Geosoft XYZ) located in the master spreadsheet : The data are of the form:

UTMeast(X) UTMnorth(Y) station uncorField corField signal_quality time line#

line		-600						
	612730.2	5721583	-1500	57394.49	57282.52	99	143430	-600
	612730.2	5721583	-1500	57405.28	57293.33	99	143422	-600
	612730.2	5721583	-1500	57409.04	57297.09	99	143414	-600
	612739.2	5721592	-1487.5	55321.96	55209.85	99	143354	-600
	612739.2	5721592	-1487.5	55322.54	55210.42	99	143346	-600
	612748.1	5721600	-1475	55924.17	55811.93	99	143326	-600
	612757.9	5721608	-1462.5	56020.32	55908.04	99	143306	-600
	612767.8	5721616	-1450	56049.37	55936.94	99	143250	-600
	612777.4	5721623	-1437.5	56019.6	55907.08	99	143230	-600
	612787.1	5721631	-1425	56051.9	55939.35	99	143214	-600
	612797.1	5721639	-1412.5	56010.04	55897.56	99	143158	-600
	612807.1	5721648	-1400	56007.7	55895.33	99	143138	-600
	612816.4	5721655	-1387.5	56049.04	55936.87	99	142954	-600
	612825.6	5721662	-1375	56188.51	56076.07	94	142710	-600
	612834.9	5721669	-1362.5	56258.24	56145.9	99	142638	-600
	612844.1	5721676	-1350	56159.67	56047.76	99	142534	-600
	612853.9	5721684	-1337.5	56348.59	56236.62	99	142518	-600
	612863.7	5721691	-1325	56236.53	56124.47	99	142458	-600
	612873.2	5721699	-1312.5	56362.45	56250.4	99	142434	-600
	612882.7	5721708	-1300	56311.1	56199.23	99	142410	-600
	612892.3	5721715	-1287.5	56174.68	56062.94	99	142350	-600
	612901.9	5721722	-1275	55988.97	55877.3	99	142330	-600
	612912.3	5721729	-1262.5	56017.02	55905.33	99	142314	-600
	612922.6	5721737	-1250	56021.13	55909.48	99	142254	-600
	612932.3	5721745	-1237.5	56040.24	55928.53	99	142234	-600
	612942.1	5721753	-1225	56376.46	56264.69	99	142218	-600
	612951.9	5721760	-1212.5	56115.87	56004.08	99	142202	-600
	612961.9	5721767	-1200	56057.52	55945.77	99	142142	-600
	612971.5	5721775	-1187.5	56223.3	56111.41	99	142118	-600
	612971.5	5721775	-1187.5	56223.14	56111.36	99	142110	-600
	612981.1	5721783	-1175	56068.23	55956.49	99	142054	-600
	612991.2	5721790	-1162.5	56098.13	55986.55	99	142026	-600
	613001.3	5721798	-1150	56178.71	56067.15	99	142010	-600
	613010.8	5721806	-1137.5	55940.7	55829.18	99	141950	-600
	613010.8	5721806	-1137.5	55942.13	55830.52	99	141942	-600
	613020.3	5721814	-1125	60703.12	60591.46	99	141922	-600
	613020.3	5721814	-1125	60701.49	60589.77	99	141914	-600
	613020.3	5721814	-1125	60713.59	60601.84	99	141910	-600
/	613020.3	5721814	-1125	60697.04	60585.37	46	141902	-600
	613020.3	5721814	-1125	60718.05	60606.42	89	141854	-600
/	613020.3	5721814	-1125	60442.65	60331.03	77	141846	-600
/	613020.3	5721814	-1125	60281.46	60169.91	86	141838	-600

Figure A.1 – Sample Data

GEM Systems
ADVANCED MAGNETOMETERS



GSM-19

high sensitivity magnetometer-VLF system

GSM-19 Overhauser System

Sensitive, Lightweight and Versatile

The GSM-19 is a state-of-the-art magnetometer / VLF system that delivers both the quality of data and the extensive capabilities required to perform a broad spectrum of applications. Whether the application calls for detailed ground surveys, high-resolution marine surveys, or remotely controlled magnetic observatory measurements, you can count on the GSM-19 system to meet your goals.

The GSM-19 can be configured as either an Overhauser effect proton precession magnetometer or a conventional proton unit.

GEM Systems' advanced Overhauser version employs continuous radiofrequency polarization and special sensors to maximize the signal-to-noise ratio. Instrument sensitivity (0.02 nT), resolution (0.01 nT) and absolute accuracy (0.2 nT) set new performance standards. Moreover, omnidirectional sensors ensure a high quality of data even in low magnetic latitudes.

You can also take advantage of versatile options that reduce field costs and increase survey productivity. And the lightweight Overhauser unit is easy to transport and operate in the field (console with rechargeable batteries weighs only 2.1 kilograms).

The modular design of the GSM-19 Overhauser magnetometer ensures that the system can be upgraded as workloads change.

Building Blocks

- ☒ Simultaneous gradiometer.
- ☒ Continuous profiling "Walking" magnetometer / gradiometer.
- ☒ Very fast sampling (up to 5 readings per second) magnetometer/gradiometer.
- ☒ Omnidirectional VLF.
- ☒ Shallow or deep marine operation.
- ☒ Remote control for observatory and airborne base station applications.
- ☒ Integrated GPS option with graphic navigation

Standard Features

- ☒ Graphic display that shows you profiles of your data as the survey is conducted in real time, or from memory.
- ☒ Easy to learn interactive menu designed with the user in mind. All functions are easily and quickly accessible.
- ☒ Streamlined grid coordinate system with "end of line" quick change capability.
- ☒ 0.5MB memory standard, expandable to 2 MB.
- ☒ Programmable RS-232 high-speed data transfer (to 38.4 kBps) with ultra-fast raw dump feature.
- ☒ 50 and 60 Hz filters, user selectable.
- ☒ Automatic tuning and base station synchronization.

If your application does not yet require the extended capabilities or the cost benefits of an Overhauser unit, a conventional GSM-19 unit is available. This dedicated proton magnetometer can be equipped with gradiometer or VLF options, and is upgradable to an Overhauser magnetometer.

A Proton total field system may be upgraded to an Overhauser system, which allows further upgrade to more advanced models

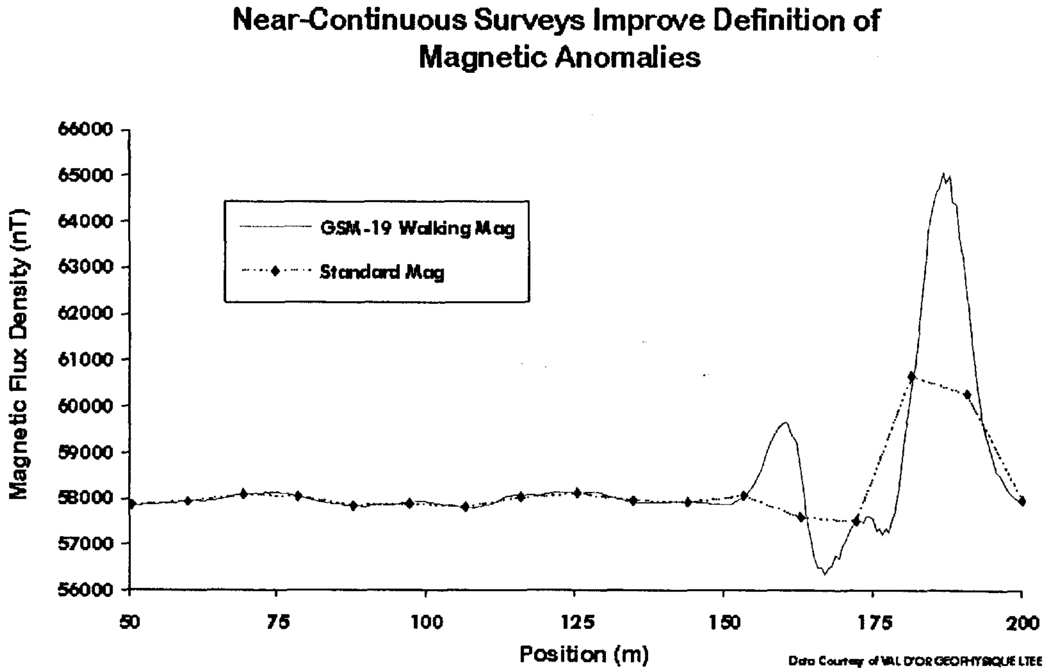
Type of Magnetometer	Building Blocks (Upgrade Options)									
	Gradiometer	"Walking" Mag	"Walking" Grad	Hip-Chain Mag	Hip Chain Grad	Fast Mag	Fast Grad	Remote Control	VLF	Shallow Marine
Conventional Proton	✓	✓	✓					✓	✓	
Overhauser Proton	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

A Full Range to Suit Diverse Needs

"Walking" Magnetometer / Gradiometer

GEM Systems pioneered the GSM-19's innovative "Walking" option that enables acquisition of nearly continuous data on survey lines. Similar to an airborne survey in principle, data is recorded at discrete time intervals (up to 2 readings per second) as the instrument travels along the line. At each major survey picket (fiducial), the operator touches a designated key. The Walking Mag automatically assigns a linearly interpolated coordinate to all intervening readings.

A main benefit of the Walking option is that the high sample density improves definition of geologic structures. And because the operator can record data on a near-continuous basis, the Walking Mag increases survey efficiency and minimizes field expenditures -- especially for highly detailed ground-based surveys.



As shown above, near-continuous measurements increase definition. Results from a GSM-19 "Walking Mag" (273 readings over 150 m with 2 sec. cycle time) were compared with results from a standard magnetometer (13 readings over 150m).

Simultaneous Gradiometer

Many mining, environmental, and archaeological applications call for high-sensitivity gradiometer surveys. The GSM-19 meets these needs in several ways. For example, simultaneous measurement of magnetic field at both sensors eliminates diurnal magnetic effects. Overhauser proton precession improves data accuracy and precision. The net result is a true gradient reading that resolves even weak anomalies (less than 0.25 nT).

Magnetic gradient can be displayed graphically as well as numerically as the survey progresses, or after the data has been collected.

Fast Sampling Magnetometer / Gradiometer

The GSM-19 fast sampling option allows you to collect data at rates as high as 5 readings per second. Fast sampling provides the high spatial resolution needed in detailed marine, or vehicle-borne surveys, and in anomalous magnetic terrain.

This fast sampling capability is also used in the *Hip Chain* magnetometer/ gradiometer -- developed primarily for environmental and archaeological applications.

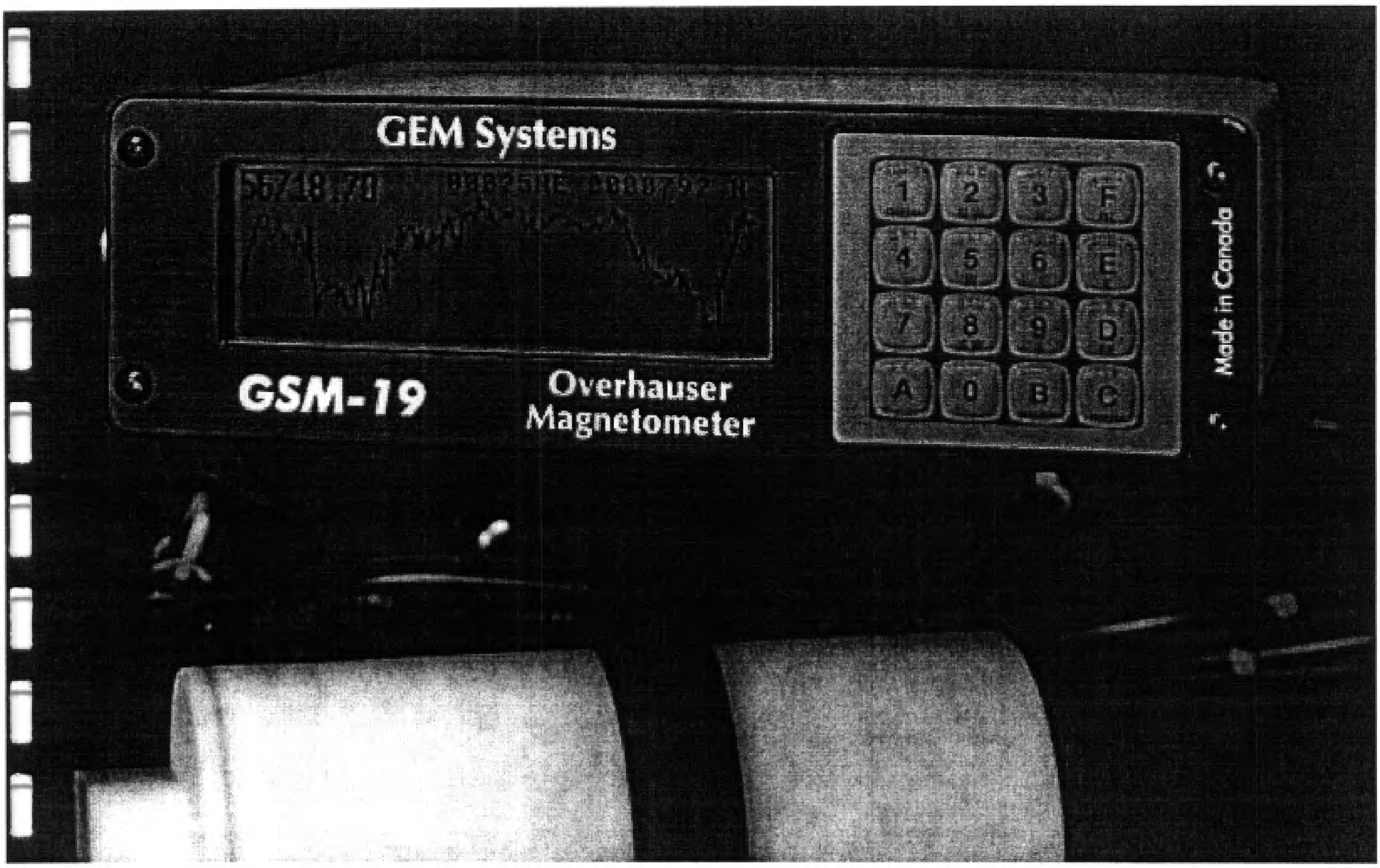
The Hip Chain system minimizes the need for pickets and reduces line preparation costs. Operators simply affix a cord at one end of the survey line, attach the Hip Chain to the waist, and walk along the line. Readings are triggered automatically as the cord unwinds.

Omnidirectional VLF

With GEM Systems' omnidirectional VLF option, up to three stations of VLF data can be acquired without orienting. Moreover, the operator is able to record both magnetic and VLF data with a single stroke on the keypad.

For high density surveys, our VLF is availabile with a Walking option that is similar in principle to a Walking Mag. VLF data can be sampled as fast as once per second, requiring the operator to press a key only at each fiducial.

GEM Systems recognizes the importance of customers' existing equipment. That's why a GSM-19 can be equipped with optional support for an EDA VLF unit. You can continue to use the VLF you're familiar with, while enjoying the benefits of our state of the art console, and Overhauser magnetometer technology.



GSM-19 console with magnetic sensor and standard real-time graphic display

Remote Control Operation

Targeted to observatory, marine, and airborne base station applications, this option allows users to set parameters and initiate measurements from a computer terminal using RS-232 commands.

Real-time transmission capability is provided so that data quality can be monitored while marine or vehicle-borne surveys are in progress.

And to ensure that the GSM-19 is fully compatible with existing marine or airborne data acquisition systems, GEM Systems can provide one and two-channel analog output capabilities.

Integrated DGPS

A significant cost in a ground magnetometer survey is marking lines and stations. The use of real-time differential GPS, and the GSM-19's optional survey navigation features can simplify, and even eliminate this costly process.

The GPS option integrates a Garmin GPS-20 and radio modem into the GSM-19 console. With a base station GPS and another radio modem, you will know your position to within 1m. In addition, the GSM-19 can generate your survey block and lines for you, and guide you graphically through the survey as you walk. Coupled with our powerful Walking Mag feature, this option can significantly boost the speed and efficiency of your magnetometer surveys.

Shallow Marine

By sealing and pressurizing the sensor in a *fish*, and allowing up to 100m of tow cable, the shallow marine option turns a GSM-19 into a cost effective marine magnetometer. All GSM-19 console functionality is available, in addition to a special surveying mode specifically designed for marine exploration. And the unit can run for days at its maximum sampling rate of 2Hz from a single 12V or 24V vehicle battery, making it ideal for small vessels, or situations where the instrument must be moved between vessels frequently.

Deep Marine

A deep marine magnetometer packs an entire Overhauser magnetometer with omnidirectional sensor into a fish pressurized to 300m. No console is required. The only on-board component is a small interface box that connects the system directly to a PC, or any RS-232 capable terminal or data acquisition system.

Our standard kevlar reinforced tow cable pulls 2000kg without breaking, but because of our sophisticated communications technology may be less expensive than you expect. The same technology allows a deep marine tow cable to be 1000m or more, and up to 16 fish can be networked together over the length of the cable, creating gradiometer configurations.

Power requirements are by far the lowest in the industry at less than 2.8W maximum per fish, and the entire system can operate from a wide voltage range of 15V to 35VDC. Sensitivity is superb at 0.02nT, and the system can sample at up to 5 readings per second. Temperature and pressure sensors are standard equipment.

Specifications

Performance

	Overhauser	Proton
Resolution:	0.01 nT	0.01 nT
Relative Sensitivity:	0.02 nT	0.2 nT
Absolute Accuracy:	0.2 nT	1 nT
Range:	20,000 to 120,000 nT	20,000 to 120,000 nT
Gradient Tolerance:	Over 10,000 nT/m	Over 7,000 nT/m

Storage Capacity (readings)

	Overhauser	Proton
Std. Magnetometer:	32,000 to 131,000	16,000 to 32,000
With 3 VLF stations:	12,000 to 58,000	6,000 to 12,000
Base Station:	170,000 to 700,000	84,000 to 170,000
Gradiometer:	25,000 to 110,000	12,000 to 25,000
With 3 VLF stations:	12,000 to 46,000	6,000 to 12,000

Operating Modes

Manual: Coordinates, time, date and reading stored automatically at a minimum 3 second interval.

Base Station: Time, date and reading stored at 3 to 60 second interval (higher speeds available).

Walking: Time, date and reading stored at coordinates of fiducial with 0.5, 1 or 2 second cycle time.

Hip Chain: Equidistant coordinates, time, date and reading stored automatically. Distance interval of readings is programmable.

Remote Control: Optional remote control using RS-232 interface.

Input/Output: RS-232 or analog (optional) output using 6 pin weatherproof connector.

Operating Parameters

Power Consumption: Only 2 Ws per reading for Overhauser, and 12 Ws per reading for Proton magnetometer. Will operate continuously for 45 hours on standby.

Power Source: 12V 2.6 Ah sealed lead acid battery standard, other batteries available.

Operating Temperature: Overhauser: -50°C to +60°C. Proton: -40°C to +60°C.

Dimensions and Weight

Dimensions:
- Console 223 x 69 x 240 mm.
- Sensor 170 x 71 mm diameter cylinder. Omnidirectional sensor 180 x 80mm.

Weight:
- Console 2.1 kg.
- Sensor and staff assembly 2.0 kg.

A Standard package includes a console with batteries, harness, battery charger, case, sensor with 2m cable, and staff.

Omnidirectional VLF

Performance: Resolution 0.5% and range to +/- 200% of total field. Frequency 15 to 30 kHz.

Measurement: Vertical in-phase & out-of-phase as a percentage of total field, 2 horizontal components, coordinates, date, and time.

Features: Up to 3 stations measured automatically, in-field data review, displays station field strength continuously, and tilt correction for up to +/- 10° tilts.

Dimensions: 160 x 150 x 150 mm and weighs only 1.3 kg.

GSM-19 Advanced Features

An instrument's effectiveness is measured by its ability .o handle highly specialized user demands. With the GSM-19, these requirements can be met through a number of dvanced features. In addition, semi-custom software and hardware modifications are available.

Compatible With Different Magnetometers

To protect our customers' investments in purchased :quipment, GEM Systems has adopted an Open Systems .pproach. Any of our lightweight GSM-19 magnetometers can be used as a field unit in combination with another nanufacturer's base station.

Automatic Tuning

Tuning is automatic in all modes of operation with automatic initialization, or manual preset, making the instrument's tuning almost invisible to the user. An override ›ption is also provided for manual and remote modes.

GPS support

In addition to an optional GPS receiver integrated into the GSM-19 console, a GSM-19 can accept data from GPS eceivers in NMEA format, a standard which virtually all eceivers support. All of the survey navigation options supported with the integrated GPS option are supported vith external units as well.

Adaptability to High Gradient

In standard instruments, a gradient in the magnetic .ield across the sensor volume can shorten the decay time of the proton precession signal. However, the GSM-19 nonitors the signal decay, and calculates the optimal time interval for measurement. Warning messages appear on the display when the measuring interval becomes too short.

Graphic Display and Keyboard

The GSM-19 has a large 240 x 64 pixel graphic display nd a 16 key keypad with tactile feedback. Operation is menu driven, and simple enough for a beginner to operate with confidence. The keypad enables operators to enter ully worded comments with no limit in the length of text.

Very Low Power Consumption

A standard Proton magnetometer uses a high power DC magnetic field to polarize its sensor, and consequently requires a large and heavy battery to operate for practical lengths of time.

An Overhauser sensor, on the other hand, uses an RF magnetic field to polarize its sensor, and requires less than a Watt of power per sensor, the lowest power consumption of any magnetometer technology in existence that is practical for geophysical applications.

This means that GEM Systems' portable Overhauser magnetometer can run for long periods of time with a smaller battery, and can be very lightweight; a feature any operator will appreciate when carrying the instrument over adverse terrain.

At the same time, you get data that are 10 to 100 times less noisy than a standard Proton magnetometer can produce. And since Overhauser polarization does not interfere with the measurement process, a GSM-19 Overhauser magnetometer can sample at up to 5 times per second, a feature that would be practically impossible with standard Proton magnetometer technology.

GEM Systems Inc.

With more than fifteen years of research and development incorporated into Overhauser and proton precession magnetometers, GEM Systems is committed to providing its customers with state-of-the-art instrumentation.

In addition to offering the GSM-19, GEM Systems also designs and builds solar-powered proton magnetometers for land-based applications, optically pumped potassium magnetometers, and high performance airborne survey navigation software.

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Appendix C Daily Field Notes

Date	Type	Line	Station From	Station To	Notes
820					- RLM departs Toronto for Sept-Iles, met helicopter in Sept-Iles, arrived in camp ~14:30, set up gear and charged batteries - set up GPS base 9999 in camp, allowed GPS to run autonomously 1.5h to establish rough reference coordinates
821	GPS				- placed GPS repeater atop hill 500m east of camp - read UTEM Loop 1 counter-clockwise from UTEM transmitter (L0, ST 350N) (8.6km)
822	GPS	200E	350N	650S	- swamp, stations read at 25m
			700S	1500S	-
		00E	1500S	350N	-
		200W	350N	325N	- Lake
			200N	1375S	- EOL Lake
		400W	1500S	350N	-
823	GPS	1600W	350N	1500S	-
		1400W	1500S	900S	- Lake
			825S	350N	-
		1200W	350N	100S	- Lake
			250S	850S	-
		1000W	1050S	225N	-
		1300W	350N	600N	-
		1000W	475N	400N	-
824					- RAIN all night and all day, no field work done today
825	GPS	800w	300N	1000S	- 325N, 350N NO SATS
			1050S	1225S	- Swamp
			1300S	1500S	- Lake
		1200W	1500S	1475S	- Lake
			1375S	1050S	- Lake
		1000W	1175S	1500S	-
		600W	1500S	1400S	- Cliff
			1350S	1025S	- Swamp
			950S	450N	-
		1300W	825N	1800N	-
		1600W	1800N	1650N	- Lake
			1525N	1300N	- NO SATS (hill)
			1250N	975N	- Pond
			925N	350N	-
826	GPS	800W	300N	1250N	- Swamp
			1300N	1800N	-
		600W	1800N	550N	-
		200W	350N	1800N	-
		400W	1800N	525N	- Lake
			475N	350N	-
		200W	50S	200S	- repeats
827	GPS	1200E	00N	1800N	-
		1000E	1800N	00N	-

Date	Type	Line	Station From	Station To	Notes
		800E	00N	950N	- Cliff
			1000N	1800N	-
		600E	1800N	00N	-
828	GPS	400E	00N	1800N	-
		200E	1800N	350N	-
		00E	350N	1800N	-
		100E	1800N	825N	- Lake
			750N	00N	-
829	GPS	100W	325N	1800N	-
		300W	1800N	275N	- Lake
			225N	00N	-
		100W	00N	225N	-
		300E	00N	550N	- Lake
			650N	1800N	-
		500E	1800N	00N	-
830	GPS	1400E			- DELAYED 2h DUE TO RAIN, - GPSed every 100m for eastern edge of Loop 2,
		1300E	1800N	1700N	- no sats
			1650N	1275N	- no sats
			1225N	00N	-
		1100E	00N	450N	- FINISHED 14:00 DUE TO RAIN
831	GPS	500W	525N	1800N	-
		700W	1800N	00N	-
		900W	00N	350N	- Lake
			525N	1775N	- Lake
		1000W	1625N	1300N	- No sats
			1250N	500N	- Lake
		500W	450N	00N	-
901	GPS	1100E	450N	1800N	- GPS COMPLETE TODAY
		900E	1800N	00N	-
		700E	00N	1800N	-
902	MAG	100E	00N	1800N	- SET UP AND TESTED MAG - VERY HIGH GRADIENTS
		00E	1800N	00N	-
903	MAG	200W	300N	1800N	- VERY SPIKEY!!
		400W	1800N	1500S	-
		200W	1500S	200N	-
904	MAG	00E	225N	1500S	- waiting for OK from R Osmond to proceed regardless of high gradient noisy data
		200E	1500S	200N	-
905	MAG	300E	00N	1775N	-
		400E	1775N	00N	-
		500E	00N	1775N	-
		600E	1775N	00N	-
		700E	00N	1775N	-
		800	1775N	00N	-
906	MAG	100W	225N	00N	-
		300W	00N	225N	-
		500W	400N	00N	-
		600W	00N	400N	-
		700W	450N	1775N	-
		800W	1775N	00N	-

Date	Type	Line	Station From	Station To	Notes
		700W	00N	450N	-
		600W	550N	1775N	-
		500W	1775N	550N	-
907	GPS	1000W	1600N	2800N	- recon. extension, 50m stations
	MAG	300W	300N	1775N	-
		100W	1775N	300N	-
908	MAG	800E	25N	1775N	- 12.5m stations
		900E	1775N	25N	-
		1000E	25N	1775N	-
		1100E	1775N	25N	-
		1200E	25N	1775N	-
		1300E	1775N	25N	-
909	MAG	1000W	550N	1625N	- 12.5m stations
		900W	1775N	00N	- FINAL DAY OF MAG
		1000W	225N	1500S	-
		800W	1500S	00N	-
		600W	00N	1500S	-
		400E	1500S	00N	-
910					- PACKED UP CAMP, DEMOBED TO BAI-COMEAU - OVERNIGHT IN BAI-COMEAU
911					- TRAVEL BAI-COMEAU TO QUEBEC CITY BY TRUCK, FLY QUEBEC TO TORONTO

Appendix D References

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Certificate of Qualifications

I, Robert L. McKeown, of the City of Oshawa, Province of Ontario, do hereby certify:

1) That I am a consulting geoscientist and reside at 48 Foxhunt Trail, Oshawa, Ontario, Canada, L1E 1E9

2) That I graduated from McMaster University in Hamilton Ontario in 1994 with the degree of Bachelor of Science (Geology).

3) That I am a Fellow of the Geological Association of Canada, and a Member of the Association of Professional Geoscientists of Ontario.

4) That I have been practicing my profession for seven years.

5) That I have no interest, nor do I expect to receive any interest in the property or securities of Falconbridge Ltd.

Oshawa, Ontario
October 2000

Robert L McKeown, BSc FGAC
McKeown Exploration Services