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Magnetic Susceptibility Measurements on Kimberlite and Sedimentary Rocks in Alberta

Alberta Energy and Utilities Board
Alberta Geological Survey

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Abstract

This report includes magnetic susceptibility measurements on Alberta ultramafic and Devonian to Late Cretaceous sedimentary rocks to allow for a comparison between Alberta kimberlite and their potential hostrocks.

The magnetic susceptibilities of kimberlitic rocks in Alberta yielded measurements of between 0.19 x 10^{-3} SI and 52.7 x 10^{-3} SI units. In contrast, the magnetic susceptibilities of middle to Late Cretaceous sedimentary rock, which includes shale interlayered with kimberlite, are generally <0.15 x 10^{-3} SI units. Therefore, the results show the contrast in magnetic properties between the kimberlitic pipes and the host sedimentary rocks is sufficient to produce a geophysical target.

Variations in magmatic differentiation between primitive and evolved kimberlite alter the mineralogy of the resulting kimberlite magma, and thus, offer a plausible explanation for variable degrees of magnetic susceptibility in the kimberlite. In addition, distinct trends of magnetic susceptibility versus kimberlite emplacement age suggest that relatively weakly magnetic northern Alberta kimberlite should be emplaced between 78 and 86 Ma. This may be an important observation for future diamond exploration in northern Alberta, particularly because pipe K252, which has the best diamond results to date is low magnetic susceptibility kimberlite.

The magnetic susceptibility data presented in this study can be considered during the planning and interpretation of future ground-based based and airborne magnetic surveys associated with diamond exploration work in Alberta. Finally, magnetic susceptibility can be used as a complementary tool in drillcore logging, particularly in sections of complicated intercalated kimberlite and sedimentary rock.

1 Introduction

Kimberlite, the predominant bedrock source for diamonds, has long been known to have physical and geophysical characteristics that make detection possible by modern exploration methods. Most of the world's known kimberlite occurrences have distinctive magnetic and/or electromagnetic geophysical signatures (e.g., Macnae, 1979, 1995; Keating 1996), and thus, greatly improved technology and understanding of airborne magnetometric systems, plus with the advent of digital recording, have made magnetic surveying the most popular geophysical technique in kimberlite exploration (e.g., Atkinson, 1996). The low cost, airborne magnetic geophysical reconnaissance technique has commonly been used to assist in the selection of targets for follow-up work, including heavy-mineral concentrate sampling, soil geochemistry and detailed ground geophysics.

The success of magnetic surveys in exploration is especially evident when the physical properties (specific gravity, magnetic susceptibility, resistivity) of kimberlite differ from those of the enclosing country rock, enabling recognition and delineation of kimberlite pipes using geophysical methods. In areas where kimberlites intrude weakly magnetic platform sedimentary rocks, such as Yakutia Province (Russia) and Fort à la Corne field (Saskatchewan), magnetic surveys have been successfully used as a primary exploration tool. To September 2003, 48 kimberlitic pipes have been discovered in northern Alberta. The majority of the kimberlite discoveries in the Buffalo Head Hills (38 pipes) and Birch Mountains (8 pipes) areas of north-central and northeastern Alberta were discovered by the succession of airborne magnetic and electromagnetic surveys followed by ground magnetic surveys and, finally, drilling.

The objective of this report is to measure the magnetic susceptibility of ultramafic samples archived at the Alberta Geological Survey (AGS) and make the data available for future geophysical surveys in Alberta. The magnetic susceptibility of various archived Devonian and mid-Cretaceous sedimentary rock types were also analyzed, allowing for a comparison between Alberta ultramafic rocks and their potential hostrocks.

2 Methodology

2.1 Magnetic Susceptibility Theory and Instrument Used

Magnetic susceptibility is defined as the degree to which a substance can be magnetized. In mathematical terms, this is the ratio k of the intensity of the magnetization I to the magnetic field H that is responsible for the magnetization,

$$\boldsymbol{k}\mathbf{H} = \mathbf{I}$$

From Faraday's law, it is known that a current (i.e., a moving electrical charge) generates a magnetic field. The inverse corollary to this is that a magnetic field can also influence a moving electrical charge. Therefore, an oscillating electromagnetic field will be influenced to varying degrees by magnetically susceptible material.

The magnetic susceptibility of rock and core samples selected in this study were measured using a KT-9 Kappameter (Exploranium G.S. Limited, 1997). The Kappameter is a handheld instrument used for fast and sensitive measurement of magnetic susceptibility of rock samples, exposures or drillcores. The KT-9 uses a 10 kHz LC oscillator and an inductive coil to measure the susceptibility.

2.2 Sample Selection and Measurement

In total, 1,547 samples were measured for magnetic susceptibility, including 1,318 ultramafic (kimberlite, ultrabasic/alkali basalt and minette) and 229 sedimentary rock samples. All of the samples are from archive material at the AGS Mineral Core Research Facility located in Edmonton, Alberta.
Of the ultramafic samples

- 1,269 measurements were completed on ‘continuous’ core (i.e., archived core that includes the entire ultramafic drill intersection from top to bottom), and
- 49 measurements were completed on hand-sized rock samples, which include individual or isolated intersections of core and/or surface samples.

Regarding the sedimentary samples analyzed, U-Pb perovskite, Rb-Sr phlogopite and palynological dates show the kimberlitic pipes in northern Alberta were emplaced in the Late Cretaceous (Coniacian to Maastrichtian) between ca. 88-68 Ma (Eccles, 2004). At this age, Smoky and Colorado groups and Upper Cretaceous Wapiti Formation would host the pipes in the near surface setting. These bedrock units comprise interbedded marine shale to non-marine sandstone and shale deposited in an actively subsiding foreland basin of the Western Canada Sedimentary Basin.

To provide representative magnetic susceptibility measurements on sedimentary rock in northern Alberta, Devonian and Cretaceous bedrock samples collected by Eccles et al. (1998, 2001) and Dufresne et al. (2001) were measured. The sample set included various lithologies: limestone, dolomite, sideritic and calcareous concretions, ooidal ironstone, sandstone, siltstone and shale. Sedimentary rocks collected in north-central to northwestern Alberta include predominately shale, siltstone and sandstone from the middle to Late Cretaceous Colorado and Smoky groups, and Wapiti Formation. Sedimentary rocks collected in northeastern Alberta are older and include Lower Cretaceous McMurray Formation sandstones and lower Upper Devonian Waterways Formation carbonates.

Three to five separate magnetic susceptibility measurements were taken on an isolated ‘spot’ of each core or rock sample that was determined macroscopically to be representative of the sample. On continuous drillcore, sample measurements were taken approximately every metre.

A special ‘measuring pin’ protrudes from the centre of the KT-9 Kappameter measuring head. To take a reading, the pin is placed against the surface of the core or rock sample to be measured. Special care was taken to place the Kappameter KT-9 perpendicular to the surface of rock and core samples.

The KT-9 Kappometer automatically displays the true measured susceptibility of the sample in dimensionless, System International (SI) units. The sequence required to obtain a measure of susceptibility is

1. The frequency of the oscillator is measured in free space.
2. The oscillator frequency is next measured when the coil is placed on the material for which the susceptibility is required.
3. The frequency difference is directly proportional to the materials’ susceptibility.
4. The susceptibility is calculated from this frequency difference and takes into account geometric corrections to determine true susceptibility.

The maximum sensitivity of the KT-9 is 1 x 10^{-5} SI units. In this report, all measurements were recorded to 1 x 10^{-3} SI units.

3 Results

3.1 Presentation of Data

The integer values of all magnetic susceptibility measurements are presented in two appendices:

Appendix 1. Magnetic susceptibility measurements of ultramafic rocks in Alberta.

Appendix 2. Magnetic susceptibility measurements of sedimentary rocks in Alberta.

A statistical representation of selected kimberlitic and sedimentary rocks in Alberta is presented in Table 1.

For the continuous core measurements, visual magnetic susceptibility graphs (three individual measurements plus the average) are included adjacent to the respective drill log and presented as a series of figures:

Figure 1. Magnetic susceptibility and lithology of the Dragon pipe, Birch Mountains field.

Figure 2. Magnetic susceptibility and lithology of the Legend pipe, Birch Mountains field.

Figure 3. Magnetic susceptibility and lithology of the Pegasus pipe, Birch Mountains field.

Figure 4. Magnetic susceptibility and lithology of the Phoenix pipe (drillhole 98DH-PH01), Birch Mountains field.

Figure 5. Magnetic susceptibility and lithology of the Phoenix pipe (drillhole 98DH-PH02), Birch Mountains field.

Figure 6. Magnetic susceptibility and lithology of the Roc pipe, Birch Mountains field.

Figure 7. Magnetic susceptibility and lithology of the Valkyrie pipe (drillhole 98DH-VA01), Birch Mountains field.

Figure 8. Magnetic susceptibility and lithology of the Valkyrie pipe (drillhole 98DH-VA02), Birch Mountains field.

Figure 9. Magnetic susceptibility and lithology of the Xena pipe, Birch Mountains field.

Figure 10. Magnetic susceptibility and lithology of the Mountain Lake North pipe (drillhole ML95-1).

Figure 11. Magnetic susceptibility and lithology of the Mountain Lake South pipe (drillhole ML95-3).

The drill logs used in these figures are scanned replicas of the original logs from the Birch Mountains pipes (Aravanis, 1999) and Mountain Lake pipes (Leckie et al., 1997).

The averaged magnetic susceptibility of ultramafic rock hand samples is presented in Figure 12. The averaged magnetic susceptibility of sedimentary rock samples is presented in Figure 13.

Finally, to place the magnetic susceptibility measurements in context with surface geophysical techniques, Appendix 3 includes scanned images of ground magnetic surveys over selected pipes. These were compiled from Aravanis (1999), Skelton and Bursey (1998, 1999), and Wood and Williams (1994).

Table 1. Statistical representation of selected kimberlitic and sedimentary rocks in Alberta

Pipe Name	Dominant Lithology	Number of Data	Magnetic Susceptibility (x 10-3 SI)			Standard Deviation	Median	Coefficient of Variation
			Average	Minimum	Maximum			
Dragon	Shale with 16 m of mud-rich kimberlite	62	0.07	-0.02	0.32	0.07	0.05	1.32
Legend	Kimberlite	224	2.04	-0.05	22.80	2.67	1.27	2.10
Pegasus	Interlayered kimberlite and shale	141	2.77	0.00	15.17	3.65	0.44	8.35
Pegasus (90-124+160-190 m)	Kimberlite	73	4.45	0.07	15.17	3.35	3.73	0.90
Pegasus (87-90+144-160+195-200 m)	Shale	34	0.10	0.00	0.23	0.04	0.10	0.42
Phoenix 1	Kimberlite	155	20.47	-0.05	52.67	11.15	18.97	0.59
Phoenix 2	Cobble/boulder till and shale	95	0.04	-0.12	0.34	0.06	0.01	4.86
Roc	Interlayered kimberlite and shale	61	2.39	-0.02	7.61	1.79	2.37	0.75
Roc (134-174 m)	Mud-rich kimberlite	43	3.15	0.06	7.61	1.48	3.01	0.49
Valkyrie 1	Cobble/boulder till	35	0.32	-0.13	4.52	0.77	0.14	5.51
Valkyrie 2	Kimberlite	80	11.26	0.16	23.10	5.92	11.68	0.51
Xena	Shale with relic kimber-litic/ultrabasic rock	82	0.21	-0.23	3.39	0.56	0.05	11.92
Mountain Lake North	Interlayered ultrabasic rock and sandstone	162	0.47	0.08	2.00	0.31	0.40	0.77
Mountain Lake South	Pyroclastic ultrabasic rock	169	0.26	0.06	3.72	0.35	0.22	1.55
Mountain Lake South (minus three outlier spikes)	Pyroclastic ultrabasic rock	166	0.22	0.06	0.46	0.07	0.22	0.32

General Lithology	Number of Data	Magnetic Susceptibility (x 10-3 SI)			Standard Deviation	Median	Coefficient of Variation
		Average	Minimum	Maximum			
Bone bed	12	0.11	0.02	0.23	0.07	0.10	0.72
Shale	67	0.14	0.01	0.54	0.08	0.13	0.66
Shale - Fish Scales	6	0.14	0.07	0.28	0.07	0.12	0.61
Sandstone	58	0.19	-0.02	1.15	0.21	0.15	1.42
Siltstone	12	0.20	0.02	0.90	0.27	0.08	3.54
Devonian carbonates	24	0.30	0.01	1.81	0.52	0.09	5.96
Sulphide nodules	6	0.40	0.03	1.82	0.70	0.10	6.90
Bad Heart ooidal ironstone	5	0.52	0.36	0.61	0.10	0.52	0.20
Siderite/calcareous concretions	30	0.58	0.01	1.70	0.52	0.40	1.29

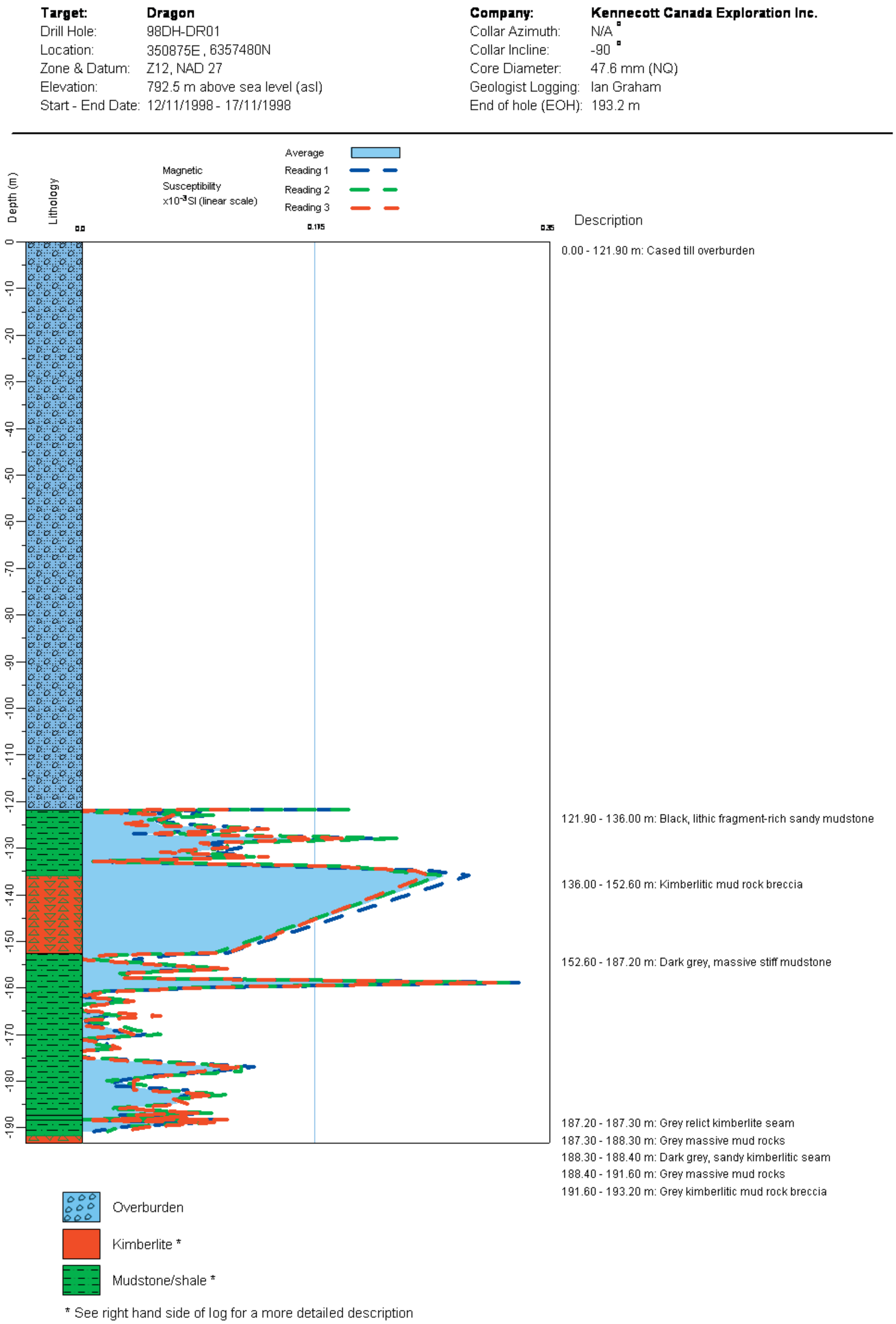


Figure 1. Magnetic susceptibility and lithology of the Dragon pipe, Birch Mountains field.

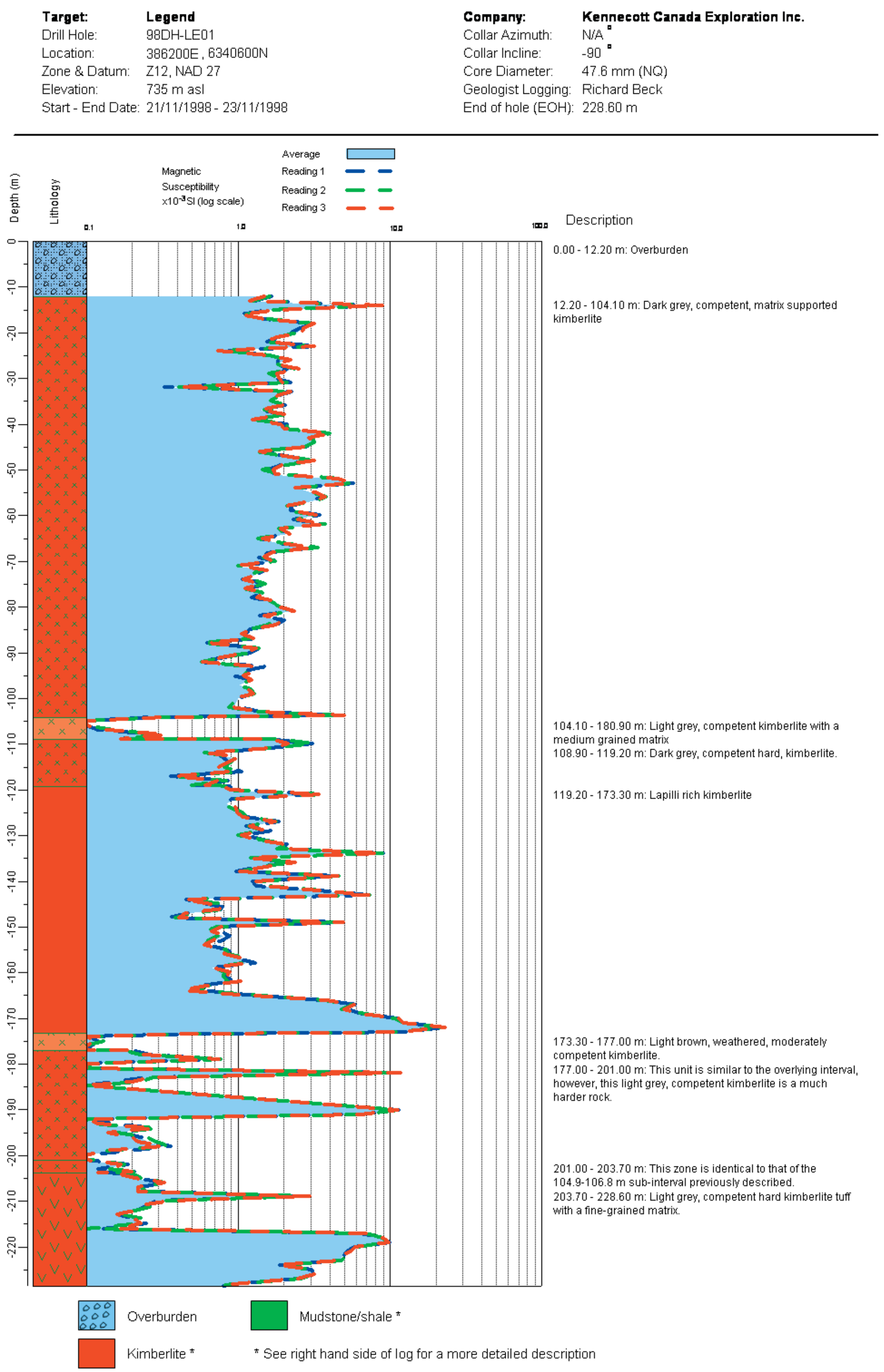


Figure 2. Magnetic susceptibility and lithology of the Legend pipe, Birch Mountains field.

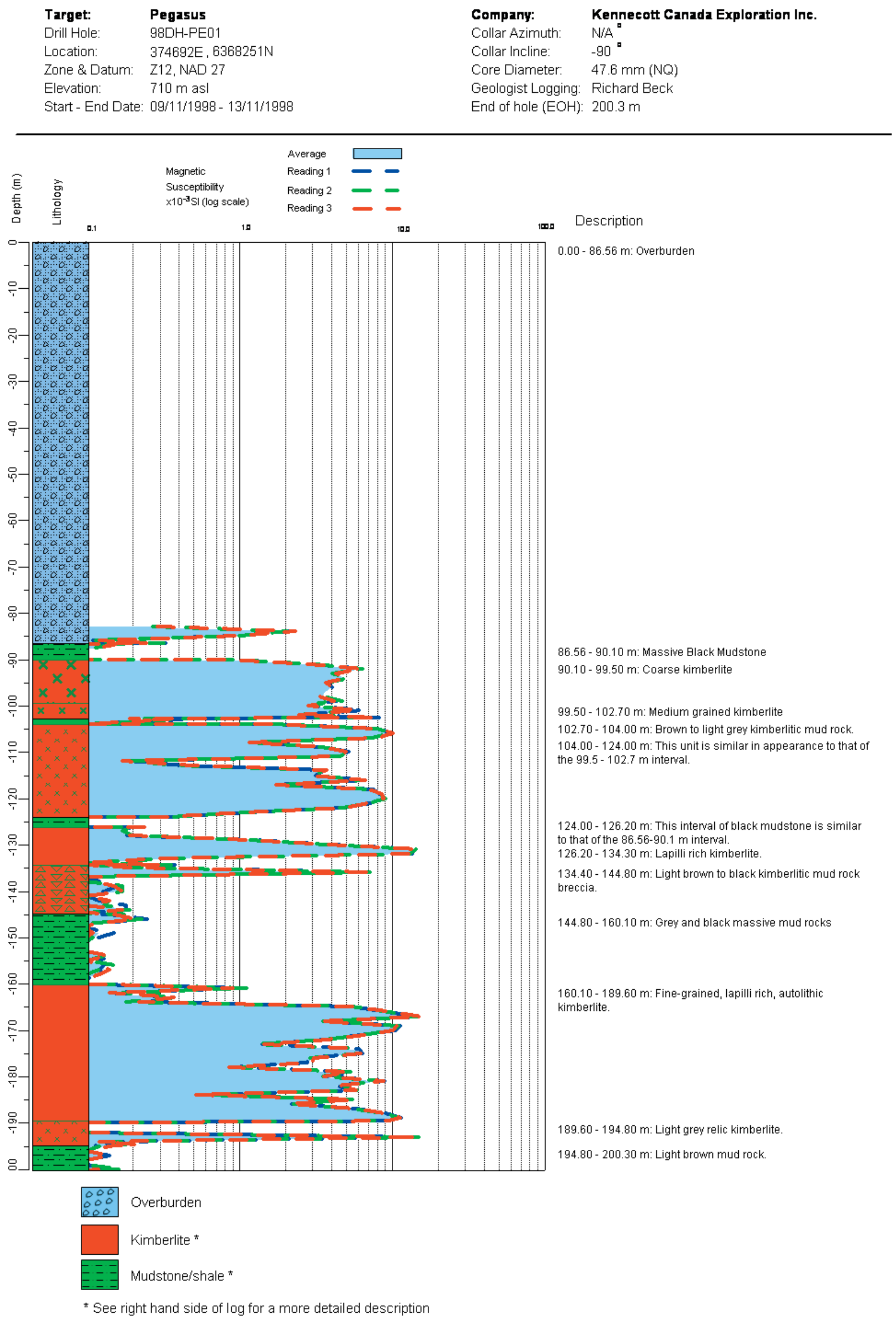


Figure 3. Magnetic susceptibility and lithology of the Pegasus pipe, Birch Mountains field.

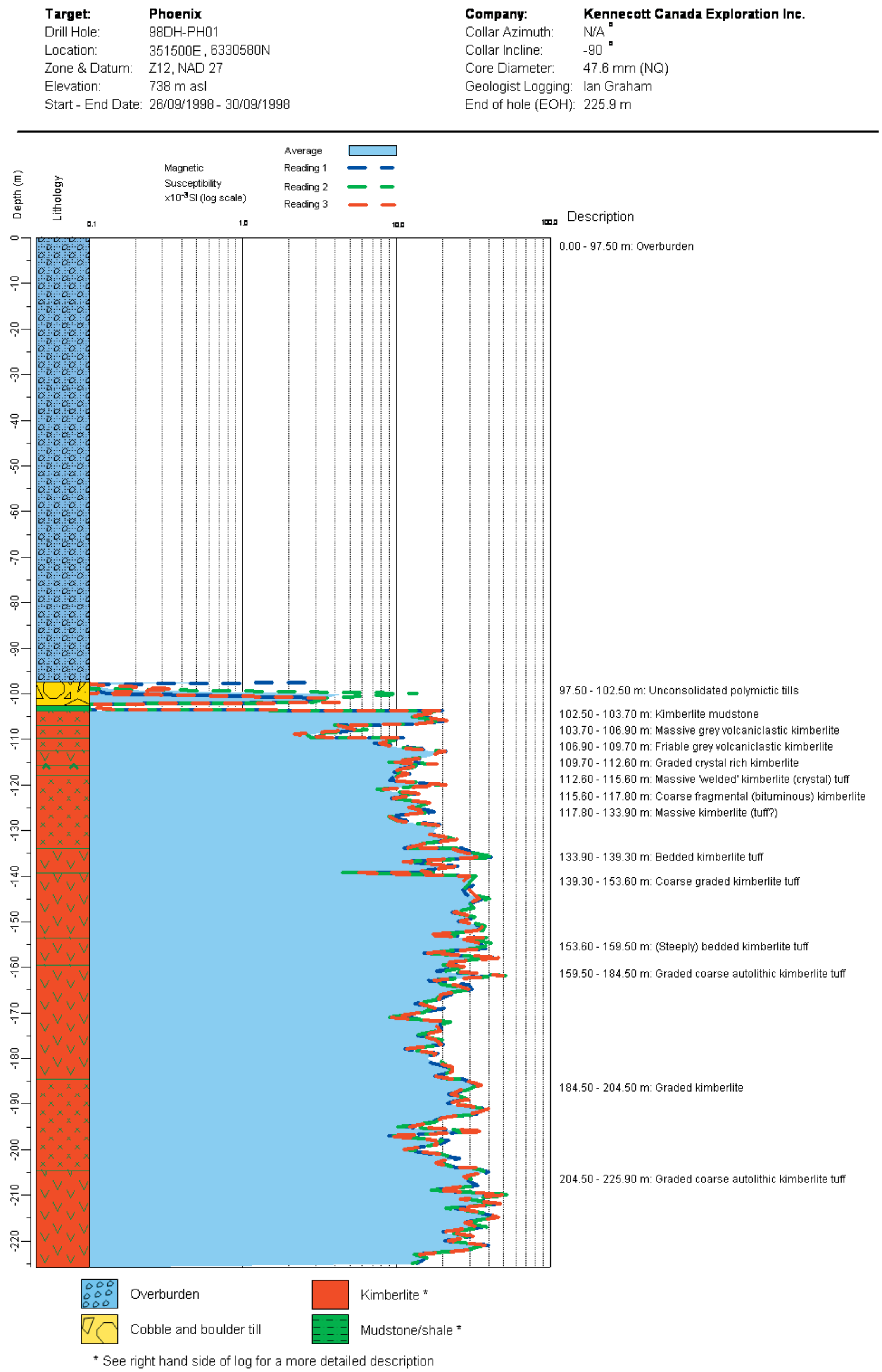


Figure 4. Magnetic susceptibility and lithology of the Phoenix pipe (drillhole 98DH-PH01), Birch Mountains field.

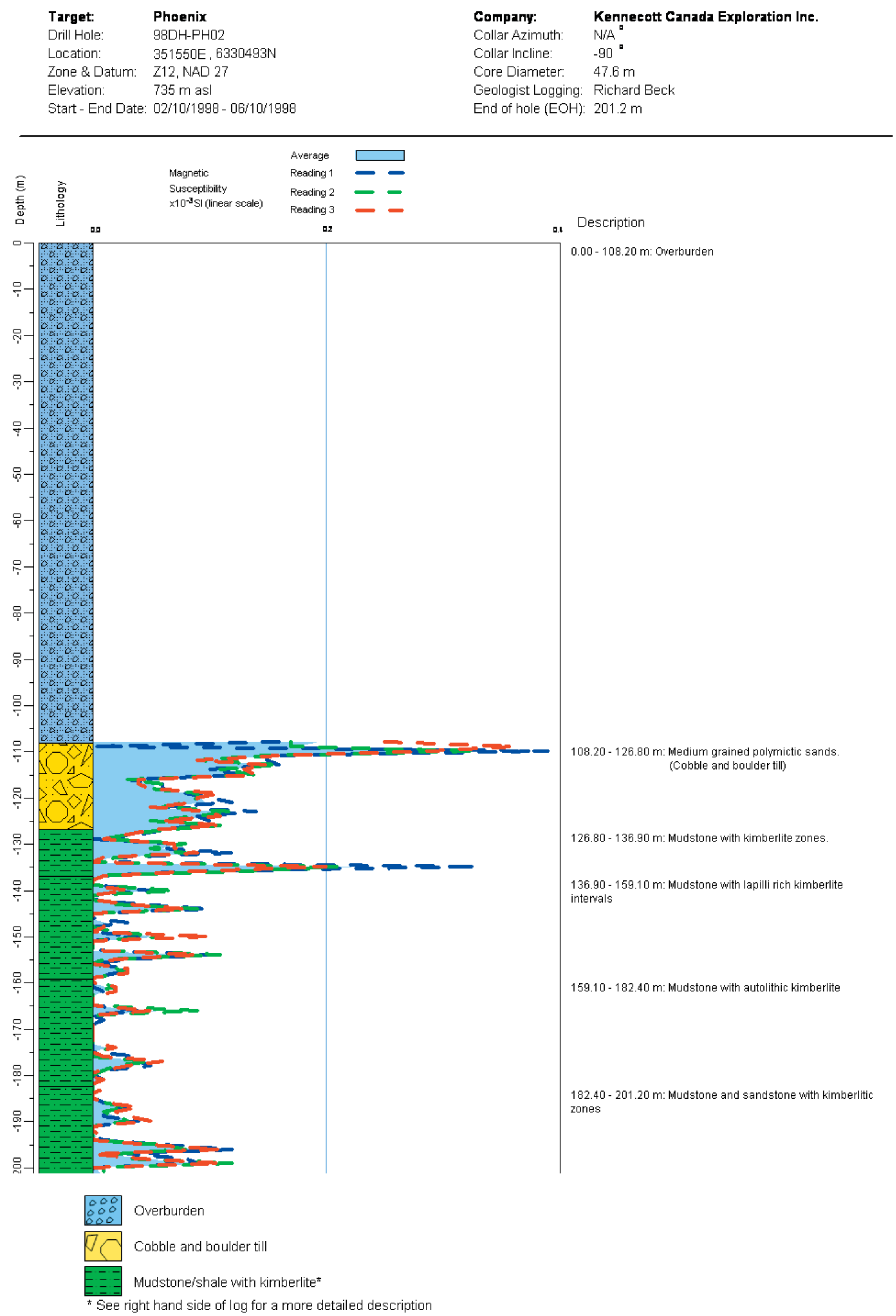


Figure 5. Magnetic susceptibility and lithology of the Phoenix pipe (drillhole 98DH-PH02), Birch Mountains field.

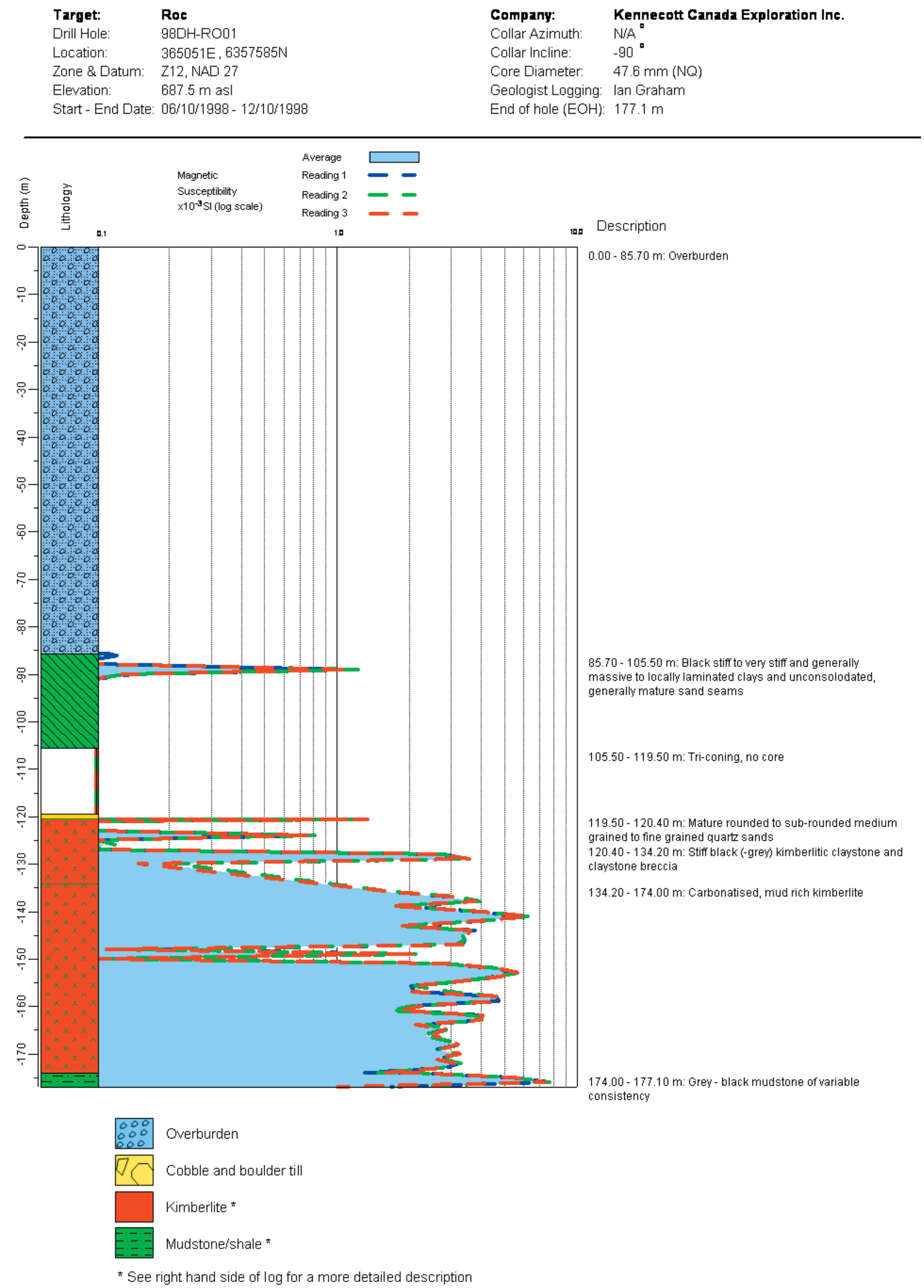


Figure 6. Magnetic susceptibility and lithology of the Roc pipe, Birch Mountains field.

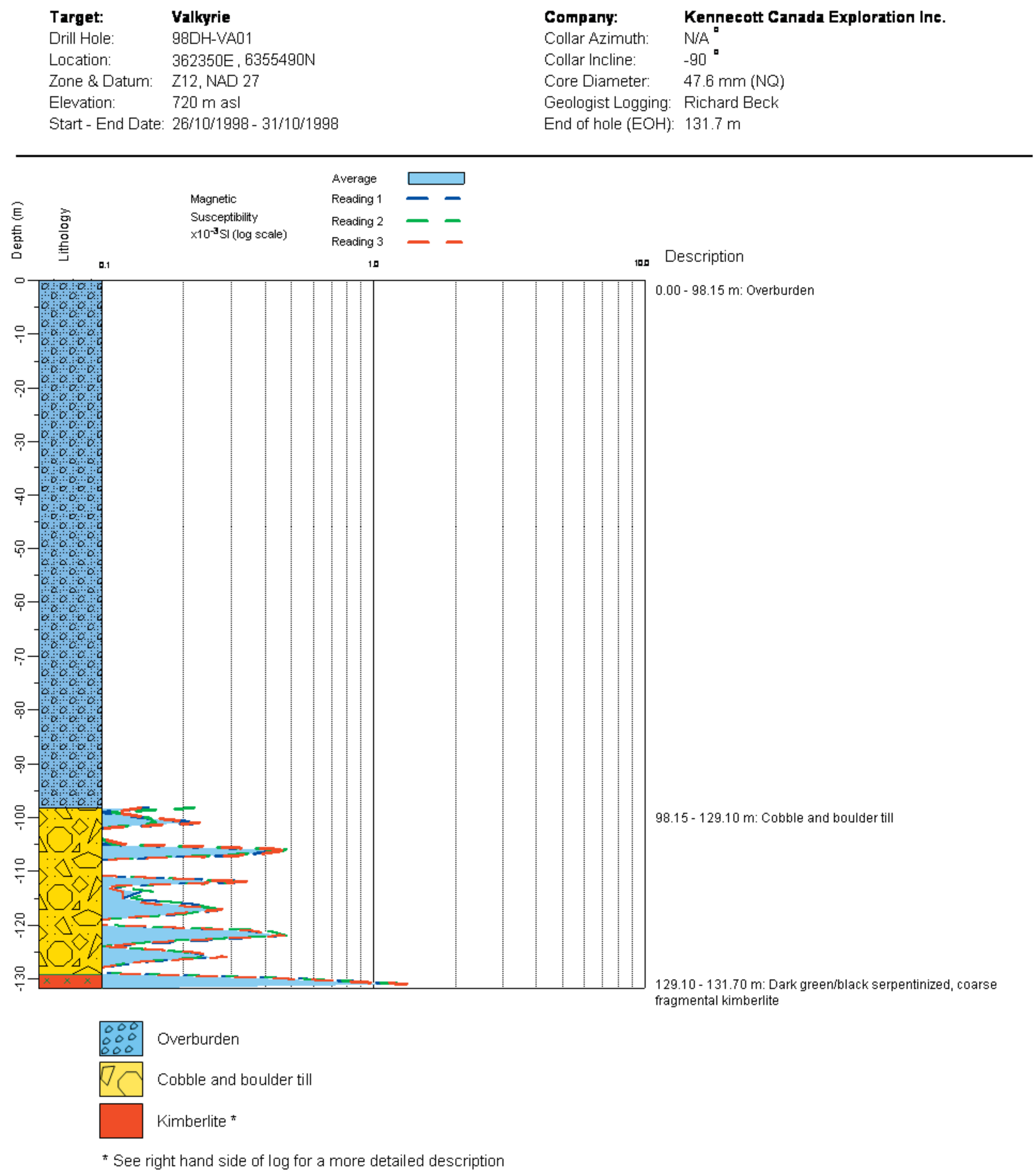


Figure 7. Magnetic susceptibility and lithology of the Valkyrie pipe (drillhole 98DH-VA01) Birch Mountains field.

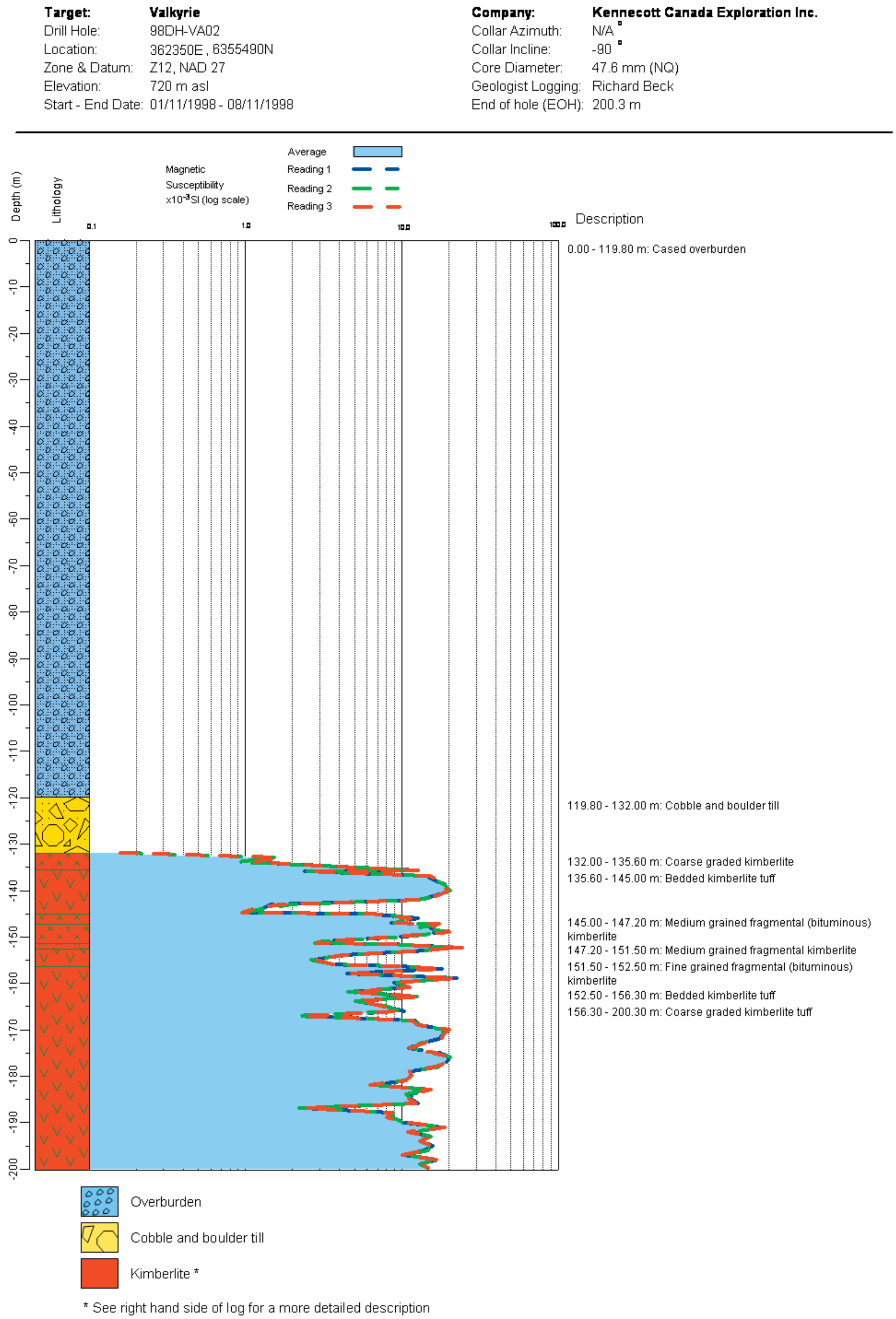


Figure 8. Magnetic susceptibility and lithology of the Valkyrie pipe (drillhole 98DH-VA02), Birch Mountains field.

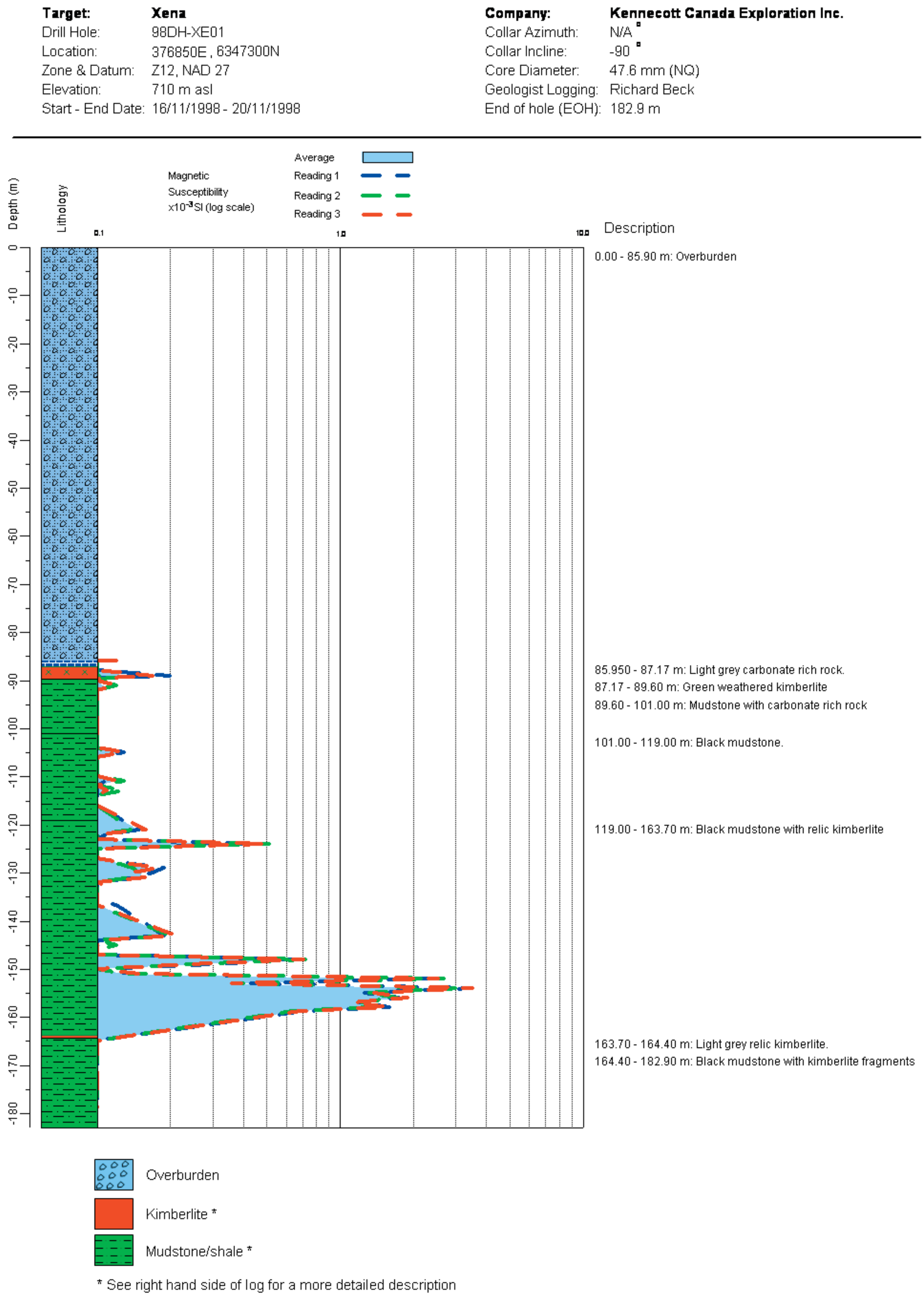
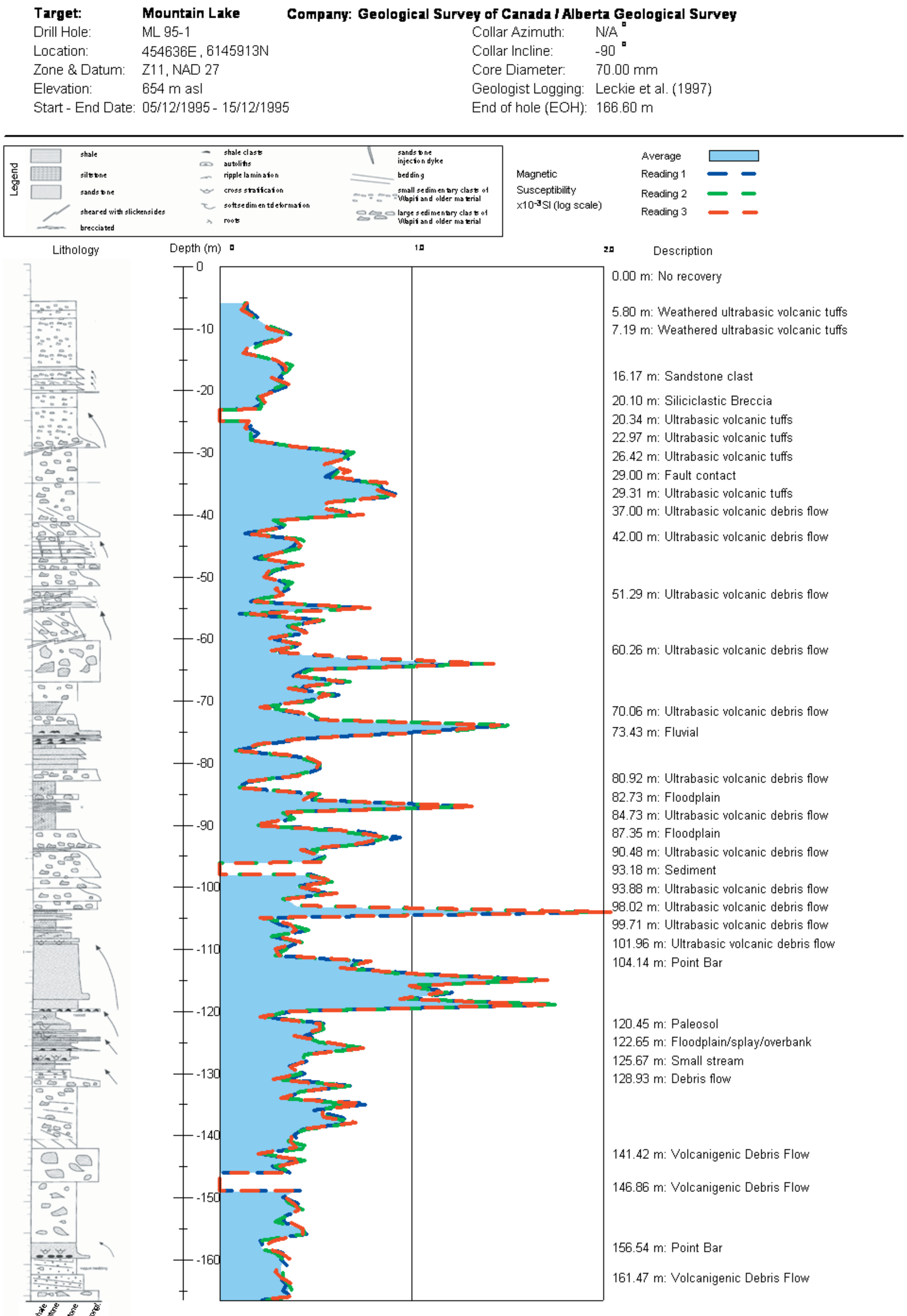
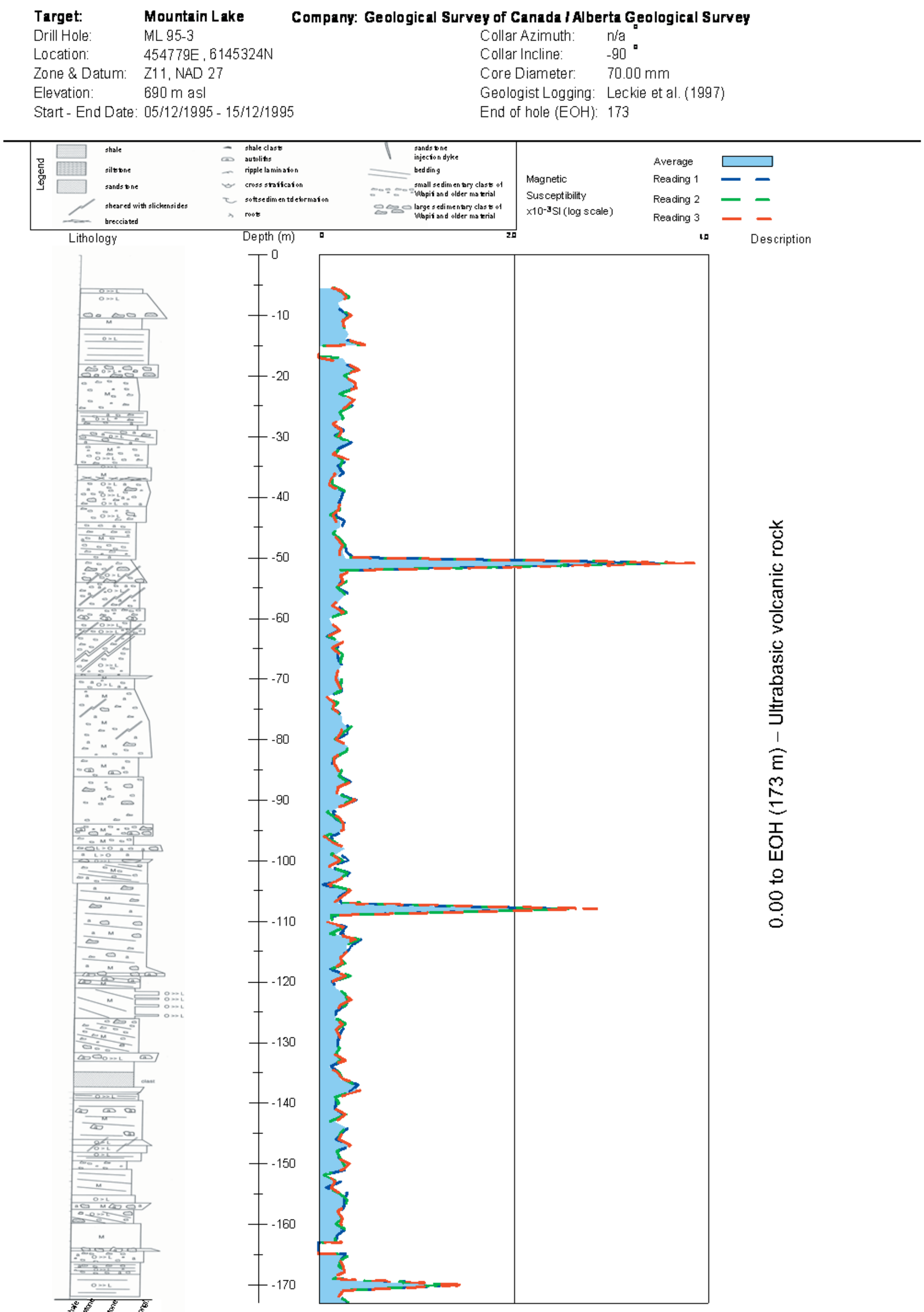


Figure 9. Magnetic susceptibility and lithology of the Xena pipe, Birch Mountains field.



Reference: Leckie, D.A., Kjarsgaard, B.A., Peirce, J.W., Grist, A.M., Collins, M., Sweet, A., Stasiuk, L., Tomica, M.A., Eccles, D.R., Dufresne, M.B., Fenton, M.M., Pawlowicz, J.G., Balzer, S.A., McIntyre, D.J. and McNeil, D.H. (1997): Geology of a Late Cretaceous possible kimberlite at Mountain Lake, Alberta – chemistry, petrology, indicator minerals, aeromagnetic signature, age, stratigraphic position and setting; Geological Survey of Canada, Open File Report 3441, 202 p.

Figure 10. Magnetic susceptibility and lithology of Mountain Lake North pipe (drillhole ML95-01).



Reference: Leckie, D.A., Kjarsgaard, B.A., Peirce, J.W., Grist, A.M., Collins, M., Sweet, A., Stasiuk, L., Tomica, M.A., Eccles, D.R., Dufresne, M.B., Fenton, M.M., Pawlowicz, J.G., Balzer, S.A., McIntyre, D.J. and McNeil, D.H. (1997): Geology of a Late Cretaceous possible kimberlite at Mountain Lake, Alberta – chemistry, petrology, indicator minerals, aeromagnetic signature, age, stratigraphic position and setting; Geological Survey of Canada, Open File Report 3441, 202 p.

Figure 11. Magnetic susceptibility and lithology of Mountain Lake South pipe (drillhole ML95-03).

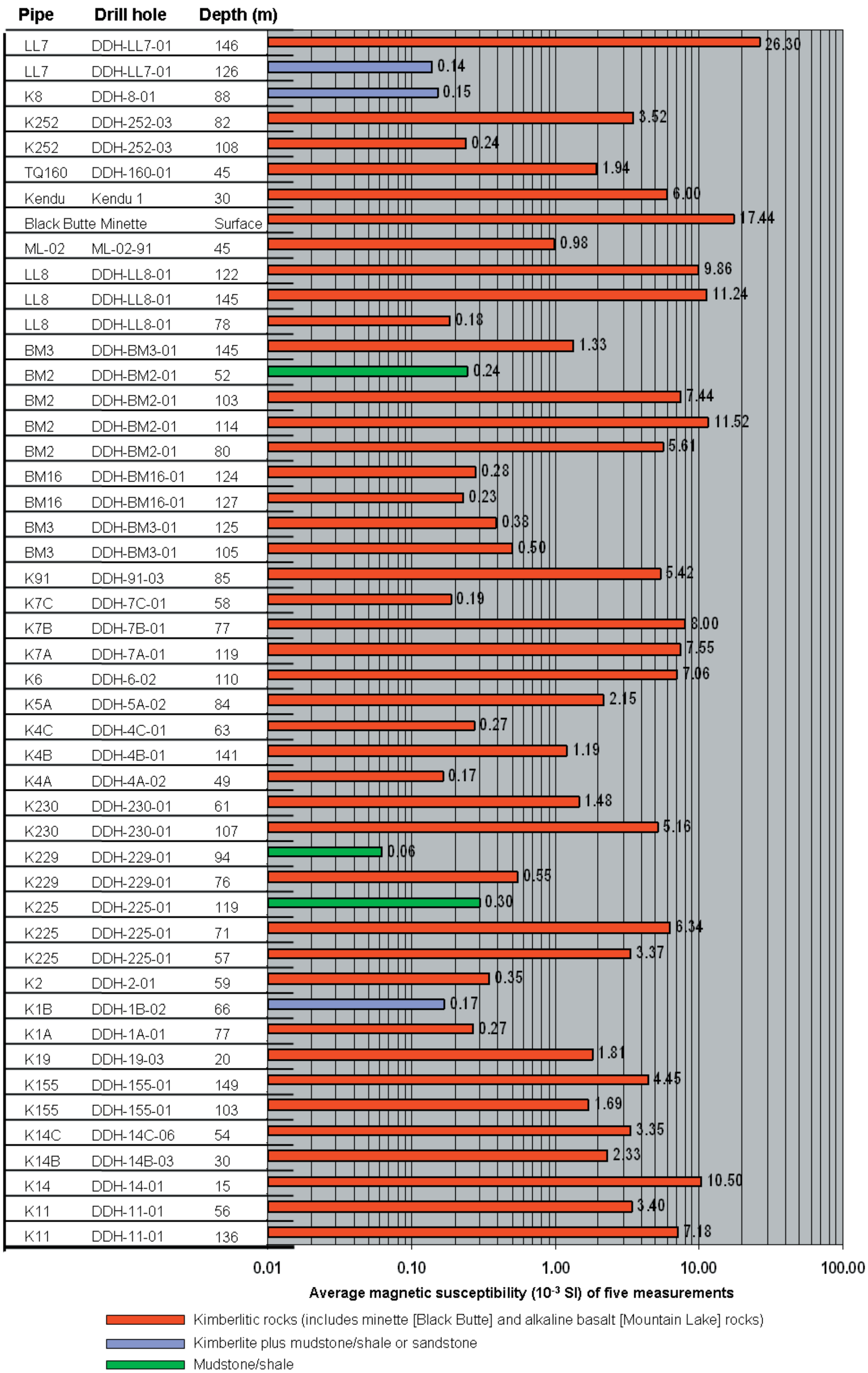


Figure 12. Averaged magnetic susceptibility from five measurements on selected kimberlitic hand-sized samples.

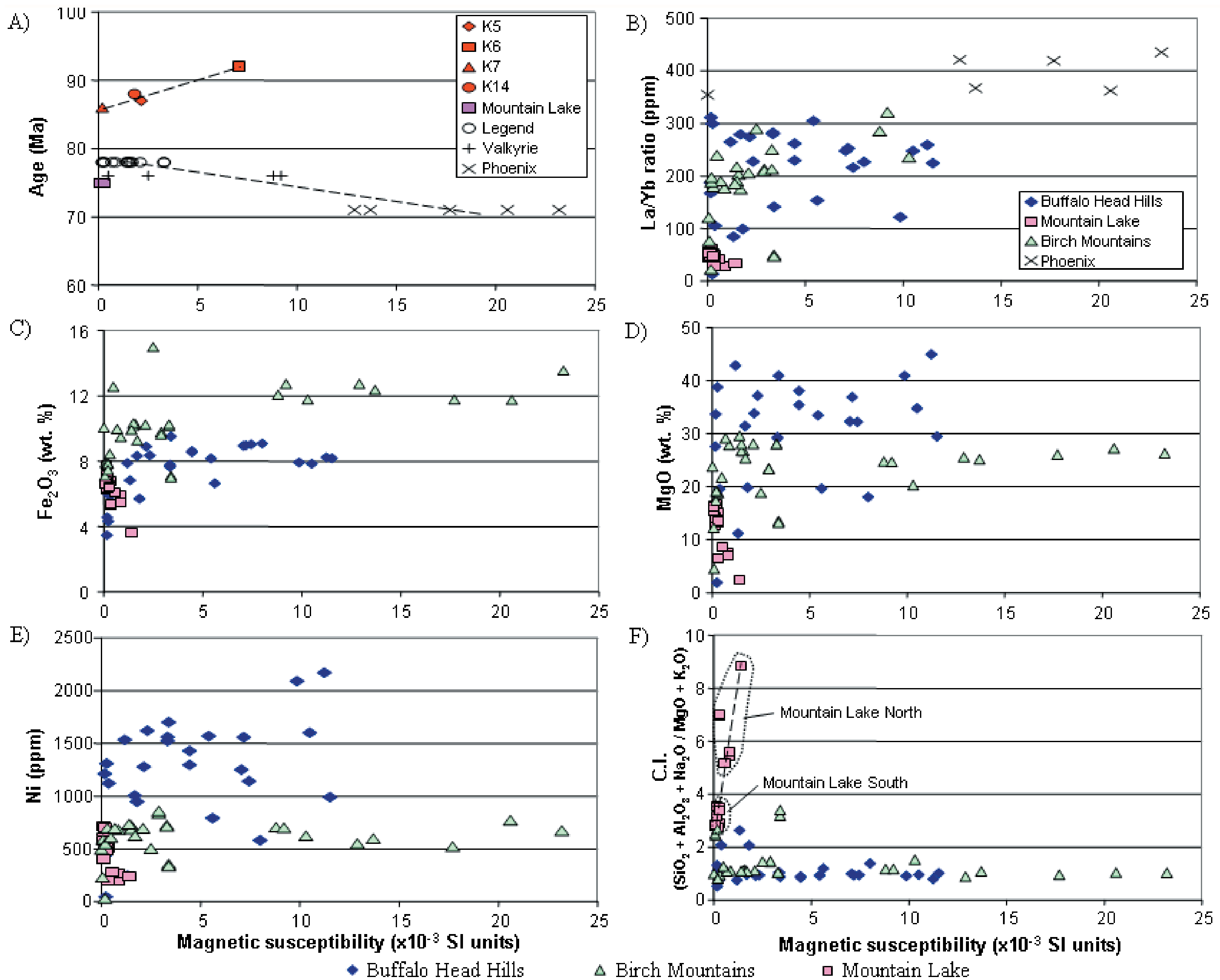


Figure 13. Magnetic susceptibility versus emplacement age and whole-rock geochemistry from selected ultramafic pipes in northern Alberta. Geochemical data from Eccles (2004) represent samples from the same core and depth as the magnetic susceptibility measurement samples.

3.2 Summary of Results

3.2.1 Devonian and Middle to Late Cretaceous Sedimentary Rocks

The median magnetic susceptibility of all measured sedimentary rocks is <0.52 x 10^{-3} SI units. The median value includes iron-rich rock sedimentary rock units such as 1) the Bad Heart Formation ooidal ironstone, which is located predominately in the Clear Hills area of northwestern Alberta and hosts the Clear Hills iron deposits, and 2) discontinuous, <1 m thick (often <0.3 m) siderite concretionary layers that occur throughout northern Alberta (Table 1). When these two lithologies are removed from the dataset, a more accurate depiction of the middle to Late Cretaceous clastic sedimentary rocks, which dominates the bedrock geology in north-central and northwestern Alberta, is characterized by a median magnetic susceptibility of <0.15 x 10^{-3} SI units.

The Devonian carbonate rocks in northeastern Alberta have some high magnetic susceptibilities (up to 1.81 x 10^{-3} SI units; Table 1). These high magnetic susceptibilities are related to areas of locally intense iron alteration and isolated development of centimetre-size sulphide nodules at the sub-Cretaceous unconformity, which Eccles and Pana (2003) suggest is associated with joints/faults that acted as pathways for up-welling iron-rich fluids in the Devonian carbonate succession. Because these are localized anomalies, geophysical surveys in northeastern Alberta, particularly in areas where the Devonian rocks crop out or sub crop, explorationists should be aware that the potential exists to confuse these anomalies with 'bulls-eye-type' anomalies associated with kimberlite pipes.

3.2.2 Birch Mountains Kimberlite Field

Magnetic susceptibility measurements on the complete drill core intersections from pipes in the Birch Mountains field, which were submitted for government archive by Kennecott Canada Exploration Inc., show why magnetic surveys are successful for the delineation of kimberlite targets in Alberta. Figures 1 to 9 and Table 1 show that the magnetic susceptibility can be used to distinguish kimberlite from clastic sedimentary rock in the Birch Mountains pipes. This observation is particularly noticeable in drill cores that include interlayered kimberlite and shale (e.g., Dragon, Figure 1; Pegasus, Figure 3).

The Legend (Figure 2), Pegasus (Figure 3), Phoenix (Figure 4) and Valkyrie (Figure 8) pipes have continuous (>20 m) intersections of kimberlite. These kimberlite intersections have median magnetic susceptibility measurements of 1.27 x 10^{-3}, 3.7 x 10^{-3}, 19.0 x 10^{-3}, and 11.7 x 10^{-3} SI units, respectively (Table 1). The Phoenix kimberlite has magnetic susceptibility readings of up to 52.7 x 10^{-3} SI units.

In contrast, shale-dominated lithologies have much lower magnetic susceptibilities. For example, kimberlite and shale intersections from the Pegasus drill core have median magnetic susceptibilities of 3.7 x 10^{-3} SI and 0.1 x 10^{-3} SI units, respectively. In general, the shale intersections have median magnetic susceptibility of <0.15 x 10^{-3} SI units.

Several cores contain discontinuous kimberlitic fragments and/or 'seams' of kimberlite in shale (e.g., Dragon, Figure 1; Phoenix, Figure 5; Xena, Figure 9). These sections are characterized by sporadic magnetic susceptibility readings that can differentiate between shale and kimberlite-rich shale, the latter of which, is depicted by higher magnetic susceptibility with readings of up to 3.4 x 10^{-3} SI units (e.g., Figure 8, Xena pipe, 154 m). Based on the aforementioned magnetic susceptibility variations between kimberlite- and shale-dominant sections, a hand-held magnetic susceptibility meter may be used as a complementary tool for drill core logging, particularly for complicated shale-kimberlite sections and resedimented volcaniclastic kimberlite.

Two drill holes (Phoenix, Figure 5; Valkyrie, Figure 7) intersected cobble-boulder till, which was described by Aravanis (1999) as intercalated rubbly, light-grey clay, rounded quartz, granodiorite and quartz diorite cobbles and interlayered light-brown, fine to medium grained sand with 20% pebbles and quartz diorite and quartzite cobbles. Magnetic susceptibility measurements of the surficial deposits are sporadic with readings between 0.03 to 0.5 and median values of 0.1.

3.2.3 Mountain Lake Ultrabasic Field

The pipes at Mountain Lake have petrographic and geochemical characteristics that are similar to ultrabasic and alkali olivine basalt rocks (Leckie et al., 1997; Eccles, 2004). The median magnetic susceptibility of the Mountain Lake North and South core is 0.4 x 10^{-3} and 0.22 x 10^{-3} SI units, respectively. Because the Mountain Lake South pipe comprises a rock type more representative of pyroclastic rock than the Mountain Lake North pipe (Leckie et al., 1997; Field and Scott Smith, 1999), and therefore, more representative of the magmatic rock-type, a value of 0.22 x 10^{-3} SI units is the recommended magnetic susceptibility for Mountain Lake. This value is particularly apparent if the three high magnetic susceptibility outliers, or spikes, are removed from Figure 11 (also see Table 1), whereby the measurements cluster near 0.22 x 10^{-3} SI units. The spikes at 51, 108 and 170 m have respective magnetic susceptibilities of 3.72, 2.64 and 1.44 x 10^{-3} SI units, and are thought to be related to abundances of basement xenoliths and/or Wapiti sedimentary clasts at these locales.

The sporadic magnetic susceptibility in Mountain Lake North core is related to moderate to high host-rock contamination, including quartz, plagioclase, alkali feldspar, hornblende and biotite intercalated into the matrix (Leckie et al., 1997). High magnetic susceptibility peaks (up to 3.9 x 10^{-3} SI) in Mountain Lake North (Figure 10) are generally related to sandstone-rich units, such as point bar, fluvial channels, floodplains and volcaniclastic rock that is highly contaminated in the matrix and by large sedimentary clasts of Wapiti siltstone and sandstone.

3.2.4 Buffalo Head Hills Kimberlite Field

Forty-five hand-sized samples from 22 separate kimberlite pipes in the Buffalo Head Hills kimberlite field have magnetic susceptibilities of between 0.06 x 10^{-3} SI (K229 pipe) and 26.3 x 10^{-3} SI (LL7 pipe) units with a median of 1.8 x 10^{-3} SI units (Appendix 1, Figure 12). Despite the limitation of not analyzing continuous drill core, magnetic susceptibilities have been separated into three distinct groups based on the lithology of the different hand samples (Figure 12), and include:

1. Kimberlite with magnetic susceptibilities >0.19 x 10^{-3} SI. Buffalo Head Hills samples measured have a median of 2.1 x 10^{-3} SI units. Kimberlite altered by carbonate and silica, and surface-exposed kimberlite was included in this group, so the median is likely higher. For example the freshest, most competent kimberlite has magnetic susceptibilities of >2.3 x 10^{-3} SI units, and often >5.2 x 10^{-3} SI units.
2. Kimberlite plus mudstone or sandstone with magnetic susceptibilities of between 0.14 x 10^{-3} SI to 0.17 x 10^{-3} SI units.
3. Mudstone with magnetic susceptibilities of between 0.06 x 10^{-3} SI to 0.3 x 10^{-3} SI units.

Samples from pipes LL7, BM2, K225 and K229 illustrate the variation in magnetic susceptibility between kimberlite and mudstone or kimberlite and mudstone groupings. The magnetic susceptibility of kimberlite from these pipes is between 5.2 x 10^{-3} SI to 26.3 x 10^{-3} SI units, while the magnetic susceptibility of mudstone or kimberlite plus mudstone is between 0.06 x 10^{-3} SI to 0.3 x 10^{-3} SI units. Being able to distinguish between kimberlite and mudstone is important because the magnetic susceptibility of the interlayered mudstone in these pipes is likely equivalent to the local host rock.

4 Discussion

Most magnetic anomalies can be explained by the presence of trace or larger amounts of strongly magnetic (ferro- or ferri-magnetic) material. In kimberlite, magnetic minerals include predominately magnetite and ilmenite (e.g., Gerryts, 1970; Campbell, 1999). Kimberlites in northern Alberta contain about 3 to 10 % iron oxides consisting predominantly of magnetite, ilmenite, spinel and a solid solution of these constituents (Eccles, 2004). The magnetic susceptibilities from Buffalo Head Hills and Birch Mountains kimberlite core and hand samples available for measurement range between 0.19 x 10^{-3} SI and 52.7 x 10^{-3} SI units. These values are similar to the reported magnetic susceptibility of worldwide kimberlite. For example, Arnotte and Kostlin (2003) reported that the magnetic susceptibility range of samples from 131 African kimberlites is between 0.5 and 40 x 10^{-3} SI.

The pipe emplacement ages, whole rock geochemistry and petrographic characteristics from northern Alberta kimberlites can be used to make inferences on the causes for intra-field magnetic susceptibility variations.

4.1 Kimberlite Emplacement Age Versus Magnetic Susceptibility

A compilation of currently available emplacement ages of northern Alberta kimberlitic pipes by Eccles (2004) shows that all of the pipes dated in northern Alberta were emplaced in the Late Cretaceous (Coniacian to Maastrichtian). Variations of up to approximately 22 million years are apparent in intra-field comparisons. The K5, K7A, K14 and K6 kimberlites from the Buffalo Head Hills have reported emplacement ages of between 86±3 Ma to 92±2 Ma by U-Pb on perovskite (Carlson et al., 1999; Skelton et al., 2003; Heaman et al., 2003; Eccles, 2004). The Birch Mountains and Mountain Lake pipes are younger: the Phoenix, Dragon, Xena, Legend and Valkyrie pipes have emplacement ages of between 70.3±1.6 Ma to 79.4±1.6 Ma as determined by U-Pb on perovskite and Rb-Sr on phlogopite (Aravanis, 1999; Eccles, 2004). Palynological results are consistent with emplacement ages for the Mountain Lake pipes of 75-76 Ma from *in situ* laminated sediments (Leckie et al., 1997) and 68 Ma from non-marine sedimentary clasts (Wood et al., 1998).

Figure 13a plots kimberlite pipe emplacement ages against magnetic susceptibility. Despite a limited dataset for the Buffalo Head Hills, a positive trend is apparent from young-low magnetic susceptibility (K7) to old-higher magnetic susceptibility (K14). In contrast, the Birch Mountains has a negative trend as shown by old-low magnetic susceptibility (Legend) to young-high magnetic susceptibility (Phoenix). If these trends are valid, then the magnetic dating method may be particularly useful in the respective northern Alberta kimberlite fields. In addition, the trends suggest that relatively weakly magnetic northern Alberta kimberlite should be emplaced between 78 Ma and 86 Ma. In theory, this may be an important observation for future diamond exploration in northern Alberta, particularly because pipe K252, which has the best diamond results to date (estimated 55 carats per hundred tonnes from a 22.8 tonne sample) is low magnetic susceptibility kimberlite. More emplacement age dates, particularly for K252 are required to prove or discredit this theory.

4.2 Kimberlite Petrogenesis Versus Magnetic Susceptibility

Variations in magmatic differentiation between primitive and evolved kimberlite alter the mineralogy of the resulting kimberlite magma, and thus, offers a plausible explanation for variable degrees of magnetic susceptibility in the kimberlite. In general, evolved kimberlite, which may be devoid of olivine macrocrysts and is composed essentially of second-generation olivine, calcite, serpentinite and magnetite together with minor phlogopite, apatite and perovskite (e.g., Mitchell, 1986), should have higher magnetic susceptibilities due to increases in magnetite and ilmenite.

Based on petrography and whole rock geochemistry, Eccles (2004) suggested that the Buffalo Head Hills and Birch Mountains kimberlite fields can be differentiated by primitive to evolved kimberlite magmatic signatures, respectively. He suggested that the main process for magmatic differentiation in the northern Alberta kimberlite province is crystal fractionation and accumulation of olivine with the Birch Mountains pipes being further influenced by variable degrees of source enrichment (i.e., mantle metasomatism and/or less efficient carbonate loss during ascent than the Buffalo Head Hills) and partial melting in the sub-continental lithosphere.

Eccles (2004) further concluded that the Phoenix pipe represents the most evolved kimberlite in northern Alberta. Petrographic evidence that supports an evolved kimberlite magmatic signature for the Phoenix pipe is the presence of abundant complex atoll-textured spinel grains, which have progressed along magmatic trends towards strongly magnetic compositions. Mitchell and Clarke (1976) used the term ‘atoll spinel’ to describe resorbed, complexly mantled spinel grains believed to have formed by the instability of magnesian ulvöspinel–ulvöspinel–magnetite spinel with late-stage, carbonate-rich fluids that formed the groundmass. The cores of the atoll spinel grains in the Phoenix pipe are almost totally altered to magnetite, whereas the rims consist of Fe, Ti and relatively little Cr (Creighton and Eccles, 2003). Eccles (2004) also used geochemical evidence to conclude that the Phoenix pipe represents the most evolved kimberlite in northern Alberta because it exhibits the lowest degree of partial melting based on, for example, its high whole rock La (1400 times chondrite abundance) and La/Yb ratio (435). When the Eccles (2004) geochemical values, which were sampled from the same core and at approximately the same depth as the samples measured for magnetic susceptibility, are plotted against magnetic susceptibility, a positive trend on the plot of La/Yb versus magnetic susceptibility (Figure 13b) can be used to show the relationship between kimberlite magmatic evolution and magnetic susceptibility. We conclude, therefore, that the that higher magnetic susceptibility from the Phoenix pipe, which has the highest magnetic susceptibility of the northern Alberta kimberlite tested, is related to the degree of differentiation of the kimberlite magma.

A more modest, but still detectable conductivity anomaly in kimberlites may be due to serpentinization of olivine, where a by-product of serpentinization is disseminated magnetite. In order to test this, Figures 13c, 13d and 13e plot Fe_2O_3, MgO and Ni versus magnetic susceptibility, respectively. The slightly positive correlation between magnetic susceptibility and MgO and Ni for the Buffalo Head Hills pipes generally reflects the higher modal abundance of olivine in comparison to Birch Mountains and Mountain Lake pipes (Eccles, 2004). This observation may indicate that the process of olivine accumulation with subsequent serpentinization might lead to higher magnetic signatures. In contrast, the Birch Mountains pipes, which are influenced by olivine fractionation (Eccles, 2004), have a flat Ni and MgO versus magnetic susceptibility trend suggestive of little influence from serpentine-magnetite. The plot of Fe_2O_3 versus magnetic susceptibility shows a bimodal population for Birch Mountains samples, where samples with higher Fe_2O_3 and magnetic susceptibility being attributed to the more evolved nature of the Valkyrie and Phoenix pipe kimberlite magma as discussed above.

4.3 Country Rock Contamination versus Magnetic Susceptibility

We have already shown that the contamination of kimberlite by shale can cause sporadic magnetic susceptibility measurements. The contamination index (C.I.) of Clement (1992; C.I. = $SiO_2 + Al_2O_3 + Na_2O$ / $MgO + K_2O$), which can be used to test the degree of country rock contamination in kimberlite, was plotted against magnetic susceptibility (Figure 13f). There are no apparent trends between the C.I. and magnetic susceptibility for the Buffalo Head Hills and the Birch Mountains kimberlite samples. Figure 13f shows a slightly negative correlation for the Mountain Lake samples, which may be related to high-C.I. (>4.0) resedimented volcaniclastic material from Mountain Lake North pipe versus low-C.I. material from the Mountain Lake South pyroclastic rock. Because the resedimented volcaniclastic material at Mountain Lake has a higher magnetic susceptibility, magnetic surveys in Alberta must consider country rock contamination during geophysical surveys. Especially since most of the pipes in northern Alberta are crater-facies and thus may be subject to reworking and introduction of the host sediments.

In addition to kimberlite contamination, the Cretaceous sediments may also be 'contaminated', or enriched, in ferro-magnetic minerals. Discontinuous Fe-rich (e.g., siderite) concretionary layers are common in sedimentary sections throughout northern Alberta. One geophysical target in the Birch Mountains resulted from pyrite- and greigite ($Fe^{2+}Fe^{3+}S_4$)-rich mudstone (Aravanis, 1999).

4.4 Geophysical Targets of Potentially Similar Response to Kimberlite

The intent of this section is to impart general geological observations to geologists not familiar with the geological setting of northern Alberta. There are a number of geological scenarios that can lead to the development of confined magnetic sources, any of which would justify further investigation from a narrow geophysical perspective without other information. Some examples that may pertain to Alberta include:

- Culture (e.g., oil and gas well-sites)
- Sulphide- or iron oxide-rich areas associated with high angle normal faults
- Magnetic concentrations in basement rocks
- Sulphide/magnetite-rich zones in soil, regolith and surficial (glacialfluvial or till) deposits
- Sediments contained in depressions or discontinuous patches of overburden or sediment
- Siderite-rich, discontinuous concretionary layers
- Collapse breccia pipes (e.g., salt diapers)

Thus, future geophysical surveys should be aware that any of these conditions could exist in northern Alberta, some of which can only be checked by thorough field investigation.

5 Conclusions

The magnetic susceptibilities of kimberlitic rocks in the Buffalo Head Hills and Birch Mountains fields yielded measurements of between 0.19 x 10^{-3} SI and 52.7 x 10^{-3} SI units. The freshest, most competent kimberlite samples had magnetic susceptibilities of >2.3 x 10^{-3} SI units. In contrast, the magnetic susceptibilities of shale, siltstone and sandstone sampled from locations throughout northern Alberta, and of shale interlayered with kimberlite, are generally <0.15 x 10^{-3} SI units. Thus, the contrast in magnetic properties between the kimberlitic pipes and the host sedimentary rocks is sufficient to produce a significant geophysical target.

Some of the pipes in the Birch Mountains have considerably higher magnetic susceptibilities. For example, the Phoenix and Valkyrie pipes have median magnetic susceptibilities of 19.0 x 10^{-3} SI and 11.7 x 10^{-3} SI units, respectively. Elevated magnetic susceptibilities in these pipes are related to the magmatic evolution of the kimberlite magma, where evolved kimberlite magma related to differences in magmatic differentiation (e.g., source composition and/or smaller degrees of partial melting) contain a higher modal volume of iron oxides such as atoll-textured spinel with magnetite-rich cores.

With respect to magnetic susceptibility versus kimberlite emplacement age, the Buffalo Head Hills and Birch Mountains kimberlites exhibit positive and negative trends, respectively. The trends suggest that relatively weakly magnetic northern Alberta kimberlite should be emplaced between 78 and 86 Ma. This may be an important observation for future diamond exploration in northern Alberta, particularly because pipe K252, which has the best diamond results to date (estimated 55 carats per hundred tonnes from a 22.8 tonne sample) is low magnetic susceptibility kimberlite.

The introduction or mixing of sedimentary host rocks with the kimberlite can affect the magnetic susceptibility signal and future airborne magnetic surveys should be aware that some of the Alberta pipes are composed of resedimented volcaniclastic kimberlite. In these instances, magnetic susceptibility measurements can aid in the logging of complicated intercalated kimberlite and sedimentary rock, and pick out for example, kimberlitic shales that are optically difficult to discern.

The magnetic susceptibility data presented in this study may be of particular interest to industry. The data can be considered for the planning and interpretation of future ground based and airborne magnetic surveys associated with diamond exploration work in Alberta.

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Appendix 1 -Magnetic susceptibility measurements of ultramafic rocks in Alberta.

Pipe:	**Dragon**			
Drillhole:	**98DH-DR01**			
Top interval:	**121.9 m**			
Bottom interval:	**190.8 m**			
Total metres:	**68.9**			
Number of measurement spots:	**62**			
Depth (m)	**10^{-3} SI**			**10^{-3} SI Average**
	Reading 1	**Reading 2**	**Reading 3**	
121.9	0.19	0.2	0.11	0.166
122	0	-0.03	-0.01	-0.013
123	0.1	0.1	0.07	0.09
124	0.05	0.05	0.06	0.053
125	0.08	0.07	0.03	0.06
126	0.14	0.14	0.14	0.14
127	0.04	0.06	0.05	0.05
128	0.22	0.24	0.2	0.22
129	0.09	0.11	0.09	0.096
130	0.12	0.11	0.11	0.113
131	0.1	0.08	0.06	0.08
132	0.13	0.13	0.14	0.133
133	0.01	0.01	0.01	0.01
134	0.15	0.2	0.18	0.176
135	0.26	0.23	0.25	0.246
135.95	0.29	0.27	0.26	0.273
152.65	0.11	0.1	0.11	0.106
153	0.07	0.03	0.02	0.04
154	0.04	0.01	0	0.016
155	0.06	0.06	0.05	0.056
156	0.09	0.11	0.11	0.103
157	0.03	0.03	0.03	0.03
158	0.03	0.04	0.03	0.033
159	0.33	0.32	0.31	0.32
160	0.1	0.09	0.1	0.096
161	0.01	0.01	0.02	0.013
162	0	0.01	0	0.003

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
163	0.04	0.04	0.04	0.04
164	-0.01	-0.01	0.01	-0.003
165	0	0	0	0
166	0.02	0.03	0.06	0.036
167	0	0	0	0
168	0.02	0.03	0	0.016
169	0.02	0.04	0.03	0.03
170	0.05	0.06	0.04	0.05
171	0.01	0	0	0.003
172	0.02	0.01	0.02	0.016
173	0.02	0.03	0.03	0.026
174	0	-0.03	-0.02	-0.016
175	0	0.01	0	0.003
176	0.07	0.07	0.05	0.063
177	0.13	0.12	0.12	0.123
178	0.1	0.12	0.09	0.103
179	0.05	0.06	0.06	0.056
180	0.03	0.02	0.04	0.03
181	0.02	0.05	0.04	0.036
182	0.08	0.06	0.04	0.06
183	0.08	0.11	0.1	0.096
184	0.07	0.07	0.07	0.07
185	0.07	0.07	0.08	0.073
186	0.03	0.02	0.03	0.026
187	0.09	0.1	0.09	0.093
187.15	0.08	0.06	0.07	0.07
187.25	0.03	0.03	0.04	0.033
187.35	0.06	0.04	0.05	0.05
188	0.07	0.07	0.08	0.073
188.25	0.03	0	0.01	0.013
188.35	0.11	0.09	0.11	0.103
188.45	0.02	0.03	0.01	0.02
189	0.09	0.1	0.1	0.096
190	0.03	0.03	0.05	0.036
190.8	0.01	0.02	0.03	0.02

Pipe:	Legend			
Drillhole:	98DH-LE01			
Top interval:	12.19			
Bottom interval:	228.6			
Total metres:	216.41			
Number of measurement spots:	224			
Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
12.19	1.67	1.63	1.49	1.596
13	1.31	1.27	1.2	1.26
14	8.64	8.4	8.91	8.65
15	1.61	1.61	1.83	1.683
16	1.05	1.13	1.04	1.073
17	1.49	1.6	1.5	1.53
18	3.14	3.14	3.2	3.16
19	2.58	2.58	2.71	2.623
20	2.26	2.46	2.66	2.46
21	1.91	1.85	1.8	1.853
22	1.55	1.54	1.54	1.543
23	3.33	2.95	3.19	3.156
24	0.87	0.82	0.74	0.81
25	1.55	1.62	1.57	1.58
26	1.84	2.1	2.23	2.056
27	1.84	1.8	1.76	1.8
28	2.1	2.37	2.54	2.336
29	1.86	1.6	1.8	1.753
30	1.68	1.84	1.85	1.79
31	2.22	2.16	1.97	2.116
32	0.33	0.41	0.41	0.383
33	2.26	2.14	2.23	2.21
34	1.81	1.85	1.78	1.813
35	1.79	1.64	1.75	1.726
36	2.06	2.06	2.02	2.046
37	1.39	1.5	1.39	1.426
38	1.95	2.09	2.01	2.016
39	1.28	1.28	1.25	1.27

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
40	2.11	2.16	1.92	2.063
41	2.04	2.05	2.03	2.04
42	4.03	4.04	4	4.023
43	2.92	3.09	2.93	2.98
44	3.35	3.18	3.24	3.256
45	2.78	2.78	2.81	2.79
46	1.42	1.32	1.39	1.376
47	2.06	2.02	2.03	2.036
48	3.08	3.12	3.18	3.126
49	1.91	2.12	1.94	1.99
50	1.59	1.46	1.72	1.59
51	1.75	1.88	1.76	1.796
52	4.65	4.71	4.55	4.636
53	5.85	5.62	5.62	5.696
54	2.62	2.54	2.4	2.52
55	3.08	3.01	3.25	3.113
56	3.71	3.83	3.77	3.77
57	2.92	3.23	3.03	3.06
58	2.25	2.08	2.08	2.136
59	2.23	2.05	2.19	2.156
60	3.48	3.22	3.27	3.323
61	2.31	2.44	2.48	2.41
62	3.67	3.74	3.73	3.713
63	1.88	1.87	1.92	1.89
64	2.13	2.02	2.21	2.12
65	1.44	1.35	1.45	1.413
66	1.86	1.97	1.91	1.913
67	3.19	3.36	3.08	3.21
68	1.69	1.65	1.71	1.683
69	1.28	1.43	1.49	1.4
70	1.81	1.76	1.69	1.753
71	1.07	1	1	1.023
72	1.52	1.45	1.55	1.506
73	1.31	1.19	1.33	1.276
74	1.08	1.22	1.09	1.13
75	1.58	1.51	1.42	1.503
76	1.18	1.09	1.12	1.13

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
77	1.48	1.5	1.52	1.5
78	1.24	1.39	1.33	1.32
79	1.76	1.68	1.88	1.773
80	1.85	1.86	1.83	1.846
81	2.32	2.27	2.34	2.31
82	1.37	1.51	1.5	1.46
83	2.01	1.78	1.98	1.923
84	1.8	1.58	1.79	1.723
85	1.2	1.22	1.25	1.223
86	1.13	1.04	1.06	1.076
87	1.33	1.24	1.27	1.28
88	0.63	0.58	0.64	0.616
89	1.39	1.41	1.32	1.373
90	1.22	1.18	1.14	1.18
91	0.83	0.81	0.78	0.806
92	0.55	0.58	0.59	0.573
93	1.53	1.17	1.3	1.333
94	1.11	1.18	1.34	1.21
95	0.94	1.09	1.09	1.04
96	1.22	1.23	1.23	1.226
97	1.05	0.99	1.04	1.026
98	1.2	1.22	1.16	1.193
99	1.23	1.28	1.27	1.26
100	1.03	1.01	0.97	1.003
101	1.02	0.93	0.98	0.976
102	1.03	0.87	0.92	0.94
103	1.39	1.36	1.38	1.376
103.85	4.97	4.99	5	4.986
104.15	0.27	0.33	0.33	0.31
105	-0.02	-0.01	0	-0.01
106	-0.01	-0.01	-0.01	-0.01
107	0.12	0.15	0.14	0.136
108	0.29	0.3	0.34	0.31
108.85	0.17	0.18	0.17	0.173
108.95	1.53	1.76	1.65	1.646
110	3.1	3.12	2.14	2.786
111	1.65	1.69	1.66	1.666

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
112	0.71	0.6	0.61	0.64
113	0.79	0.96	1.02	0.923
114	0.86	0.91	0.89	0.886
115	0.81	0.81	0.74	0.786
116	1.06	1.02	0.9	0.993
117	0.36	0.37	0.38	0.37
118	0.86	0.84	0.74	0.813
119	0.52	0.5	0.61	0.543
119.15	0.67	0.69	0.63	0.663
119.25	0.89	0.86	0.79	0.846
120	0.92	0.8	0.89	0.87
121	3.34	3.69	3.55	3.526
122	0.91	0.94	0.97	0.94
123	0.87	0.81	0.86	0.846
124	0.96	0.9	0.97	0.943
125	1.04	1.07	0.99	1.033
126	1.14	1.15	1.07	1.12
127	1.85	1.78	1.77	1.8
128	1.14	1.19	1.2	1.176
129	1.68	1.43	1.5	1.536
130	1.12	1	1.06	1.06
131	1.46	1.41	1.3	1.39
132	2.12	2.1	2.05	2.09
133	1.89	1.8	1.95	1.88
134	9.11	8.97	8.85	8.976
135	1.2	1.22	1.19	1.203
136	2.22	2.3	2.4	2.306
137	1.37	1.4	1.51	1.426
138	0.98	1.07	1.02	1.023
139	4.47	4.59	4.58	4.546
140	1.25	1.38	1.3	1.31
141	1.32	1.54	1.47	1.443
142	3.39	3.54	3.43	3.453
143	7.43	7.36	7.31	7.366
144	0.46	0.47	0.44	0.456
145	0.64	0.79	0.67	0.7
146	0.89	0.85	0.8	0.846

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
147	0.48	0.52	0.45	0.483
148	0.35	0.39	0.41	0.383
149	4.9	4.91	4.93	4.913
150	0.74	0.73	0.78	0.75
151	0.75	0.62	0.67	0.68
152	0.89	0.74	0.81	0.813
153	0.79	0.64	0.68	0.703
154	0.64	0.62	0.6	0.62
155	0.83	0.84	0.8	0.823
156	0.96	0.86	0.82	0.88
157	0.99	1.17	1.07	1.076
158	1.3	1.07	1.18	1.183
159	0.67	0.7	0.68	0.683
160	0.86	0.81	0.88	0.85
161	0.83	0.8	0.84	0.823
162	0.95	0.86	1.04	0.95
163	0.57	0.63	0.62	0.606
164	0.57	0.55	0.43	0.516
165	1.13	1.17	1.02	1.106
166	3.64	3.7	3.83	3.723
167	6.12	5.75	5.82	5.896
168	5.21	4.84	5	5.016
169	6.62	6.88	6.55	6.683
170	11.1	10.9	11.5	11.166
171	12.9	12.3	12.2	12.466
172	22.8	22.4	23.2	22.8
173	12.5	11.1	11.6	11.733
173.25	4.19	4.23	4.18	4.2
173.35	0.57	0.46	0.42	0.483
174	0.05	0.06	0.04	0.05
175	0.12	0.13	0.12	0.123
176	0.11	0.06	0.07	0.08
176.95	0.09	0.1	0.1	0.096
177.05	0.2	0.17	0.2	0.19
178	0.26	0.23	0.24	0.243
179	0.72	0.81	0.75	0.76
180	0.09	0.11	0.09	0.096

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
181	0.05	0.04	0.05	0.046
182	11.4	11.7	11.7	11.6
183	0.26	0.28	0.27	0.27
184	0.15	0.23	0.2	0.193
184.7	0.08	0.08	0.07	0.076
190.2	11.5	11.5	11.3	11.433
191	6.44	6.33	6.49	6.42
192	0.09	0.07	0.05	0.07
193	0.15	0.1	0.12	0.123
194	0.28	0.3	0.28	0.286
195	0.17	0.16	0.14	0.156
196	0.23	0.25	0.2	0.226
197	0.27	0.29	0.22	0.26
198	0.36	0.35	0.32	0.343
199	0.19	0.13	0.13	0.15
200	-0.05	-0.02	-0.07	-0.046
200.95	0.04	0.03	0.06	0.043
201.05	0.07	0.11	0.08	0.086
202	0.19	0.18	0.17	0.18
203	0.12	0.14	0.15	0.136
203.65	0.21	0.22	0.2	0.21
203.75	0.12	0.15	0.12	0.13
204	0.19	0.2	0.16	0.183
205	0.2	0.23	0.21	0.213
206	0.34	0.33	0.33	0.333
207	0.23	0.23	0.22	0.226
208	0.26	0.25	0.22	0.243
209	2.74	2.98	2.96	2.893
210	0.29	0.32	0.36	0.323
211	0.26	0.3	0.23	0.263
212	0.22	0.22	0.22	0.22
213	0.16	0.17	0.16	0.163
214	0.21	0.24	0.21	0.22
215	0.25	0.23	0.23	0.236
216	0.13	0.1	0.16	0.13
217	6.42	6.93	6.77	6.706
218	8.96	8.9	9.04	8.966

Depth (m)	10^{-3} SI			10^{-3} SI Average
	Reading 1	Reading 2	Reading 3	
219	10	9.68	9.78	9.82
220	5.83	6.11	5.9	5.946
221	5.23	5.42	5.5	5.383
222	4.92	5.14	4.61	4.89
223	4.61	4.78	4.6	4.663
224	1.89	2	1.81	1.9
225	3.04	2.94	3.15	3.043
226	3.17	3.17	3.19	3.176
227	2.55	2.58	2.48	2.536
228	1.11	1.09	1.08	1.093
228.6	0.79	0.72	0.73	0.746

Pipe:	Pegasus			
Drillhole:	98DH-PE01			
Top interval:	83			
Bottom interval:	200.3			
Total metres:	117.3			
Number of measurement spots:	141			
Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
83	0.29	0.27	0.29	0.283
84	2.26	2.06	2.33	2.216
85	0.97	1.03	0.99	0.996
86	0.11	0.11	0.12	0.113
86.55	0.33	0.32	0.25	0.3
86.65	0.1	0.1	0.1	0.1
87	0.13	0.14	0.15	0.14
88	0.11	0.09	0.07	0.09
89	0.07	0.08	0.1	0.083
90	0.11	0.1	0.09	0.1
90.05	0.07	0.08	0.07	0.073
90.15	0.92	0.89	0.88	0.896
91	3.07	3.14	2.9	3.036
92	6.42	6.42	6.35	6.396
93	4.18	4.04	4.27	4.163
94	5.02	5.25	5.05	5.106
95	3.72	3.78	3.7	3.733
96	4.05	3.92	4.04	4.003
97	3.62	3.65	3.66	3.643
98	3.62	3.52	3.35	3.496
99	4.33	4.71	4.2	4.413
99.45	3.46	3.3	3.43	3.396
99.55	3.57	3.47	3.45	3.496
100	2.87	3.01	2.83	2.903
101	6.52	5.49	6.02	6.01
102	2.45	2.46	2.47	2.46
102.65	8.23	7.75	7.9	7.96
102.75	0.26	0.22	0.19	0.223
103	0.42	0.37	0.34	0.376

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
103.95	0.1	0.09	0.09	0.093
104.05	1.69	1.64	1.53	1.62
105	8.03	8.05	7.9	7.993
106	10.2	9.9	10.1	10.066
107	8.01	7.5	8.02	7.843
108	1.21	1.19	1.14	1.18
109	3.46	3.49	3.53	3.493
110	5.2	5.11	5.03	5.113
111	4.48	4.6	4.54	4.54
112	0.19	0.19	0.17	0.183
113	0.43	0.39	0.49	0.436
114	3.65	3.65	3.76	3.686
115	3.16	3.09	2.99	3.08
116	6.66	6.67	6.67	6.666
117	1.73	1.78	1.75	1.753
118	7.58	7.36	7.13	7.356
119	8.27	8.39	8.58	8.413
120	8.78	9.15	8.86	8.93
121	7.22	7.08	6.99	7.096
122	4.86	4.82	4.9	4.86
123	1.11	1.1	1.09	1.1
123.95	0.34	0.35	0.31	0.333
124.05	0.1	0.07	0.09	0.086
125	0.07	0.08	0.07	0.073
126	0.06	0.07	0.06	0.063
126.15	0.08	0.09	0.08	0.083
126.25	0.2	0.2	0.24	0.213
127	0.16	0.17	0.2	0.176
128	0.17	0.2	0.19	0.186
129	1.23	1.16	1.17	1.186
130	4.01	3.74	3.86	3.87
131	15.1	14.4	14.7	14.733
132	13.6	13.3	14	13.633
133	0.33	0.36	0.3	0.33
134	0.1	0.09	0.1	0.096
134.25	0.4	0.37	0.3	0.356
134.35	0.11	0.11	0.1	0.106

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
135	0.25	0.2	0.19	0.213
136	7.16	7.2	7.44	7.266
137	0.06	0.07	0.09	0.073
138	0.12	0.07	0.11	0.1
139	0.16	0.17	0.15	0.16
140	0.13	0.17	0.17	0.156
141	0.03	0.01	0.05	0.03
142	0.12	0.14	0.14	0.133
143	0.18	0.13	0.1	0.136
144	0.18	0.19	0.17	0.18
144.75	0.08	0.07	0.08	0.076
144.85	0.11	0.11	0.13	0.116
145	0.14	0.17	0.15	0.153
146	0.25	0.23	0.21	0.23
147	0.11	0.1	0.11	0.106
148	0	0.01	0	0.003
149	0.15	0.1	0.11	0.12
150	0.12	0.11	0.1	0.11
151	0.06	0.06	0.04	0.053
152	0.09	0.09	0.06	0.08
153	0.09	0.08	0.07	0.08
154	0.14	0.13	0.14	0.136
155	0.12	0.1	0.1	0.106
156	0.13	0.15	0.12	0.133
157	0.12	0.12	0.14	0.126
158	0.13	0.09	0.12	0.113
159	0.08	0.07	0.08	0.076
160	0.07	0.07	0.04	0.06
160.05	0.01	0.05	0.04	0.033
160.15	0.12	0.15	0.14	0.136
161	1.06	1.11	0.9	1.023
162	0.14	0.17	0.14	0.15
163	0.36	0.39	0.37	0.373
164	0.25	0.18	0.22	0.216
165	5.43	5.41	5.47	5.436
166	9.41	9.61	10.1	9.706
167	14.9	15	15.6	15.166

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
168	3.58	3.51	3.35	3.48
169	11.4	11	10.8	11.066
170	10.6	10.2	10.1	10.3
171	6.27	6.35	6.53	6.383
172	3.74	3.67	3.77	3.726
173	1.41	1.28	1.45	1.38
174	6.04	6.13	6.02	6.063
175	6.4	6.14	6.28	6.273
176	2.8	2.89	3.08	2.923
177	2.78	2.88	2.98	2.88
178	0.92	0.91	0.86	0.896
179	5.38	5.57	5.22	5.39
180	3.7	3.45	3.57	3.573
181	8.91	8.67	8.89	8.823
182	4.16	4.44	4.42	4.34
183	5.94	5.89	5.82	5.883
184	0.61	0.61	0.52	0.58
185	5.38	5.49	5.63	5.5
186	2.2	2.26	2.13	2.196
187	5.79	5.41	5.71	5.636
188	9.13	8.86	8.95	8.98
189	11.5	11.2	11.4	11.366
189.55	9.95	9.68	9.63	9.753
189.65	3.74	3.49	3.41	3.546
190	0.1	0.1	0.09	0.096
191	0.08	0.1	0.09	0.09
192	0.09	0.1	0.1	0.096
193	14.2	14.9	14.7	14.6
194	0.16	0.13	0.12	0.136
194.75	0.12	0.18	0.21	0.17
194.85	0.11	0.14	0.15	0.133
195	0.12	0.12	0.14	0.126
196	0.05	0.04	0.05	0.046
197	0.14	0.1	0.14	0.126
198	0.05	0.04	0.05	0.046
199	0.1	0.07	0.07	0.08
200	0.16	0.17	0.12	0.15
200.3	0.08	0.05	0.06	0.063

Pipe:	Phoenix			
Drillhole:	98DH-PH01			
Top interval:	97.54			
Bottom interval:	225.9			
Total metres:	128.36			
Number of measurement spots:	155			
Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
97.54	2.53	0	0.09	0.873
98	0.09	0.05	0.07	0.07
99	0.01	0.08	0.36	0.15
100	0.13	13.7	-0.04	4.596
101	3.39	3.58	3.49	3.486
102	2.51	2.82	4.32	3.216
102.45	-0.05	-0.04	-0.05	-0.046
102.55	-0.01	-0.01	0.01	-0.003
103	0.1	0.09	0.09	0.093
103.65	0.1	0.07	0.15	0.106
103.75	20.1	16.7	19.7	18.833
104	16.1	17.9	20.2	18.066
105	13.6	12.1	13.1	12.933
106	21.7	19.6	21.8	21.033
106.85	13.5	13.4	13.1	13.333
106.95	6.84	5.39	4.1	5.443
107	4.09	3.97	4.07	4.043
108	5.6	6.52	5.39	5.836
109	3.54	2.62	2.19	2.783
109.65	2.93	2.78	3.66	3.123
109.75	11.1	10.3	10.6	10.666
110	9.43	10.6	10.6	10.21
111	7.17	8.15	7.86	7.726
112	12.8	11.4	9.88	11.36
112.55	17.4	17.4	16.4	17.066
112.65	21.1	20.5	20.8	20.8
113	17.7	18.3	18.9	18.3
114	16.4	16.4	16.7	16.5
115	10.7	8.92	9.19	9.603

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
115.55	17	18	18.5	17.833
115.65	14.4	12.6	14.7	13.9
116	12.5	13.3	13	12.933
117	9	9.8	9.39	9.396
117.75	12.3	11.5	12	11.933
117.85	11	11.1	11.5	11.2
118	9.92	10.2	10.7	10.273
119	9.13	9.13	8.97	9.076
120	19.2	20	21.2	20.133
121	7.91	7.52	8.3	7.91
122	13.5	12.6	14.5	13.533
123	9.37	9.68	9.62	9.556
124	16.3	16.3	16.5	16.366
125	13.5	13.5	12.1	13.033
126	17.8	16.8	16.5	17.033
127	8.52	8.99	9.07	8.86
128	12.1	10.1	10.3	10.833
129	20.5	18.1	19.6	19.4
130	18.4	17.7	16.9	17.666
131	17.4	17.5	16.5	17.133
132	24.4	24	26	24.8
133	15.5	15.1	15.4	15.333
133.85	11.3	11.6	11.7	11.533
133.95	19.7	16	18.6	18.1
134	26.7	26.6	22.2	25.166
135	31.5	30.8	28.2	30.166
136	42	44.6	36.1	40.9
137	11.4	11.8	11.2	11.466
138	25.3	24.9	25.1	25.1
139	15.3	15	14.6	14.966
139.25	18	17.5	16.7	17.4
139.35	5.59	4.51	5.16	5.086
140	31.6	33.3	29.9	31.6
141	34.8	31.1	27.9	31.266
142	32.3	29.1	25.6	29
143	27.5	27.4	30.1	28.333
144	28.4	31.2	32.3	30.633

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
145	37.1	40.5	34.9	37.5
146	30.3	30.2	29.7	30.066
147	31.5	32.4	27.7	30.533
148	23.3	23.4	23.9	23.533
149	34	32.5	33.3	33.266
150	25.7	28.8	26.1	26.866
151	37.4	37.7	37.4	37.5
152	33.6	36.9	33.9	34.8
153	17.8	17.9	15.7	17.133
153.55	36.2	33.1	30.9	33.4
153.65	36.1	38.9	36.8	37.266
154	29.7	31.3	27.9	29.633
155	36	45.1	37.5	39.533
156	38.6	32	37	35.866
157	15.3	15.7	15.8	15.6
158	42.6	40.1	49.5	44.066
159	23.7	23.8	22.2	23.233
159.45	25	22.3	19.5	22.266
159.55	20.4	20.3	20.5	20.4
160	27.3	28.7	27.8	27.933
161	18.4	20.6	23.9	20.966
162	50.8	52.1	49.4	50.766
163	15.4	17	17.8	16.733
164	29.8	20.4	24.2	24.8
165	31.2	30.6	29.8	30.533
166	22.4	18.7	19.4	20.166
167	19.1	18.6	19.3	19
168	13.3	13.8	14.5	13.866
169	20.5	17.2	18	18.566
170	14.3	14.8	14.1	14.4
171	11.7	9.17	8.95	9.94
172	20.1	22.7	21.3	21.366
173	19.3	17.6	18.4	18.433
174	20.3	18.4	19.4	19.366
175	13.8	13.1	14.2	13.7
176	18.5	20.1	18.3	18.966
177	20.3	20.9	19.8	20.333

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
178	11.5	12.1	11.6	11.733
179	18.7	17.4	18.3	18.133
180	14.9	16.6	16.9	16.133
181	16.6	20.4	17.8	18.266
182	22	21.9	23.4	22.433
183	23.9	22.8	23.3	23.333
184	17.9	18.5	17.9	18.1
184.45	21	22.1	22.6	21.9
184.55	27.1	26.2	27.2	26.833
185	29	29.7	29	29.233
186	33.1	34.2	36.1	34.466
187	30	29.1	26.8	28.633
188	22.1	23.4	22.8	22.766
189	28	28.9	31.1	29.333
190	21.8	23.8	21.5	22.366
191	38.4	36.7	40.7	38.6
192	38.5	36.9	32	35.8
193	20	20	20.3	20.1
194	17.1	17.9	17.5	17.5
195	11.4	10.3	12.3	11.333
196	35.9	35.6	39	36.833
197	9.03	9.46	8.9	9.13
198	22	20	18.3	20.1
199	18.8	17.8	18.5	18.366
200	11.1	11.5	11.3	11.3
201	16.8	19.8	18.9	18.5
202	25.8	23.8	22.7	24.1
203	19.6	19.2	18.3	19.033
203.95	24.5	24.1	23.1	23.9
204.05	31.3	31	34.1	32.133
205	39.9	39.6	38.1	39.2
206	31.3	28	27.7	29
207	29.5	32.6	30.4	30.833
208	34.2	34.4	29.5	32.7
209	17.4	17.1	18.3	17.6
210	50.3	55.8	51.9	52.666
211	29.7	29.6	26.3	28.533

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
212	47.9	45.1	47.7	46.9
213	24.1	21.1	24.6	23.266
214	35.2	36.8	36.8	36.266
215	45	44.1	46.2	45.1
216	26.8	27.8	28.2	27.6
217	36.3	40	33.4	36.566
218	20.1	21.6	20.2	20.633
219	30.6	29.1	32.8	30.833
220	20.9	22.4	22	21.766
221	39.8	37.1	38	38.3
222	29.6	29.4	30	29.666
223	13.8	13.1	14.2	13.7
224	15.7	16.7	15.8	16.066
225	13.5	12.6	13.7	13.266
225.9	11.5	11.8	9.63	10.976

Pipe:	Phoenix			
Drillhole:	98DH-PH02			
Top interval:	108			
Bottom interval:	201.2			
Total metres:	93.2			
Number of measurement spots:	95			
Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
108	0.16	0.17	0.25	0.193
109	0	0.17	0.36	0.176
110	0.39	0.33	0.29	0.336
111	0.15	0.15	0.16	0.153
112	0.15	0.09	0.09	0.11
113	0.16	0.16	0.15	0.156
114	0.1	0.11	0.13	0.113
115	0.13	0.14	0.14	0.136
116	0.03	0.03	0.04	0.033
117	0.06	0.06	0.04	0.053
118	0.06	0.05	0.05	0.053
119	0.08	0.09	0.11	0.093
120	0.1	0.09	0.09	0.093
121	0.12	0.08	0.09	0.096
122	0.06	0.06	0.05	0.056
123	0.14	0.12	0.1	0.12
124	0.09	0.09	0.11	0.096
125	0.1	0.05	0.06	0.07
126	0.09	0.11	0.11	0.103
127	0.06	0.06	0.05	0.056
128	0.04	0.03	0.03	0.033
129	-0.02	0.01	0.01	0
130	0.07	0.08	0.07	0.073
131	0.06	0.05	0.07	0.06
132	0.12	0.08	0.09	0.096
133	0.02	0.02	0.01	0.016
134	-0.01	0	-0.02	-0.01
135	0.33	0.21	0.2	0.246
136	0.08	0.13	0.09	0.1

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
137	0.01	0	0.01	0.006
138	-0.01	-0.01	-0.02	-0.013
139	-0.01	0	-0.02	-0.01
140	0.05	0.07	0.03	0.05
141	-0.02	-0.01	-0.02	-0.016
142	0	-0.01	-0.01	-0.006
143	0.04	0.02	0.03	0.03
144	0.1	0.09	0.08	0.09
145	-0.03	-0.02	0	-0.016
146	0	0	0	0
147	0.03	0	0.01	0.013
148	-0.01	0	0.01	0
149	-0.01	0.02	0	0.003
150	0.04	0.06	0.1	0.066
151	-0.01	0	0	-0.003
152	-0.01	-0.02	0	-0.01
153	0	0	0	0
154	0.1	0.11	0.09	0.1
155	0.03	0.01	0.02	0.02
156	-0.01	0	-0.01	-0.006
157	0.03	0.02	0.03	0.026
158	0.02	0.03	0.03	0.026
159	-0.01	-0.01	-0.01	-0.01
160	0	-0.01	0	-0.003
161	0	0.02	0.02	0.013
162	0.01	0	0.02	0.01
163	-0.14	-0.09	-0.12	-0.116
164	0	-0.01	0	-0.003
165	-0.01	-0.02	-0.02	-0.016
166	0.04	0.09	0.05	0.06
167	-0.03	0	0	-0.01
168	0.01	-0.01	-0.03	-0.01
169	0	0	-0.01	-0.003
170	-0.02	-0.02	-0.01	-0.016
171	-0.02	-0.01	-0.02	-0.016
172	0	0	0	0
173	-0.02	-0.01	-0.02	-0.016

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
174	0	0.02	0.02	0.013
175	-0.01	-0.01	0	-0.006
176	0.04	-0.01	0.01	0.013
177	0.04	0.05	0.06	0.05
178	0.05	0.02	0.03	0.033
179	0.01	0.01	0.01	0.01
180	0	-0.02	-0.01	-0.01
181	0.01	0.01	0.01	0.01
182	-0.05	-0.03	-0.02	-0.033
183	-0.01	-0.02	0.01	-0.006
184	-0.01	-0.02	-0.02	-0.016
185	-0.06	-0.02	-0.02	-0.033
186	0.01	0.01	0.01	0.01
187	0.03	0.03	0.04	0.033
188	0.01	0.01	0.02	0.013
189	0.01	0.02	0.03	0.02
190	0.04	0.03	0.05	0.04
191	-0.02	-0.04	-0.03	-0.03
192	0	0	-0.02	-0.006
193	0	0	0.01	0.003
194	0.01	-0.02	-0.01	-0.006
195	0.06	0.06	0.05	0.056
196	0.12	0.08	0.11	0.103
197	0.03	0.02	0	0.016
198	0.08	0.03	0.04	0.05
199	0.09	0.12	0.11	0.106
200	0	0.01	0	0.003
201	0	0.01	0.01	0.006
201.2	0.04	0.02	0.02	0.026

Pipe:	Roc	
Drillhole:	98DH-RO01	
Top interval:	85.7	
Bottom interval:	177	
Total metres:	91.3	
Number of measurement spots:	61	

Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
85.7	0.1	0.09	0.1	0.096
86	0.13	0.09	0.1	0.106
87	0.08	0.06	0.06	0.066
88	-0.04	-0.01	0	-0.016
89	1.07	1.23	1.13	1.143
90	0.14	0.13	0.12	0.13
91	0.03	0.03	0.01	0.023
120.6	1.23	1.32	1.35	1.3
121	0.07	0.05	0.06	0.06
122	0.09	0.1	0.09	0.093
123	0.06	0.07	0.09	0.073
124	0.76	0.81	0.77	0.78
125	0.08	0.06	0.08	0.073
126	0.1	0.12	0.1	0.106
127	0.08	0.09	0.08	0.083
128	2.77	2.81	2.65	2.743
129	3.44	3.36	3.57	3.456
130	0.21	0.21	0.15	0.19
136	1.73	1.74	1.73	1.733
137	2.9	3.13	3	3.01
138	3.83	3.96	3.77	3.853
139	1.93	1.74	1.69	1.786
140	3.91	4.07	4.05	4.01
141	6.04	6.4	6.33	6.256
142	3.91	3.95	3.83	3.896
143	1.91	1.84	1.88	1.876
144	3.8	3.56	3.63	3.663
145	3.39	3.35	3.53	3.423

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
146	3.41	3.42	3.6	3.476
147	3.35	3.15	3.54	3.346
148	0.16	0.14	0.11	0.136
149	2.17	2.14	2.15	2.153
150	0.06	0.07	0.06	0.063
151	2.84	2.75	2.81	2.8
152	4.44	4.7	4.66	4.6
153	5.54	5.68	5.81	5.676
154	4.35	4.4	4.55	4.433
155	3.04	2.99	2.99	3.006
155.75	2.04	2.11	2.01	2.053
157	2.11	2.97	2.04	2.373
158	4.66	4.7	4.8	4.72
159	4.75	4.51	4.73	4.663
160	2.11	2.09	2.28	2.16
161	1.81	1.66	1.83	1.766
162	4.05	3.78	4.06	3.963
163	4.13	4.02	3.98	4.043
164	2.37	2.36	2.14	2.29
165	2.86	3	2.83	2.896
166	2.28	2.27	2.53	2.36
167	2.81	2.76	2.82	2.796
168	3.27	3.34	3.2	3.27
169	2.63	2.66	2.73	2.673
170	3.22	3.23	3.27	3.24
171	2.71	2.64	2.54	2.63
172	3.23	3.29	3.11	3.21
173	2.85	2.72	2.74	2.77
173.95	1.3	1.47	1.6	1.456
174.05	2.09	2.08	2.03	2.066
175	5.31	5.36	5.43	5.366
176	7.69	7.76	7.39	7.613
177	1.68	1.6	1.66	1.646

Pipe:	Valkyrie			
Drillhole:	98DH-VA01			
Top interval:	98.15			
Bottom interval:	131.7			
Total metres:	33.55			
Number of measurement spots:	35			
Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
98.15	0.15	0.22	0.14	0.17
99	0.1	0.11	0.11	0.106
100	0.14	0.15	0.15	0.146
101	0.24	0.16	0.23	0.21
102	0.1	0.1	0.1	0.1
103	0.09	0.09	0.09	0.09
104	0.09	0.07	0.08	0.08
105	0.1	0.11	0.12	0.11
106	0.47	0.5	0.5	0.49
107	0.34	0.3	0.37	0.336
108	-0.14	-0.18	-0.08	-0.133
109	0	0.05	0	0.016
110	-0.04	-0.01	-0.02	-0.023
111	-0.04	-0.05	0	-0.03
112	0.35	0.34	0.35	0.346
113	0.11	0.11	0.1	0.106
114	0.14	0.16	0.12	0.14
115	0.12	0.13	0.12	0.123
116	0.21	0.21	0.15	0.19
117	0.28	0.27	0.28	0.276
118	0.2	0.2	0.18	0.193
119	0.02	0	0	0.006
120	0.02	0.02	0.02	0.02
121	0.34	0.41	0.35	0.366
122	0.47	0.48	0.47	0.473
123	0.23	0.17	0.19	0.196
124	0.07	0.08	0.06	0.07
125	0.21	0.2	0.21	0.206

126	0.26	0.24	0.29	0.263
127	0.14	0.13	0.13	0.133
128	0.06	0.08	0.06	0.066
129	0.04	0.1	0.09	0.076
130	0.52	0.51	0.44	0.49
131	1.36	1.35	1.35	1.353
131.7	4.4	4.65	4.52	4.523

Pipe:	Valkyrie	
Drillhole:	98DH-VA02	
Top interval:	132	
Bottom interval:	200	
Total metres:	68	
Number of measurement spots:	80	

Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
132	0.16	0.17	0.16	0.163
133	1.65	1.55	1.65	1.616
134	1.1	0.91	1.16	1.056
135	3.99	4.15	3.8	3.98
135.55	9.11	9.25	8.91	9.09
135.65	13.6	12	12.8	12.8
136	2.42	2.5	2.54	2.486
137	14.4	14.2	15.1	14.566
138	16.3	16.6	17.5	16.8
139	19.6	18.9	17.5	18.666
140	20	20.6	20	20.2
141	16.8	18	17.2	17.333
142	13.3	12.8	13.3	13.133
143	1.47	1.99	1.68	1.713
144	1.28	1.28	1.12	1.226
144.95	0.96	1	0.96	0.973
145.05	6.06	6.99	6.4	6.483
146	12.8	12.2	11.5	12.166
147	8.59	8.96	8.85	8.8
147.15	14.1	14.2	13.3	13.866
147.25	18.3	18.7	17.4	18.133
148	15	13	15.4	14.466
149	17.7	20	20.4	19.366
150	10.6	10.6	9.08	10.093
151	3.15	3.15	3.27	3.19
151.45	3.02	2.79	2.89	2.9
151.55	8.56	8.42	8.5	8.493
152	14	13.6	13.6	13.733

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
152.45	22.8	21.6	24.9	23.1
152.55	17.8	17.2	18.2	17.733
153	14.6	14.2	14.9	14.566
154	4.32	4.43	4.23	4.326
155	2.79	2.62	2.85	2.753
156	3.51	3.68	3.6	3.596
156.25	5.25	5.45	5.71	5.47
156.35	9.82	9.59	9.55	9.653
157	18.2	17.5	18.3	18
158	4.51	4.7	4.58	4.596
159	22.7	20.6	22.4	21.9
160	9.03	9.37	9.1	9.166
161	11	10.9	11.4	11.1
162	4.88	4.59	4.95	4.806
163	12.4	12.6	13.1	12.7
164	5.24	5.08	5.29	5.203
165	7.57	7.89	7.44	7.633
166	10.5	9.7	9.5	9.9
167	2.28	2.06	2.33	2.223
168	12.3	12	11.7	12
169	13.1	12.9	12.8	12.933
170	19.3	18.7	20.2	19.4
171	18.4	18.5	18.6	18.5
172	17.6	18	17.9	17.833
173	13.2	13	13.7	13.3
174	11.2	11.9	11.3	11.466
175	17.4	15.6	16.4	16.466
176	20.7	21.2	20.4	20.766
177	19.6	20.4	20.3	20.1
178	17.7	17.9	16.6	17.4
179	11.7	11.2	11.4	11.433
180	11.9	11.7	11.7	11.766
181	10.9	10.6	10.7	10.733
182	6.65	6.84	6.32	6.603
183	15.3	14.8	15.5	15.2
184	11.7	10.7	11.3	11.233
185	11.5	11.5	11.2	11.4

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
186	12.8	12.5	12.4	12.566
187	2.38	2.22	2.42	2.34
188	8.46	8.91	8.69	8.686
189	8.85	8.62	8.09	8.52
190	9.68	10.1	10.1	9.96
191	17.9	18.8	18.9	18.533
192	11.8	12	11	11.6
193	15.1	15.4	15.5	15.333
194	13.3	12.9	13.2	13.133
195	16	15.3	15.7	15.666
196	14.1	14.9	14.1	14.366
197	10.4	10.4	10.2	10.333
198	17	17.1	16.8	16.966
199	13.1	13.1	13.5	13.233
200	15.5	15.2	15	15.233

Pipe:	Xena	
Drillhole:	98DH-Xe02	
Top interval:	85.95	
Bottom interval:	179	
Total metres:	93.05	
Number of measurement spots:	85	

Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
85.95	0.1	0.1	0.12	0.106
86	0	-0.01	0.04	0.01
87	0.02	0.02	0	0.013
87.12	0	-0.03	0	-0.01
87.22	0.1	0.1	0.1	0.1
88	0	0.02	0.02	0.013
89	0.2	0.06	0.17	0.143
89.55	0.08	0.12	0.11	0.103
89.65	0	0	-0.02	-0.006
90	0	0	0.01	0.003
91	0.08	0.12	0.12	0.106
92	0.05	0.03	0.07	0.05
93	0.01	0	0	0.003
94	-0.01	0	0	-0.003
95	0.05	0.06	0.06	0.056
100.2	0.04	0.03	0.04	0.036
100.95	-0.02	-0.03	0	-0.016
101.05	-0.25	-0.15	-0.16	-0.186
102	0	0	0.01	0.003
103	-0.01	-0.02	-0.02	-0.016
104	0.02	0.03	0.03	0.026
105	0.13	0.11	0.13	0.123
106	0.02	0.03	0.03	0.026
107	0.03	-0.02	0	0.003
108	0.07	0.05	0.04	0.053
109	0.02	0	-0.01	0.003
110	0.07	0.07	0.09	0.076
111	0.11	0.13	0.12	0.12

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
112	0.05	0.04	0.04	0.043
113	0.09	0.13	0.11	0.11
114	0.06	0.07	0.08	0.07
115	-0.06	-0.04	-0.06	-0.053
116	0.03	0.03	0.03	0.03
121	0.15	0.14	0.16	0.15
122	0.11	0.1	0.1	0.103
123	0.04	0.02	0.03	0.03
124	0.41	0.51	0.5	0.473
125	0.07	0.07	0.05	0.063
126	0	-0.01	0.02	0.003
127	0	-0.03	-0.01	-0.013
128	0.13	0.12	0.13	0.126
129	0.19	0.14	0.18	0.17
130	0.17	0.15	0.14	0.153
131	0.15	0.14	0.16	0.15
132	0.04	0.07	0.05	0.053
133	0.1	0.08	0.11	0.096
134	0.1	0.07	0.07	0.08
135	-0.08	0.01	-0.01	-0.026
136	-0.01	0	0	-0.003
136.7	0.12	0.1	0.09	0.103
143	0.19	0.2	0.21	0.2
144	0.02	0.02	0.02	0.02
145	0.1	0.12	0.09	0.103
146	0	0	0	0
147	0.01	0	0	0.003
148	0.64	0.72	0.71	0.69
149	0.3	0.24	0.24	0.26
150	0.07	0.05	0.03	0.05
151	0.14	0.13	0.15	0.14
152	2.49	2.68	2.53	2.566
153	0.42	0.37	0.36	0.383
154	3.51	3.16	3.51	3.393
155	1.27	1.29	1.39	1.316
156	1.75	1.72	1.9	1.79
157	1.2	1.21	1.13	1.18

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
158	1.6	1.35	1.57	1.506
158.8	0.71	0.64	0.69	0.68
165	0.02	0.03	0.01	0.02
166	0.04	0.03	0.02	0.03
167	-0.01	-0.01	0	-0.006
168	0.06	0.08	0.06	0.066
169	0.03	0.01	0	0.013
170	0.01	0	0	0.003
171	0.02	0.02	0.02	0.02
172	-0.27	-0.2	-0.22	-0.23
173	0.08	0.08	0.1	0.086
174	-0.09	-0.1	-0.06	-0.083
175	-0.02	-0.02	-0.04	-0.026
176	0	0	0.01	0.003
177	-0.06	-0.04	-0.02	-0.04
178	0.03	0.02	0.02	0.023
179	-0.05	-0.06	-0.05	-0.053

Pipe:	Mountain Lake North	
Drillhole:	95ML-1	
Top interval:	6	
Bottom interval:	166.6	
Total metres:	160.6	
Number of measurement spots:	164	

Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
6	0.14	0.13	0.14	0.136
7	0.14	0.12	0.11	0.123
8	0.19	0.17	0.17	0.176
9	0.23	0.2	0.23	0.22
10	0.29	0.29	0.25	0.276
11	0.37	0.36	0.37	0.366
12	0.26	0.26	0.29	0.27
13	0.13	0.19	0.15	0.156
14	0.13	0.13	0.12	0.126
15	0.28	0.28	0.29	0.283
16	0.32	0.38	0.34	0.346
17	0.34	0.35	0.35	0.346
18	0.31	0.27	0.27	0.283
19	0.38	0.34	0.36	0.36
20	0.3	0.27	0.31	0.293
21	0.18	0.2	0.21	0.196
22	0.23	0.22	0.24	0.23
23	0.17	0.21	0.24	0.206
24				0.2
25	0.18	0.13	0.15	0.153
26	0.15	0.16	0.13	0.146
27	0.2	0.16	0.17	0.176
28	0.16	0.16	0.16	0.16
29	0.39	0.39	0.39	0.39
30	0.65	0.7	0.67	0.673
31	0.67	0.64	0.65	0.653
32	0.61	0.6	0.54	0.583
33	0.61	0.62	0.68	0.636

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
34	0.55	0.59	0.58	0.573
35	0.83	0.81	0.89	0.843
36	0.85	0.89	0.82	0.853
37	0.94	0.88	0.91	0.91
38	0.58	0.59	0.57	0.58
39	0.56	0.55	0.51	0.54
40	0.71	0.71	0.75	0.723
41	0.29	0.28	0.31	0.293
42	0.33	0.36	0.34	0.343
43	0.13	0.14	0.14	0.136
44	0.4	0.42	0.39	0.403
45	0.39	0.47	0.42	0.426
46	0.34	0.34	0.34	0.34
47	0.18	0.21	0.2	0.196
48	0.42	0.42	0.43	0.423
49	0.29	0.28	0.26	0.276
50	0.24	0.23	0.23	0.233
51	0.34	0.38	0.34	0.353
52	0.36	0.33	0.29	0.326
53	0.3	0.33	0.33	0.32
54	0.16	0.14	0.18	0.16
55	0.74	0.78	0.79	0.77
56	0.1	0.13	0.16	0.13
57	0.55	0.54	0.52	0.536
58	0.35	0.36	0.37	0.36
59	0.47	0.42	0.45	0.446
60	0.26	0.26	0.25	0.256
61	0.43	0.44	0.43	0.433
62	0.27	0.26	0.25	0.26
63	0.62	0.67	0.69	0.66
64	1.37	1.4	1.43	1.4
65	0.45	0.48	0.48	0.47
66	0.38	0.39	0.4	0.39
67	0.67	0.68	0.64	0.663
68	0.37	0.37	0.36	0.366
69	0.62	0.59	0.57	0.593
70	0.46	0.5	0.45	0.47

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
71	0.23	0.21	0.21	0.216
72	0.4	0.45	0.43	0.426
73	0.48	0.52	0.48	0.493
74	1.5	1.52	1.46	1.493
75	1.05	1.18	1.13	1.12
76	0.46	0.42	0.44	0.44
77	0.25	0.22	0.2	0.223
78	0.08	0.08	0.09	0.083
79	0.4	0.39	0.44	0.41
80	0.52	0.51	0.52	0.516
81	0.52	0.53	0.5	0.516
82	0.43	0.39	0.43	0.416
83	0.15	0.15	0.12	0.14
84	0.09	0.1	0.09	0.093
85	0.51	0.52	0.5	0.51
86	0.48	0.45	0.43	0.453
87	1.3	1.29	1.36	1.316
88	0.36	0.32	0.35	0.343
89	0.38	0.39	0.37	0.38
90	0.22	0.2	0.17	0.196
91	0.71	0.61	0.68	0.666
92	0.94	0.87	0.86	0.89
93	0.8	0.77	0.74	0.77
94	0.42	0.48	0.42	0.44
95	0.56	0.57	0.52	0.55
96	0.47	0.5	0.55	0.506
97				0.5
98	0.47	0.43	0.41	0.436
99	0.57	0.61	0.6	0.593
100	0.4	0.41	0.4	0.403
101	0.56	0.59	0.61	0.586
102	0.37	0.33	0.35	0.35
103	0.4	0.4	0.4	0.4
104	2.01	1.95	2.04	2
105	0.24	0.24	0.21	0.23
106	0.31	0.36	0.37	0.346
107	0.46	0.46	0.4	0.44

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
108	0.28	0.26	0.31	0.283
109	0.41	0.43	0.42	0.42
110	0.33	0.35	0.29	0.323
111	0.28	0.29	0.31	0.293
112	0.74	0.78	0.79	0.77
113	0.67	0.64	0.63	0.646
114	1	0.93	0.98	0.97
115	1.71	1.69	1.71	1.703
116	0.98	0.97	0.99	0.98
117	1.22	1.19	1.16	1.19
118	1	0.98	0.94	0.973
119	1.73	1.79	1.73	1.75
120	0.38	0.35	0.37	0.366
121	0.23	0.25	0.21	0.23
122	0.55	0.53	0.52	0.533
123	0.54	0.54	0.52	0.533
124	0.44	0.43	0.39	0.42
125	0.56	0.52	0.56	0.546
126	0.74	0.76	0.75	0.75
127	0.43	0.44	0.45	0.44
128	0.47	0.43	0.45	0.45
129	0.35	0.39	0.37	0.37
130	0.44	0.42	0.42	0.426
131	0.36	0.29	0.28	0.31
132	0.68	0.68	0.64	0.666
133	0.43	0.42	0.44	0.43
134	0.34	0.33	0.32	0.33
135	0.79	0.67	0.75	0.736
136	0.48	0.51	0.53	0.506
137	0.63	0.56	0.54	0.576
138	0.69	0.71	0.71	0.703
139	0.43	0.45	0.42	0.433
140	0.39	0.36	0.38	0.376
141	0.41	0.36	0.37	0.38
142	0.43	0.48	0.4	0.436
143	0.22	0.23	0.2	0.216
144	0.42	0.44	0.44	0.433

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
145	0.27	0.29	0.31	0.29
146	0.37	0.38	0.36	0.37
147				0.5
148				0.5
149	0.42	0.38	0.4	0.4
150	0.33	0.32	0.34	0.33
151	0.41	0.37	0.39	0.39
152	0.42	0.43	0.41	0.42
153	0.34	0.35	0.35	0.346
154	0.33	0.29	0.36	0.326
155	0.41	0.43	0.43	0.423
156	0.45	0.44	0.43	0.44
157	0.21	0.21	0.28	0.233
158	0.23	0.19	0.22	0.213
159	0.33	0.29	0.32	0.313
160	0.32	0.33	0.37	0.34
161	0.35	0.29	0.31	0.316
162	0.33	0.33	0.29	0.316
163	0.3	0.33	0.32	0.316
164	0.35	0.36	0.38	0.363
165	0.33	0.38	0.35	0.353
166	0.38	0.38	0.38	0.38
166.6	0.21	0.24	0.19	0.213

Pipe:	Mountain Lake South	
Drillhole:	95ML-3	
Top interval:	5.5	
Bottom interval:	173	
Total metres:	167.5	
Number of measurement spots:	167	

Depth (m)	**10-3 SI**			**10-3 SI**
	Reading 1	**Reading 2**	**Reading 3**	**Average**
5.5	0.15	0.15	0.13	0.143
6	0.22	0.22	0.23	0.223
7	0.3	0.31	0.28	0.296
8	0.16	0.21	0.21	0.193
9	0.21	0.24	0.24	0.23
10	0.3	0.31	0.33	0.313
11	0.24	0.24	0.24	0.24
12	0.26	0.26	0.26	0.26
13	0.3	0.32	0.29	0.303
14	0.27	0.26	0.27	0.266
15	0.45	0.45	0.47	0.456
16				0.3
17	0.25	0.24	. 28	0.245
18	0.26	0.29	0.28	0.276
19	0.39	0.38	0.41	0.393
20	0.27	0.26	0.22	0.25
21	0.28	0.35	0.36	0.33
22	0.37	0.39	0.38	0.38
23	0.21	0.21	0.22	0.213
24	0.34	0.36	0.36	0.353
25	0.34	0.35	0.29	0.326
26	0.21	0.21	0.2	0.206
27	0.25	0.25	0.24	0.246
28	0.12	0.16	0.14	0.14
29	0.25	0.24	0.23	0.24
30	0.15	0.17	0.2	0.173
31	0.33	0.33	0.27	0.31
32	0.2	0.2	0.2	0.2

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
33	0.16	0.16	0.14	0.153
34	0.29	0.24	0.32	0.283
35	0.19	0.22	0.24	0.216
36	0.25	0.23	0.17	0.216
37	0.17	0.13	0.12	0.14
38	0.12	0.13	0.1	0.116
39	0.25	0.26	0.21	0.24
40	0.23	0.19	0.22	0.213
41	0.2	0.18	0.21	0.196
42	0.28	0.21	0.2	0.23
43	0.15	0.11	0.14	0.133
44	0.26	0.23	0.17	0.22
45	0.23	0.22	0.18	0.21
46	0.15	0.14	0.11	0.133
47	0.2	0.22	0.19	0.203
48	0.27	0.27	0.24	0.26
49	0.28	0.25	0.21	0.246
50	0.35	0.25	0.2	0.266
51	3.55	3.74	3.88	3.723
52	0.28	0.22	0.33	0.276
53	0.24	0.16	0.22	0.206
54	0.23	0.28	0.25	0.253
55	0.18	0.18	0.18	0.18
56	0.31	0.26	0.25	0.273
57	0.23	0.22	0.2	0.216
58	0.19	0.18	0.13	0.166
59	0.27	0.28	0.25	0.266
60	0.1	0.1	0.12	0.106
61	0.14	0.14	0.13	0.136
62	0.19	0.21	0.21	0.203
63	0.08	0.09	0.09	0.086
64	0.26	0.25	0.25	0.253
65	0.18	0.15	0.13	0.153
66	0.19	0.24	0.21	0.213
67	0.2	0.22	0.2	0.206
68	0.25	0.21	0.22	0.226
69	0.19	0.17	0.18	0.18

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
70	0.24	0.23	0.17	0.213
71	0.22	0.22	0.2	0.213
72	0.23	0.22	0.23	0.226
73	0.06	0.06	0.08	0.066
74	0.19	0.19	0.15	0.176
75	0.13	0.13	0.14	0.133
76	0.25	0.23	0.22	0.233
77	0.21	0.24	0.25	0.233
78	0.3	0.33	0.24	0.29
79	0.29	0.24	0.22	0.25
80	0.18	0.16	0.17	0.17
81	0.28	0.31	0.28	0.29
82	0.27	0.28	0.27	0.273
83	0.16	0.15	0.15	0.153
84	0.13	0.11	0.15	0.13
85	0.25	0.24	0.19	0.226
86	0.2	0.2	0.22	0.206
87	0.32	0.29	0.33	0.313
88	0.18	0.18	0.19	0.183
89	0.21	0.2	0.18	0.196
90	0.38	0.34	0.37	0.363
91	0.24	0.19	0.24	0.223
92	0.14	0.08	0.1	0.106
93	0.16	0.17	0.21	0.18
94	0.27	0.25	0.25	0.256
95	0.31	0.24	0.25	0.266
96	0.12	0.06	0.05	0.076
97	0.14	0.16	0.13	0.143
98	0.28	0.25	0.27	0.266
99	0.23	0.12	0.14	0.163
100	0.3	0.24	0.21	0.25
101	0.08	0.1	0.1	0.093
102	0.31	0.29	0.24	0.28
103	0.26	0.22	0.23	0.236
104	0.04	0.09	0.09	0.073
105	0.31	0.33	0.32	0.32
106	0.2	0.24	0.23	0.223

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
107	0.23	0.23	0.15	0.203
108	2.51	2.56	2.85	2.64
109	0.17	0.12	0.14	0.143
110	0.08	0.13	0.06	0.09
111	0.28	0.27	0.25	0.266
112	0.22	0.11	0.15	0.16
113	0.43	0.41	0.37	0.403
114	0.34	0.28	0.22	0.28
115	0.29	0.29	0.29	0.29
116	0.2	0.21	0.22	0.21
117	0.26	0.27	0.24	0.256
118	0.11	0.11	0.11	0.11
119	0.33	0.32	0.27	0.306
120	0.13	0.13	0.13	0.13
121	0.18	0.17	0.18	0.176
122	0.26	0.27	0.25	0.26
123	0.3	0.29	0.33	0.306
124	0.27	0.27	0.21	0.25
125	0.17	0.15	0.19	0.17
126	0.18	0.17	0.14	0.163
127	0.27	0.27	0.24	0.26
128	0.24	0.18	0.17	0.196
129	0.2	0.21	0.21	0.206
130	0.19	0.18	0.19	0.186
131	0.19	0.21	0.18	0.193
132	0.23	0.17	0.15	0.183
133	0.25	0.23	0.27	0.25
134	0.12	0.1	0.08	0.1
135	0.19	0.2	0.18	0.19
136	0.19	0.24	0.24	0.223
137	0.4	0.36	0.42	0.393
138	0.33	0.37	0.43	0.376
139	0.17	0.16	0.19	0.173
140	0.17	0.2	0.19	0.186
141	0.16	0.15	0.16	0.156
142	0.25	0.28	0.27	0.266
143	0.21	0.11	0.18	0.166

Depth (m)	10-3 SI			10-3 SI
	Reading 1	Reading 2	Reading 3	Average
144	0.31	0.27	0.27	0.283
145	0.24	0.22	0.24	0.233
146	0.17	0.2	0.2	0.19
147	0.34	0.33	0.32	0.33
148	0.19	0.18	0.24	0.203
149	0.2	0.21	0.18	0.196
150	0.31	0.25	0.31	0.29
151	0.3	0.27	0.25	0.273
152	0.06	0.05	0.08	0.063
153	0.22	0.18	0.16	0.186
154	0.07	0.08	0.12	0.09
155	0.29	0.21	0.21	0.236
156	0.26	0.29	0.24	0.263
157	0.26	0.27	0.27	0.266
158	0.22	0.17	0.19	0.193
159	0.21	0.24	0.24	0.23
160	0.18	0.17	0.22	0.19
161	0.26	0.28	0.26	0.266
162	0.18	0.15	0.19	0.173
163	0.17	0.17	0.23	0.19
164				0.2
165	0.27	0.33	0.26	0.286
166	0.22	0.22	0.22	0.22
167	0.22	0.2	0.25	0.223
168	0.26	0.3	0.26	0.273
169	0.15	0.14	0.1	0.13
170	1.41	1.37	1.53	1.436
171	0.25	0.23	0.25	0.243
172	0.22	0.2	0.2	0.206
173	0.29	0.31	0.32	0.306

Magnetic susceptibility readings on individual kimberlitic hand samples				
Hole ID	Pipe	Depth (m)	10-3 SI	
			Reading 1	Reading 2
DDH11-01	K11	135.5	7.15	7.04
DDH11-01	K11	55.5	3.4	3.55
DDH14-01	K14	14.65	10.7	10.3
DDH14B-03	K14	30.17	2.36	2.37
DDH14C-06	K14	54.3	3.38	3.38
DDH155-01	TQ155	102.5	1.65	1.67
DDH155-01	TQ155	148.6	4.44	4.44
DDH19-03	K19	19.85	1.78	1.79
DDH1A-01	K1A	76.7	0.27	0.27
DDH1B-02	K1B	66.1	0.2	0.16
DDH2-01	K2	59.13	0.33	0.34
DDH225-01	K225	57	3.4	3.32
DDH225-01	K225	71.4	6.17	6.29
DDH225-01	K225	118.9	0.29	0.29
DDH229-01	K229	75.6	0.55	0.54
DDH229-01	K229	94.1	0.07	0.05
DDH230-01	K230	106.7	5.03	4.99
DDH230-01	K230	61	1.47	1.44
DDH4A-02	K4A	49.15	0.18	0.16
DDH4B-01	K4B	140.65	1.19	1.2
DDH4C-01	K4C	63	0.25	0.29
DDH5A-02	K5	84.23	2.1	2.17
DDH6-02	K6	110.15	7.08	7.05
DDH7A-01	K7A	119	7.58	7.52
DDH7B-01	K7B	76.93	8.08	7.87
DDH7C-01	K7C	58.4	0.18	0.19
DDH91-03	K91	84.93	5.49	5.35
DDHBM3-01	BM3	105.2	0.51	0.51
DDHBM3-01	BM3	124.9	0.37	0.38
DDH160-01	TQ160	44.7	1.8	1.87
DDHBM160-01	BM16	127.3	0.21	0.22
DDHBM160-01	BM16	124.3	0.29	0.28
DDHBM2-01	BM2	79.5	5.58	5.38
DDHBM2-01	BM2	113.8	11	11.1
DDHBM2-01	BM2	103.3	7.47	7.46
DDHBM2-01	BM2	52	0.25	0.25

Hole ID	Pipe	Depth (m)	10-3 SI	
			Reading 1	**Reading 2**
DDHBM3-01	BM3	144.9	1.28	1.32
DDHLL8-01	LL08	77.8	0.2	0.18
DDHLL8-01	LL08	144.9	11.7	10.7
DDHLL8-01	LL08	121.5	9.96	9.99
DDH252-03	K252	107.7	0.17	0.19
DDH252-03	K252	82.1	3.52	3.43
DDH8-01	K8	88.3	0.14	0.14
DDHLL7-01	LL07	126.35	0.12	0.13
DDHLL7-01	LL07	146.3	25.9	27.1
ML-02-91	Mountain Lake	45	1.04	0.96
Mountain Lake	Mountain Lake	Surface	0.35	0.35
Kendu	Kendu	Not avail-able	6.11	6.01
Magnetic susceptibility readings on individual hand samples				
Black Butte	Minette	n/a	16.5	17.8
Steen River	Astrobleme	230	0.53	0.55
Steen River	Astrobleme	210	0.14	0.14
Crowsnest	Analcite-bearing igneous rock	Surface	0.9	0.93

Appendix 2. Magnetic susceptibility measurements of sedimentary rocks in Alberta

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Beaver River	RE-NE96-01-001	462470	6331072	Beaver River Formation	0.05	0.09	0.08	0.07
Beaver River	RE-NE96-01-003	462470	6331072	Beaver River Formation Sandstone	-0.02	-0.05	0.02	-0.02
Beaver River	RE-NE96-02-002	464247	6333540	Beaver River Formation Sandstone	0.02	0.02	0.04	0.03
Waterways (Moberley)	RE-NE96-03-002	464172	6334654	Moberley Member	0.08	0.11	0.11	0.10
Waterways (Moberley)	RE-NE96-03-005	464172	6334654	Moberley Member	0.06	0.05	0.05	0.05
Waterways (Moberley)	RE-NE96-03-008	464172	6334654	Moberley Member	0.11	0.11	0.12	0.11
Waterways (Moberley)	RE-NE96-03-012	464172	6334654	Moberley Member	0.1	0.1	0.08	0.09
Beaver River	RE-NE96-04-001	463644	6336579	Beaver River Formation Sandstone	0.06	0.05	0.05	0.05
Firebag	RE-NE96-05-001	530004	6289540	Firebag Formation	0.1	0.14	0.08	0.11
Firebag	RE-NE96-05-002	530004	6289540	Firebag Formation	0.1	0.12	0.08	0.10
Firebag	RE-NE96-05-003	530004	6289540	Firebag Formation	0.09	0.08	0.06	0.08
Waterways (Christina)	RE-NE96-06-001	498407	6278031	Christina Member calc-shale	1.6	1.56	1.56	1.57
Waterways (Christina)	RE-NE96-06-002	498407	6278031	Christina Member calc-shale	0.97	0.93	0.87	0.92
McMurray	RE-NE96-06-005	498407	6278031	Basal McMurray Formation	0.06	0.06	0.06	0.06
Waterways (Christina)	RE-NE96-06-008	498407	6278031	Christina Member calc-shale	1.81	1.81	1.81	1.81
Waterways (Christina)	RE-NE96-06-011	498407	6278031	Unaltered Christina Member	0.05	0.05	0.06	0.05
Calumet or (Moberley)	RE-NE96-07-002	462503	6367404	Calumet or Moberley Member	0.05	0.05	0.06	0.05
Calumet or (Moberley)	RE-NE96-08-002	461688	6368207	Calumet or Moberley Member	1.21	1.19	1.16	1.19
Waterways (Calumet or Moberley)	RE-NE96-08-005	461688	6368207	Calumet or Moberley Member	0.08	0.09	0.08	0.08
Waterways (Moberley)	RE-NE96-10-001	454615	6336700	Moberley Member	0.03	0.02	0.03	0.03
Waterways (Moberley)	RE-NE96-10-004	454615	6336700	Moberley Member with beehive texture	0.04	0.04	0.03	0.04
Waterways (Moberley)	RE-NE96-10-006	454615	6336700	Moberley Member	0.02	0.03	0.01	0.02
Firebag	RE-NE96-11-001	530004	6289540	Firebag Member	0.43	0.37	0.43	0.41
McMurray	RE-NE96-11-005	530004	6289540	McMurray Formation oil sands	0.07	0.07	0.05	0.06
Beaver River	RE-NE96-13-001	464599	6338809	Beaver River Formation Sandstone	0.07	0.08	0.08	0.08

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Beaver River	RE-NE96-13-003	464599	6338809	Beaver River Formation Sandstone	0.11	0.07	0.08	0.09
Waterways (Moberley)	RE-NE96-14-002	475768	6287435	Moberley Member	0.07	0.07	0.13	0.09
Waterways (Moberley)	RE-NE96-15-001	475381	6294226	Moberley Member	0.04	0.08	0.05	0.06
Waterways (Moberley)	RE-NE96-16-002	475066	6297846	Moberley Member	0.05	0.06	0.05	0.05
Waterways (Moberley)	RE-NE96-16-003	475066	6297846	Rusty-weathered 'rind'	0.14	0.08	0.1	0.11
McMurray	RE-NE96-16-004	475066	6297846	McMurray oil sands	0	0	0	0.00
McMurray	RE-NE96-18-002	472286	6313267	Basal McMurray Formation	0.45	0.43	0.41	0.43
Waterways (Moberley)	RE-NE96-20-001	463087	6333871	Moberley Member	0.05	0.04	0.03	0.04
McMurray	RE-NE96-22-006	463115	6342616	McMurray Formation oil sands	0.07	0.06	0.07	0.07
McMurray	RE-NE96-23-001	460012	6339034	McMurray oil sands	0.06	0.07	0.08	0.07
McMurray	RE99-74E-85-007	498037	6368858	McMurray Formation	0.09	0.09	0.06	0.08
McMurray	RE99-74E-85-008	498037	6368858	Sulphide nodule	0.05	0.03	0.02	0.03
McMurray	RE99-74E-96-007	459519	6338652	McMurray Formation	0.04	0.05	0.1	0.06
Waterways (Moberley)	RE99-74E-96-011	459519	6338652	Moberley Member	0.02	0	0	0.01
Waterways (Moberley)	RE99-74E-96-013	459519	6338652	Sideritized Moberley Member	1.59	1.53	1.49	1.54
McMurray	RE99-74E-96-017(O)	459519	6338652	Sulphid nodlues in McMurray Formation	0.07	0.06	0.02	0.05
McMurray	RE99-74E-96-019	459519	6338652	McMurray Formation	0.06	0.05	0.09	0.07
McMurray	RE99-74E-96-021	459519	6338652	McMurray Formation	0.09	0.05	0.07	0.07
McMurray	RE99-74E-96-023	459519	6338652	McMurray Formation	0.07	0.06	0.11	0.08
Float: sulphide nodule	RE99-74E-96-026	459519	6338652	Float: sulphide nodules	0.06	0.06	0.08	0.07

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
McMurray	RE99-74E-96-REF3	459519	6338652	McMurray Formation	0.04	0.04	0.01	0.03
McMurray	RE99-74E-97-002	466280	6372687	Concretion in McMurray Formation	0.01	0	0.01	0.01
Waterways (Moberley)	RE99-74E-97-003	466280	6372687	Float: Concretion in Moberley Member	0.08	0.12	0.13	0.11
McMurray	RE99-74E-99-001	464072	6332450	Float: highly altered McMurray Formation	0.19	0.16	0.22	0.19
Float: sulphide nodule	RE99-74E-99-003	464072	6332450	Float: sulphide nodules	1.92	1.83	1.7	1.82
Nikanassin	KW96-01-003	361826	5985005	siltstone; rusty, qtz coated fracture planes.	0.57	0.64	0.54	0.58
Nikanassin	KW96-01-004	361826	5985005	Rusty siltstone	0.9	0.92	0.88	0.90
Cadomin	KW96-01-006	361826	5985005	Rusty weathered sandstone	0.11	0.06	0.06	0.08
Gladstone	KW96-01-008	361826	5985005	pebble lag; Cherty pebbles, shells	0.72	0.78	0.72	0.74
Lower Brazeau	KW96-06-004	383798	6103436	Smectitic shales, wood and coal frags	0.16	0.18	0.17	0.17
Lower Coalspur	KW96-09-001	335997	6037234	Light gray smectitic shale	0.07	0.06	0.05	0.06
Lower Coalspur	KW96-09-002	335997	6037234	buff, brownish sandstone with coal and plant frags	0.06	0.08	0.07	0.07
Lower Brazeau	KW96-12-007	346475	6080080	immed. above the coal seam	0.1	0.11	0.09	0.10
Boulder Creek	KW96-15-002	305710	6025825	Dark grey shale, blocky, bioturbated	0.13	0.09	0.1	0.11
Boulder Creek	KW96-15-003	305710	6025825	Rusty, silty sandstone, possible bentonite	0.01	0.03	0.03	0.02
Boulder Creek	KW96-15-004	305710	6025825	Cherty Pebble conglomerate	0.07	0.1	0.09	0.09
Westgate	KW96-15-005	305710	6025825	Blocky, silty shale	0.01	0.03	0.02	0.02
Boulder Creek	KW96-15-006	305710	6025825	Shale	0.04	0.07	0.05	0.05
Belle Fourche	KW96-17-001	325816	6005921	sandstone/siltstone, concrtionary. rusty	0.17	0.23	0.19	0.20
Shaftesbury	KW96-17-003	325011	6005840	concretionary unit, rusty, sandstone	0.44	0.44	0.43	0.44
Belle Fourche	KW96-17-004	325011	6005840	Shale	0.13	0.12	0.11	0.12
Dunvegan	KW96-17-005	325011	6005840	lithic sandstone, slightly rusty weatherd colour	0	0.01	0.01	0.01

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Kaskapau	KW96-19-002	328337	6011030	rusty, sulphur, dark grey to black shale	0.14	0.14	0.15	0.14
Kaskapau	KW96-19-003	328337	6011030	Rusty weathered silty concretionary layer.	0.07	0.06	0.12	0.08
Kaskapau	KW96-19-004	328337	6011030	Dark, bioturbated shale	0.08	0.11	0.07	0.09
Westgate/Fish Scales	KW96-20-001	333970	6005325	beige to grey, blocky, bioturbated shale	0.09	0.09	0.07	0.08
Westgate/Fish Scales	KW96-20-003	333970	6005325	Grey to rusty bentonite	0	0.02	0.04	0.02
Westgate/Fish Scales	KW96-20-006	333970	6005325	Carbonaceous shale and siltstone	0.04	0.09	0.08	0.07
Shaftesbury	KW96-22-001	333470	6005325	Grey, very platey, bioturbated shale.	0.04	0.08	0.05	0.06
Shaftesbury	KW96-22-002	333470	6005325	silty shale.	0	0.01	0.03	0.01
Gorman Cr.	KW96-61-002	314400	6015360	Taken from o/c at LIck Creek and Kakwa Falls road.	0.02	0.03	0.03	0.03
Gorman Cr.	KW96-61-003	314400	6015360	Taken from o/c at LIck Creek and Kakwa Falls road.	0.85	0.69	0.76	0.77
Dunvegan	KW96-61-004	314400	6015360	Taken from o/c at LIck Creek and Kakwa Falls road.	0.32	0.34	0.37	0.34
Fernie	RR94-15b	308034	6018811	Grey shale, part of a silty to sandy interbed.	0.06	0.07	0.08	0.07
Kaskapau	RR94-18b	315794	5997173	Medium to dark grey shale	-0.01	0	0.03	0.01
Kaskapau	RR94-18c	315794	5997173	Medium to dark grey silty shale	0.22	0.21	0.25	0.23
Kaskapau	RR94-23a	351085	5981012	Siliceous siltstone	0.18	0.17	0.18	0.18
Kaskapau	RR94-23b	351085	5981012	Grey, silty shale	0.03	0.03	0.03	0.03
Dunvegan	RR94-24a	315473	6023090	Silicified, rusty stained siltstone to FG sandstone	0.03	0.03	0.05	0.04
Dunvegan	RR94-24b	315473	6023090	Silicified, rusty stained siltstone to FG sandstone	0.04	0.05	0.05	0.05
Dunvegan	RR94-24c	315473	6023090	Dark grey to black micaceous shale.	0.05	0.05	0.04	0.05
Boulder Creek	RR94-25b	306926	6025768	Rusty stained siltstone to FG sandstone.	0.02	0.03	0.04	0.03

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Boulder Creek	RR94-25c	306926	6025768	Rusty weathered siltstone to shaley siltstone.	0.02	0.02	0.05	0.03
Gorman Creek	RR94-26	319389	6003379	Dark grey, carbonaceous to coaly FG sandstone.	0	0.03	0.03	0.02
Fernie	RR94-28	317409	6007659	Dark olive brown to grey, slightly silty shale.	0.04	0.02	0.06	0.04
Kaskapau	RR95-09a	318404	6024825	Dark grey to black, slightly silty shale	0.03	0.05	0.04	0.04
Kaskapau	RR95-09b	318404	6024825	Siltstone	0.02	0.02	0.03	0.02
White Specks	95DB01-006	450511	6399824	Hot black shale; higher organic carbon	0.29	0.22	0.23	0.25
Westgate	95DB011-007	447000	6376280	shale, angular, rusty layers, grey; mud-stone interlayered	0.08	0.13	0.14	0.12
Float	95DB012-002	450090	6390660	Limonitic concretion; from slumped till?/ bedrock?	0.26	0.27	0.25	0.26
Pelican	95DL001-002	448249	6384773	Shale	0.22	0.24	0.22	0.23
Pelican	95DL001-005	448249	6384773	Shale, finely bedded, 70% mudstone	0.26	0.23	0.17	0.22
Pelican	95DL001-009	448249	6384773	Shale	0.19	0.14	0.15	0.16
Westgate	95DL001-010	448249	6384773	shale, black, stringers of fine sand	0.07	0.1	0.05	0.07
Fish Scales	95DL002-001	445505	6378128	Float of fish scale layer, good wave ripple bedding	0.3	0.28	0.25	0.28
White Specks	95DL003-002	448184	6397971	Top of sandstone, pyritic, part of bone bed unit	0.24	0.25	0.21	0.23
White specks concretion	95DL003-014	448184	6397971	Calcite concretion	0.16	0.12	0.14	0.14
White Specks	95DL004-001	443600	6387700	shale	0.12	0.08	0.17	0.12
White Specks	95DL004-002	443600	6387700	Sandstone with fine grained pyrite and fish debris	0.11	0.19	0.17	0.16
White specks concretion	95DL004-005	443600	6387700	Calcite concretion	0.12	0.1	0.13	0.12
Pelican	95DL005-002	437864	6432762	Pelican Sandstone	0.07	0.07	0.12	0.09
Westgate	95DL006-003	436830	6434008	Bioturbated, silty, shale, rusty weathering	0.19	0.22	0.17	0.19

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Fish Scales	95DL009-005	443338	6421368	Fish Scales Bone Bed	0.12	0.11	0.11	0.11
Fish Scales	95DL009-008	443338	6421368	Fish Scales Silty Shale	0.05	0.11	0.04	0.07
Fish Scales	95DL009-013	443338	6421368	Fish Scales Black Shale	0.11	0.09	0.15	0.12
	95MD001-003	450511	6399824	concretion, red limonitic to orange, synresis creacks	0.38	0.35	0.37	0.37
White Specks	95MD001-008	450511	6399824	Pale green blocky shale, partly clay altered	0.59	0.56	0.46	0.54
White Specks	95MD002-001	448191	6397945	slumped consolidated bone bed	0.05	0.08	0.08	0.07
White Specks	95MD002-002	448191	6397945	typical pebbly bone bed material	0.19	0.19	0.14	0.17
White Specks	95MD002-003	448191	6397945	black shale; carbonate concretions, organic carbon	0.14	0.12	0.13	0.13
White Specks	95MD003-001	409780	6437185	Black carbonaceous shale with mollusk shells, platey	0.17	0.11	0.1	0.13
White Specks	95MD003-005	409780	6437185	bone bed, non-calcareous, white grains??, biotite??	0.16	0.15	0.19	0.17
White specks concretion	95MD005-004	436298	6435502	Limonitic carbonate concretions, dissem. py	0.14	0.08	0.15	0.12
Pelican	95MD006-001	448450	6383545	White sandstone, dark chert and qtz grains, mdst lenses	0.06	0.09	0.1	0.08
Pelican	95MD006-002	448450	6383545	shale	0.2	0.15	0.16	0.17
Pelican	95MD006-004	448450	6383545	rusty limonitic sandstone, partially cemented	0.26	0.26	0.27	0.26
Pelican	95MD006-005	448450	6383545	laminated bioturbated shale	0.17	0.21	0.17	0.18
Pelican	95MD006-006	448450	6383545	Rusty limonitic sandstone interbedded in mudstone unit	0.21	0.21	0.15	0.19
Westgate	95MD006-009	448450	6383545	Westgate shale containing concretion	0.07	0.11	0.14	0.11
White Specks	95MD008-001	443700	6387800	Dark grey massive clay rich shale, trace to minor calcite	0.15	0.14	0.2	0.16

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
White specks concretion	95RE006-001	435770	6437910	Rusty concretionary float, calcareous, py, weakly stratified	0.13	0.1	0.08	0.10
White specks concretion	95RE006-003	435770	6437910	concretions, dark silty unit, compaction, calcareous wisps	0.15	0.12	0.12	0.13
Float	95RE006-004	435770	6437910	Float of carbonate nodules with sulphide pods, altered	0.13	0.12	0.16	0.14
White Specks	95RE007-001	450627	6399919	Rusty weathered bone bed, py, aspy?	0.17	0.14	0.18	0.16
White specks concretion	95RE008-001	436248	6435502	concretionary layer, rusty weathered, py in blebs and diss.	0.05	0.02	0.04	0.04
Shaftesbury concretion	95SH007-004	482176	6232212	Alterred shell of siderite nodule	0.23	0.26	0.32	0.27
Fish Scales	95SH007-005	482176	6232212	Bone bed	0.22	0.2	0.28	0.23
Dunvegan	95SH008-001	467602	6203160	Porous Sandstone	0.17	0.16	0.15	0.16
Fish Scales	95SH010-005	476242	6218100	Bone bed	0.13	0.16	0.12	0.14
Fish Scales	95SH010-007	476242	6218100	Fish Scales	0.15	0.15	0.17	0.16
Westgate	95SH010-009	476242	6218100	Rusty Westgate	0.17	0.2	0.22	0.20
Notikewin	95SH011-001	489570	6251035	arkosic Sandstone.	0.32	0.37	0.2	0.30
Harmon	95SH011-004	489570	6251035	More typical less stained shale	0.19	0.27	0.23	0.23
Harmon	95SH011-005	489570	6251035	Hulcross shale	0.15	0.13	0.08	0.12
Cadotte	95SH011-007	489570	6251035	Cadotte Sandstone	0.26	0.29	0.28	0.28
Harmon	95SH011-008	489570	6251035	Shale	0.09	0.12	0.08	0.10
Grand Rapids	95SH012-002	494200	6259890	Grand Rapids; lithic sandstone	0.48	0.45	0.49	0.47
Grand Rapids	95SH012-003	494200	6259890	Grand Rapids Sandstone	0.3	0.26	0.28	0.28
Notikewin	95SH012-004	494200	6259890	Notikewin Shale	0.22	0.22	0.18	0.21
Notikewin	95SH012-005	494200	6259890	blocky shale, black, gastropods	0.11	0.15	0.18	0.15
Shaftesbury concretion	95SH012-006	494200	6259890	Carbonate concretion	0.29	0.31	0.31	0.30
Notikewin	95SH012-007	494200	6259890	Sandstone, interbedded silts and shales, rusty in colour	0.1	0.11	0.05	0.09

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Notikewin	95SH012-008	494200	6259890	cross-bedding, fine grained Sandstone	0.24	0.2	0.18	0.21
Westgate	95SH013-002	487370	6282370	Black shales, no fish	0.13	0.12	0.19	0.15
Shaftesbury concretion	95SH013-005	487370	6282370	Rusty weathered siderite concretion	1.67	1.72	1.7	1.70
Shaftesbury concretion	95SH013-007	487370	6282370	Siderite, ironstone	1.43	1.51	1.4	1.45
Shaftesbury concretion	95SH013-009	487370	6282370	Float - ironstone, glauconitic sandstone, siderite cement	0.74	0.89	0.78	0.80
Shaftesbury concretion	95SH013-010	487370	6282370	Float - Ironstone concretion	1.12	1.06	1.14	1.11
Notikewin	95SH015-002	488823	6286604	grey siltstone	0.11	0.08	0.13	0.11
Notikewin	95SH015-006	488823	6286604	interbedded sandstone, shale and siltstone	0.28	0.25	0.29	0.27
Cadotte	95SH015-007	488823	6286604	Hummocky cross-bedded sandstone	0.21	0.31	0.25	0.26
Concretion	95SH015-009	488823	6286604	Rusty siderite concretion	0.52	0.57	0.56	0.55
Paddy	95SH015-010	488823	6286604	Paddy Sandstone	0.17	0.21	0.15	0.18
Grimshaw gravel pit; ?volcanic clasts	95SH018-001	463170	6231835	Grimshaw gravel pit; volcanic clasts	14.7	14.5	14.7	14.63
Kaskapau	95SH019-001	459701	6251480	carbonaceous shaleweak sulphur stain-ing	0.21	0.21	0.2	0.21
Kaskapau	95SH019-003	459701	6251480	black, carbonaceous shale, weak sulphur staining	0.18	0.23	0.21	0.21
Notikewin	95SH021-003	489880	6279480	sandstone unlithified, Massive, f.gr. beige	0.16	0.15	0.14	0.15
Concretion	95SH021-004	489880	6279480	Carbonate cemented sandstone, strong fizz	0.29	0.33	0.26	0.29
Concretion	95SH021-005	489880	6279480	Concoidal fracture, carbonate/silica cemented sandstone	0.28	0.33	0.38	0.33
Paddy	95SH022-005	486963	6273391	quartzose sandstone, rusty	0.16	0.19	0.16	0.17
Wapiti	95SH024-003	454801	6145350	Unlithified sand (lithic)	1.02	1.15	1.08	1.08
Wapiti	95SH024-004	454801	6145350	Blocky silty mudstone	0.02	0.02	0.05	0.03
Wapiti	95SH024-005	454801	6145350	Silty mudstone	0.14	0.19	0.22	0.18

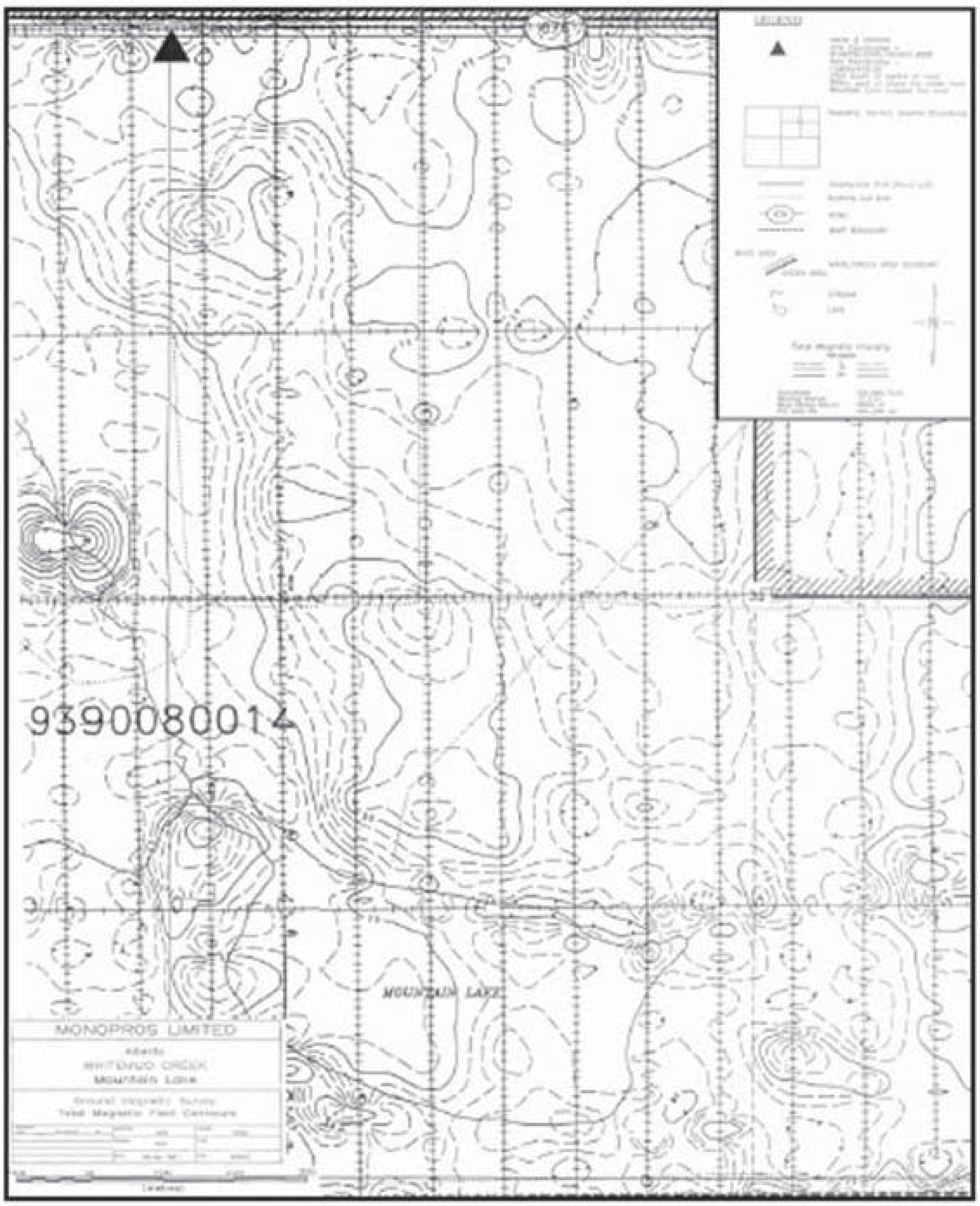
Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Wapiti	95SH024-006	454801	6145350	Partly lithified lithic sandstone	0.35	0.36	0.33	0.35
Float	95SH024-009	454801	6145350	Granite possibly volcanic	1.12	1.23	1.26	1.20
Paddy	95SH027-001	481240	6228675	Paddy Formation sandstone	0.18	0.2	0.28	0.22
Cadotte	95SH027-010	481240	6228675	Cadotte sandstone; arkosic	0.13	0.15	0.17	0.15
Siderite concretion	95SH029-004	469363	6331180	possible ammonite	0.55	0.57	0.59	0.57
Siderite concretion	95SH029-009	469363	6331180	Siderite, very heavy	0.66	0.68	0.69	0.68
Siderite concretion	95SH029-013	469363	6331180	siderite, very rusty	0.92	0.93	0.86	0.90
Siderite concretion	95SH029-014	469363	6331180	siderte	0.72	0.74	0.73	0.73
Notikewin	95SH030-003	481365	6341425	Green sandstone with biotite	0.34	0.32	0.4	0.35
Notikewin	95SH030-007	481365	6341425	Shale, black, fish remains, some sulphur	0.11	0.17	0.14	0.14
Harmon	95SH030-010	481365	6341425	Shale	0.2	0.14	0.2	0.18
Fish Scales	95SH030-015	481365	6341425	Shale immed. above bone bed	0.21	0.19	0.25	0.22
Fish Scales	95SH030-017	481365	6341425	Shale above bone bed	0.17	0.18	0.14	0.16
Dunvegan	95SH032-001	544442	6424912	Dunvegan Formation sandstone	0.26	0.33	0.27	0.29
Fish Scales	95SH032-004	544442	6424912	Shale; fish scales	0.26	0.22	0.26	0.25
Fish Scales	95SH032-007	544442	6424912	Shale; fish scales	0.29	0.21	0.21	0.24
Fish Scales	95SH032-009	544442	6424912	Shale; fish scales; minor py	0.35	0.31	0.28	0.31
Loon River	95SH034-001	537400	6486500	Shale, grey to black, sulphur stained	0.12	0.08	0.12	0.11
Float	95SH036-006	595011	6400316	Float of concretions	1.53	1.68	1.46	1.56
Fish Scales	95SH036-007	595011	6400316	Sandy silt with bones	0.14	0.15	0.21	0.17
Float	95SH037-001	589705	6394880	Large concretion washing out of shale outcrop	0.33	0.3	0.46	0.36
Dunvegan	95SH037-005	589705	6394880	Probably Dunvegan sandstone	0.4	0.44	0.41	0.42
Westgate	95SH039-001	572130	6418660	Silty shale, sulfur along fractures	0.14	0.18	0.17	0.16
Fish Scales	95SH039-005	572130	6418660	platey resistant ledge, Fish scales abundant	0.13	0.09	0.14	0.12

Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Fish Scales	95SH039-012	572130	6418660	up to 80% bones, bone bed, phosphorous, larger teeth	0.01	0.05	0	0.02
Westgate	95SH040-001	589163	6374789	Westgate shale, massive, slightly rusty, sulfur bloom	0.2	0.14	0.15	0.16
Loon River	95SH041-002	513590	6380540	inoceramus, burrowed sandstone, abundant fossils	0.07	0.11	0.11	0.10
Clearwater	95SH042-001	500590	6402010	Rusty concretion	0.55	0.5	0.57	0.54
Westgate	95SH043-002	473813	6326497	Concretion or concretionary bed	1.22	0.93	1.08	1.08
Paddy	95SH044-001	478054	6333300	Shale below bone bed	0.11	0.19	0.18	0.16
Westgate	95SH044-003	478054	6333300	Shale	0.07	0.12	0.16	0.12
Shaftesbury	95SH045-007	471055	6320865	Concretion	1.23	1.09	1.43	1.25
Fish Scales	95SH046-002	484870	6268005	organic shale, lots of fish, minor sulfur; slightly siltier	0.14	0.13	0.16	0.14
Bad Heart	95SH047-004	376247	6273884	Oolitic Sandstone	0.64	0.62	0.57	0.61
Bad Heart	95SH047-005	376247	6273884	Oolitic Sandstone; consists of shale clasts, chert pebbles	0.58	0.63	0.6	0.60
Bad Heart	95SH047-006	376247	6273884	Oolitic Sandstone	0.37	0.39	0.31	0.36
Bad Heart	95SH047-007	376247	6273884	Oolitic Sandstone	0.51	0.52	0.51	0.51
Bad Heart	95SH047-008	376247	6273884	Oolitic Sandstone	0.51	0.58	0.48	0.52
Wapiti	95SH048-002	404016	6124648	sandstone, lithic	0.26	0.25	0.25	0.25
Wapiti	95SH048-006	404016	6124648	sandstone, matrix of rim: melted or magmatic	1.05	1.26	1.13	1.15
Wapiti	95SH048-007	404016	6124648	Lithic sandstone, organic bedding	0.17	0.21	0.18	0.19
Westgate	95SH049-003	538875	6425325	Westgate shale	0.25	0.25	0.27	0.26
Fish Scales	95SH049-006	538875	6425325	2nd bone bed, less dense, more shell fragments	0.07	0.06	0.09	0.07
Fish Scales	95SH049-007	538875	6425325	Platey, grey shale, sulfur stained on bedding planes	0.13	0.1	0.12	0.12

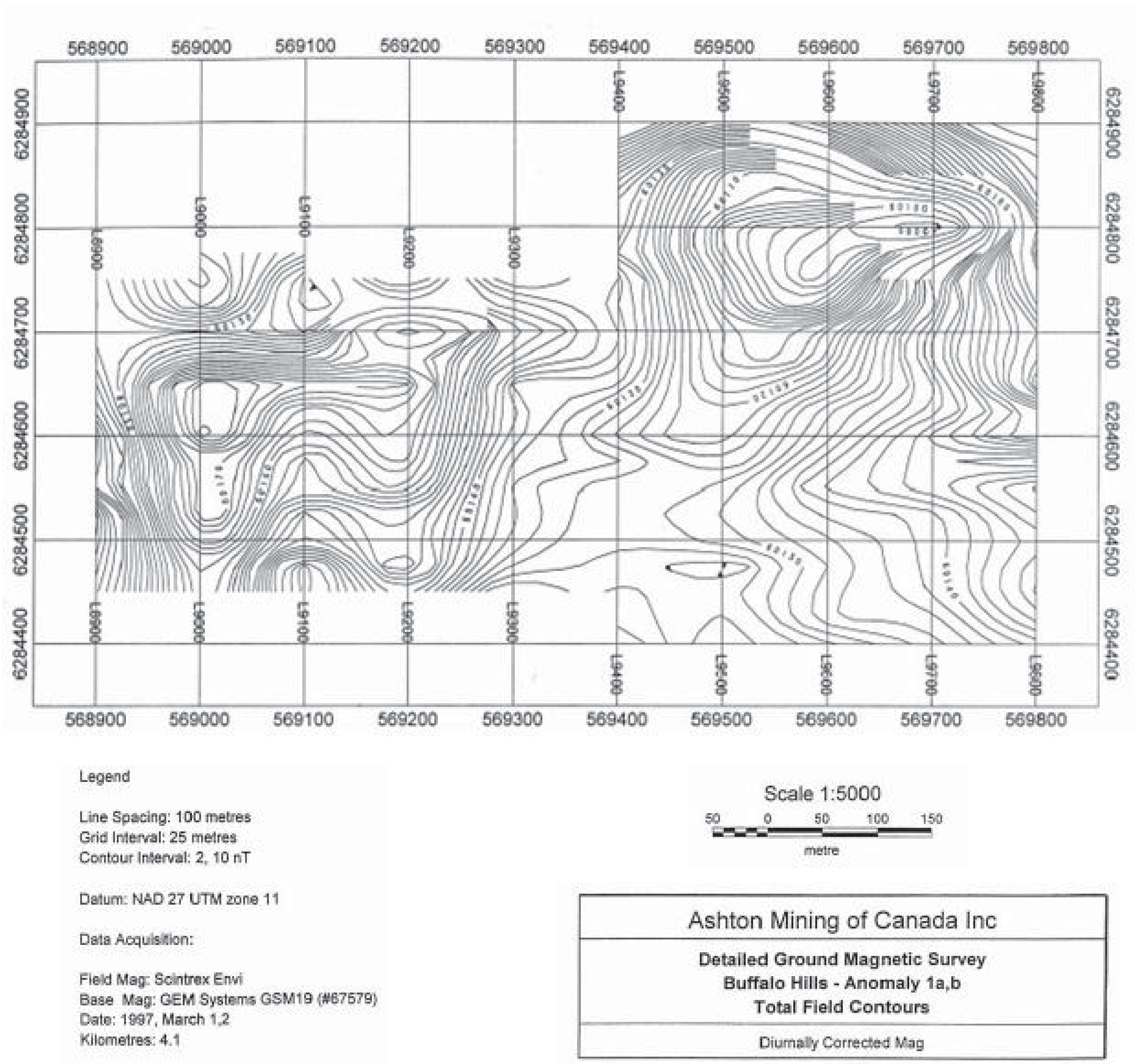
Formation	Sample ID	Location NAD27		General Lithology Description	Magnetic Susceptibility (10-3 SI)			
		Easting	Northing		Reading 1	Reading 2	Reading 3	Average
Westgate	95SH049-015	538875	6425325	sulphurous, bioturbated, black shale	0.09	0.07	0.14	0.10
Westgate	95SH049-017	538875	6425325	massive grey shale with incipient ovoid concretions	0.12	0.14	0.18	0.15
Fish Scales	95SH049-018	538875	6425325	Alterred light to dark green bone bed	0.11	0.1	0.15	0.12
Westgate	95SH050-001	610600	6508315	dark grey to black shale, blocky, rusty	0.09	0.1	0.12	0.10
Fish Scales	95SH050-004	610600	6508315	Organic bone bed, minor py replacing organic remains	0.09	0.04	0.07	0.07
Fish Scales	95SH050-007	610600	6508315	Carbon-rich shale, organic rich on bedding surfaces	0.06	0.08	0.08	0.07
Fish Scales	95SH050-011	610600	6508315	laminated, platey shale, slightly bioturbated	0.09	0.13	0.09	0.10
Fish Scales	95SH050-013	610600	6508315	bone bed with rusty organic-rich shale, pinches and swails	0.07	0.01	0.02	0.03
Westgate	95SH052-008	559910	6512150	shale, sandstone top, bioturbated, sulfur, blocky	0.16	0.14	0.09	0.13
Westgate	95SH053-001	552295	6519850	Silty black, bioturbated shale, minor fish scales	0.06	0.05	0.04	0.05
Westgate	95SH055-009	346306	6417285	bioturbated, muddy shale, crumbly, weakly sulferous	0.07	0.1	0.1	0.09
Westgate	95SH055-010	346306	6417285	Blockier shale, sulfur	0.08	0.08	0.08	0.08
White Specks	95SH057-001	575858	6554571	Blocky Shale	0.07	0.06	0.07	0.07
White Specks	95SH057-003	575858	6554571	Dark grey shale	0.09	0.1	0.11	0.10

Appendix 3. Scanned ground magnetic surveys over selected ultramafic pipes in the Mountain Lake (A; Wood and Williams, 1994), Buffalo Head Hills (B to P; Skelton and Bursey, 1998, 1999) and Birch Mountains (Q to W; Aravanis, 1999) fields.

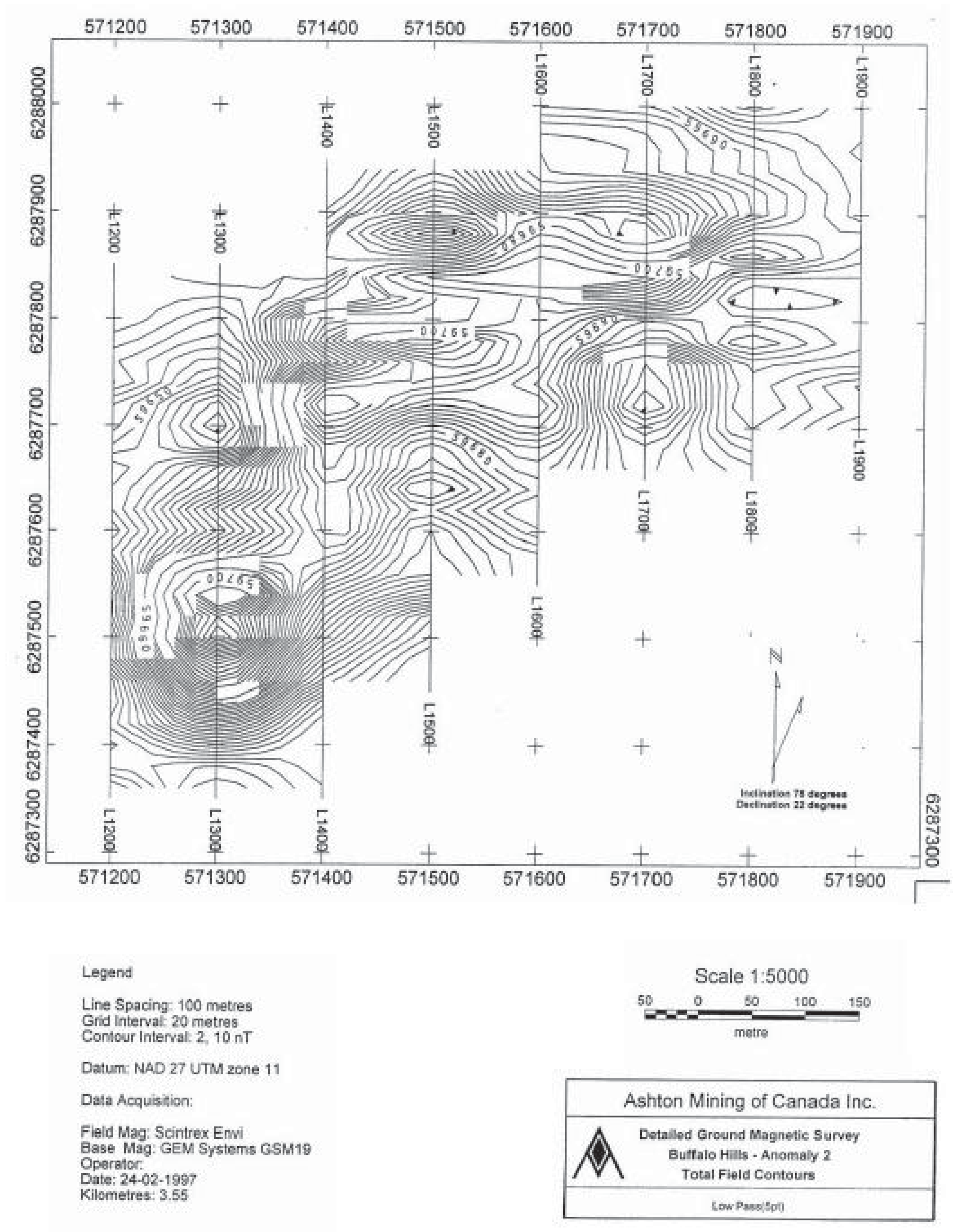
A) Mountain Lake pipes



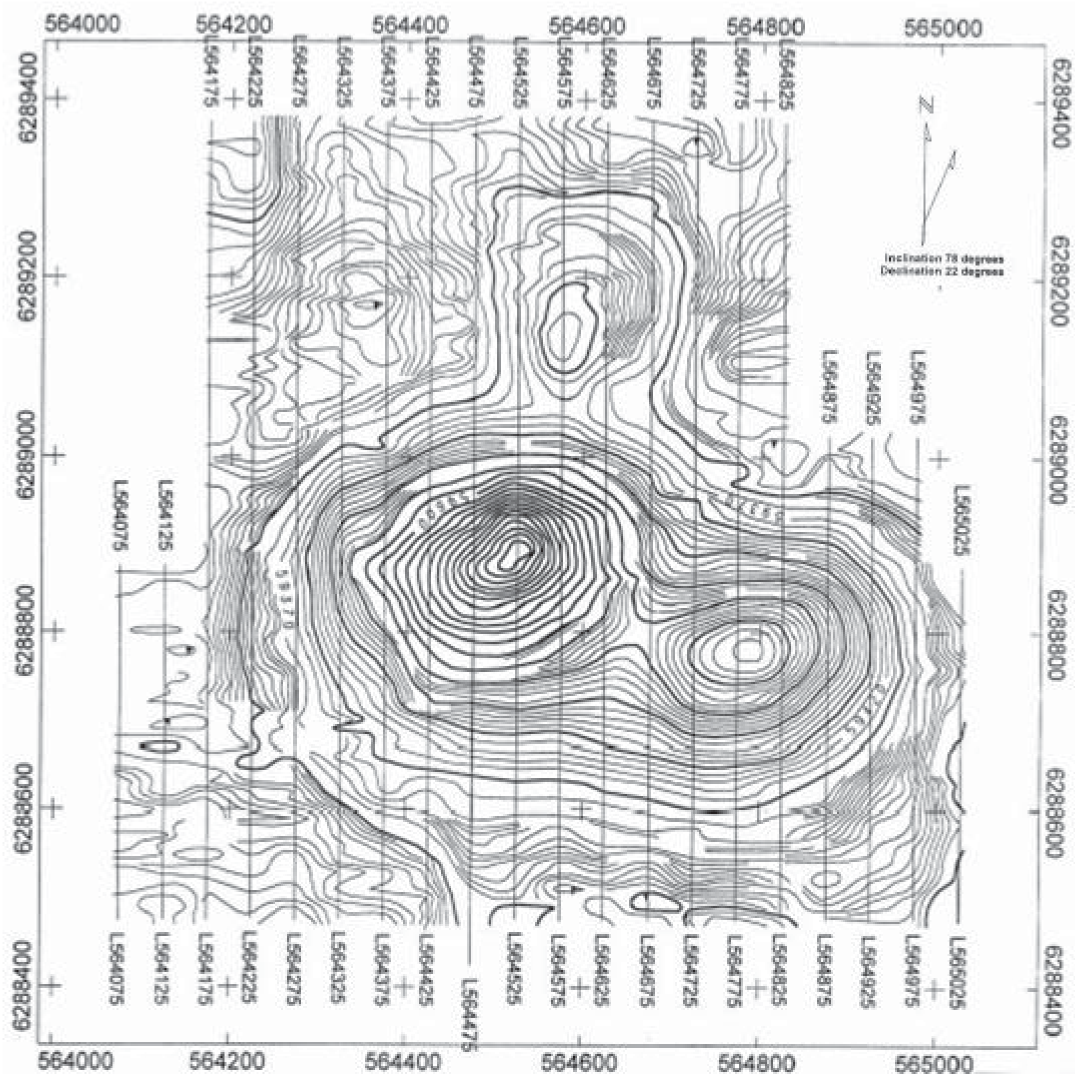
B) Buffalo Head Hills: K1 pipe



C) Buffalo Head Hills: K2 pipe



D) Buffalo Head Hills: K3 pipe



Legend

Line Spacing: 50 metres
Grid Interval: 10 metres
Contour Interval: 2, 10 nT

Datum: NAD 27 UTM zone 11

Data Acquisition:

Field Mag: GEM Systems GSM19 GW (#68586)
Base Mag: GEM Systems GSM19 W (#67577)
Operator:
Date: 1998 February 10 & 11
Kilometres: 15.5

Scale 1:7500

100 0 100 200

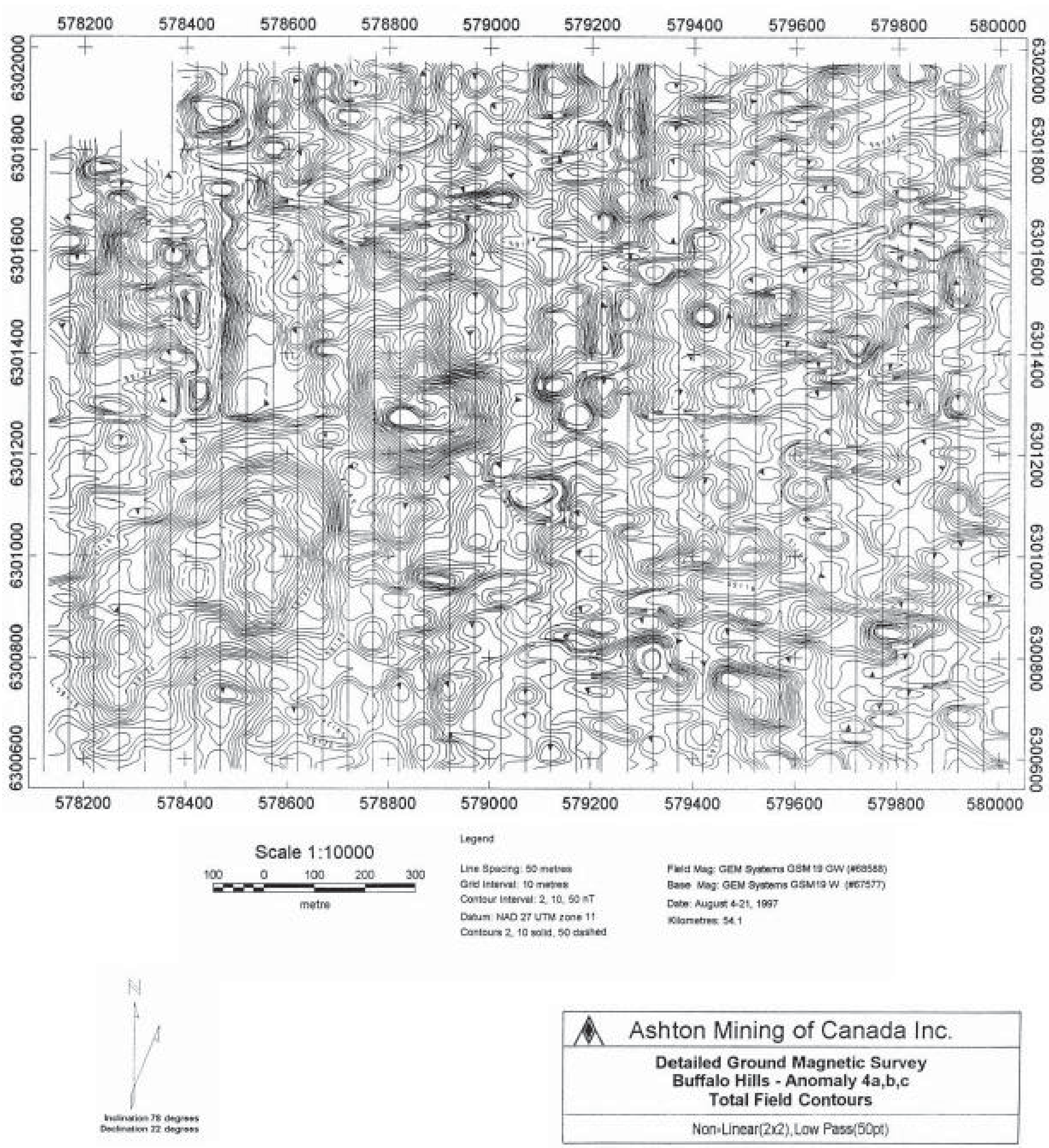
metre

Ashton Mining of Canada Inc.

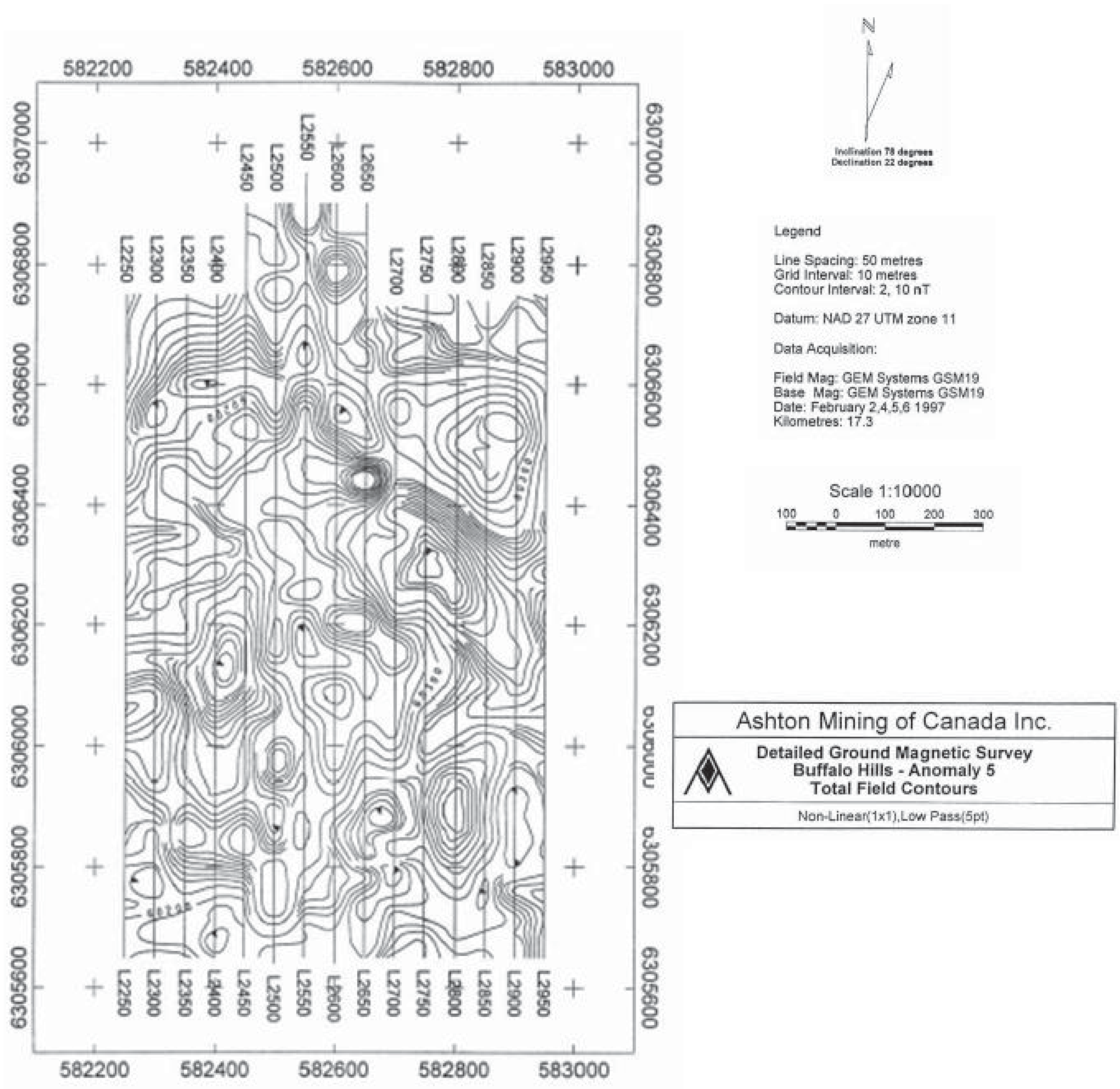
Detailed Ground Magnetic Survey
Buffalo Hills - Anomaly 3
Total Field Contours

Non-Linear(2x2),Low Pass(10pt)

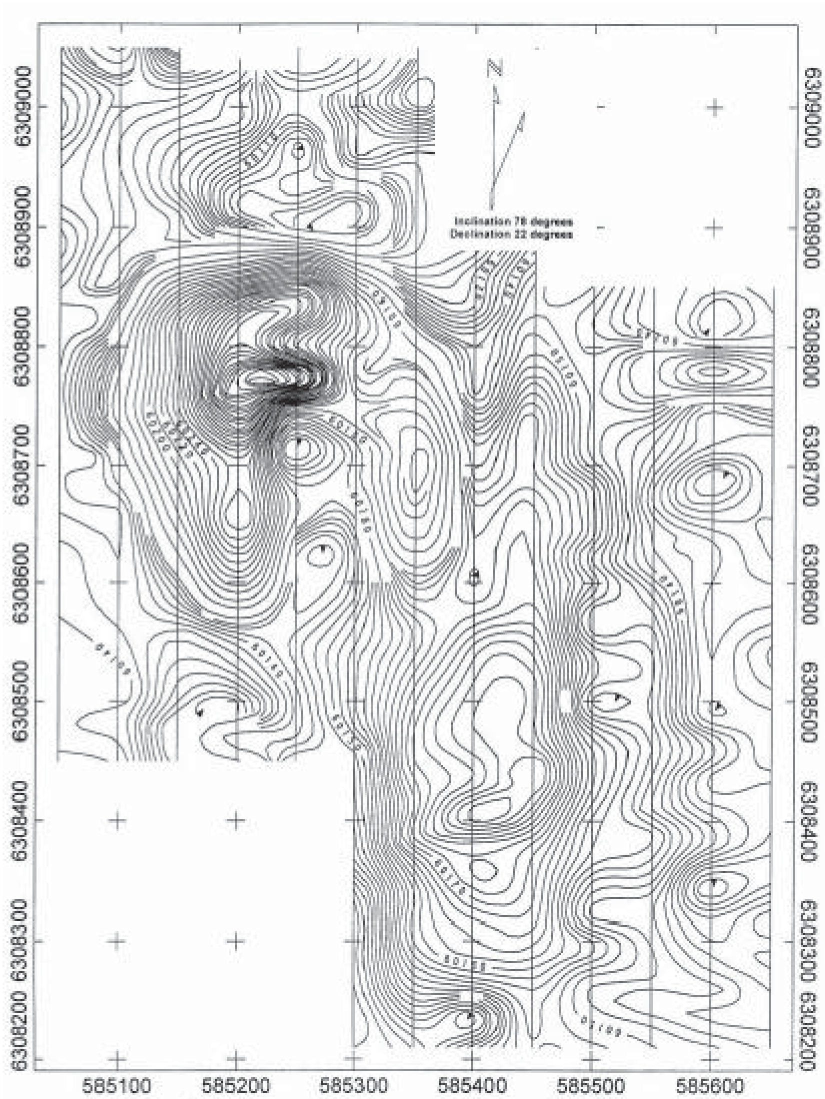
E) Buffalo Head Hills: K4 pipe



F) Buffalo Head Hills: K5 pipe



G) Buffalo Head Hills: K6 pipe



Legend

Line Spacing: 50 metres
Grid Interval: 10 metres
Contour Interval: 2, 10 nT

Datum: NAD 27 UTM zone 11

Data Acquisition:

Field Mag: GEM Systems GSM19
Base Mag: GEM Systems GSM19
Date: January 25-27, 1997
Kilometres: 8.9

Scale 1:5000

50 0 50 100 150

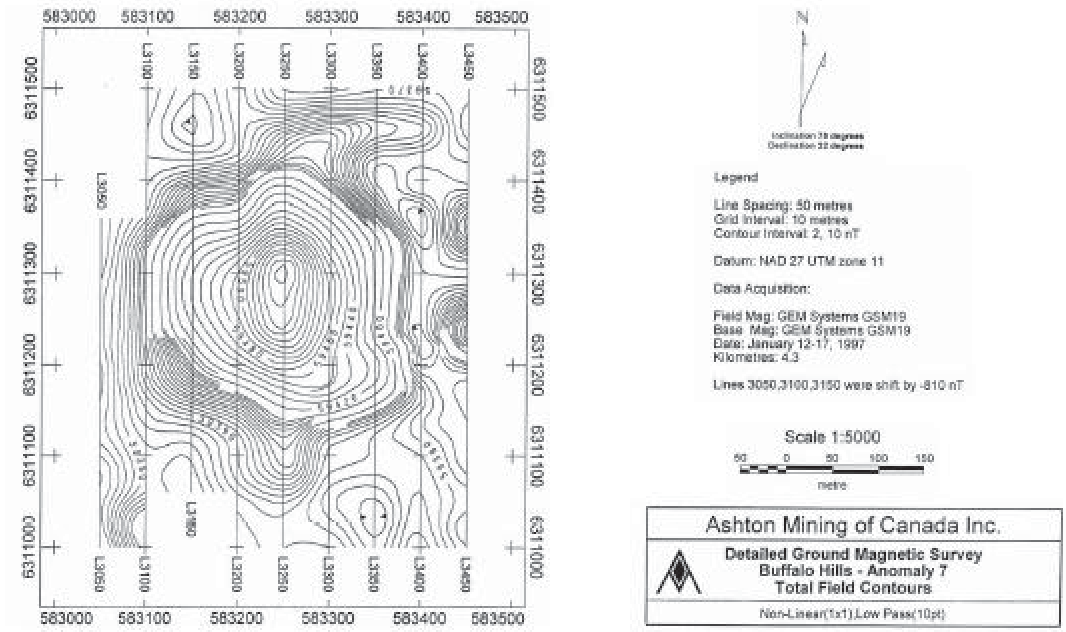
metre

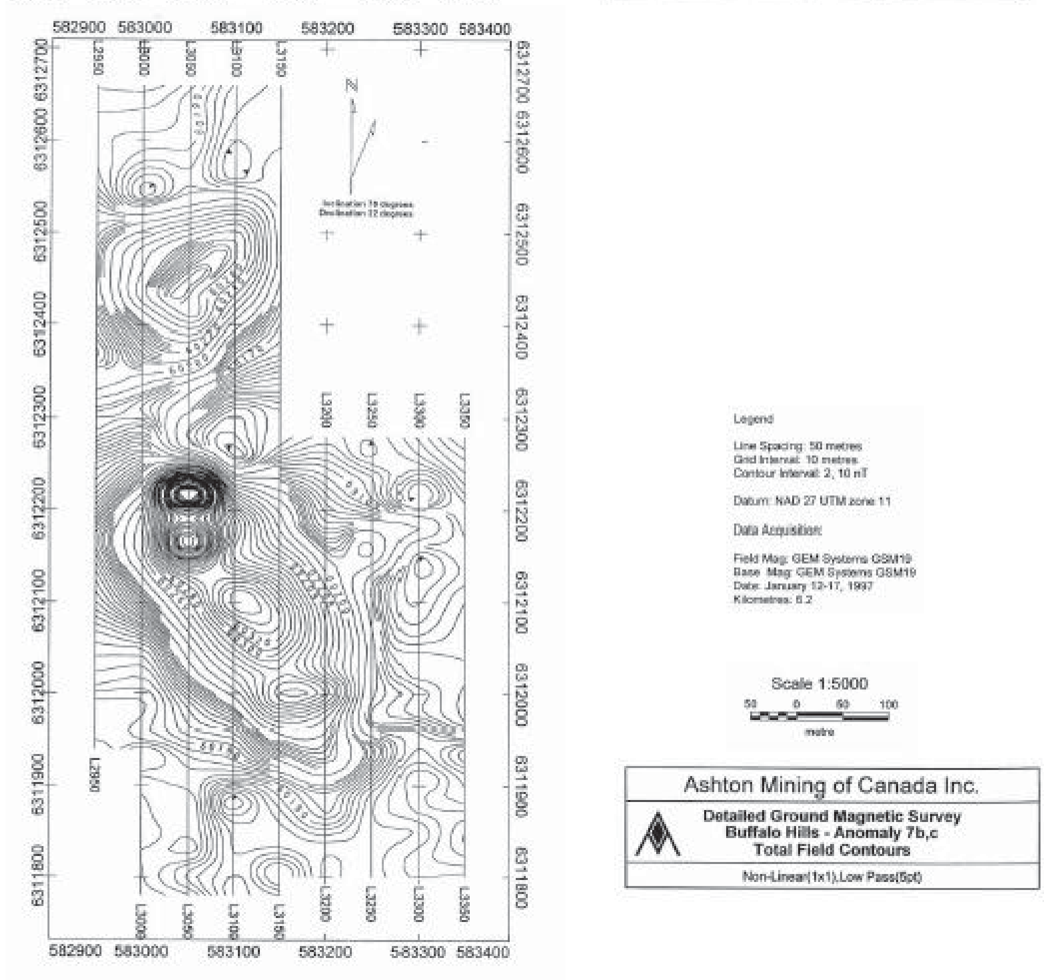
Ashton Mining of Canada Inc.

Detailed Ground Magnetic Survey
Buffalo Hills - Anomaly 6
Total Field Contours

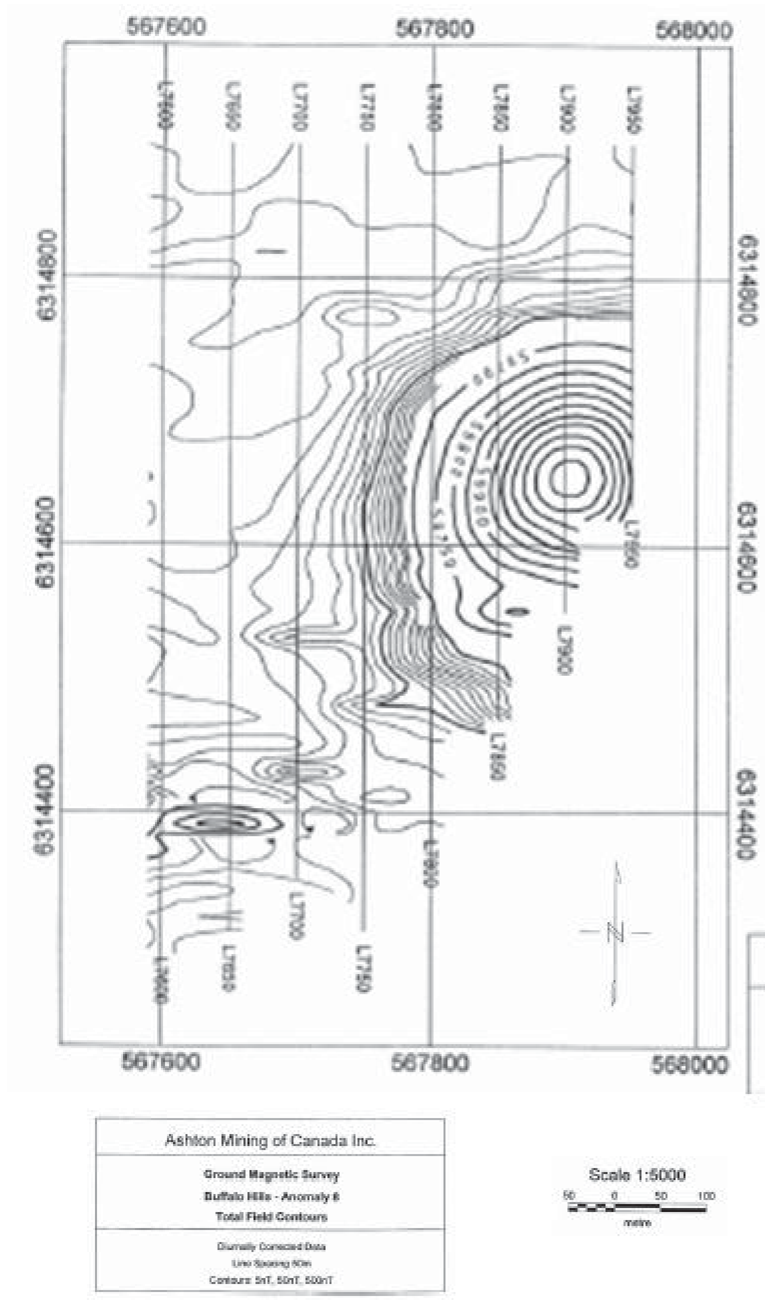
Non-Linear(1x1),Low Pass(5pt)

H) Buffalo Head Hills: K7 pipe

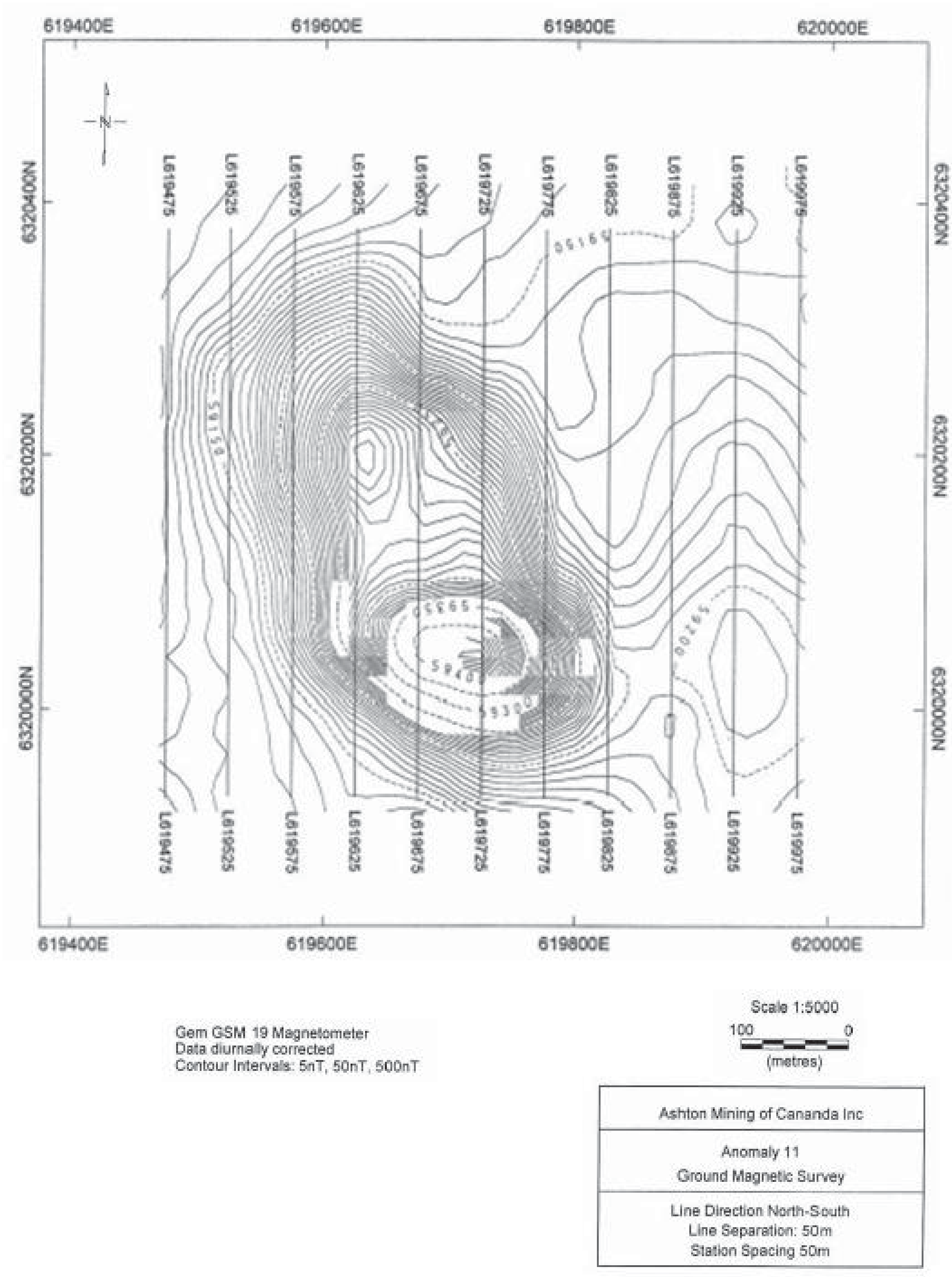




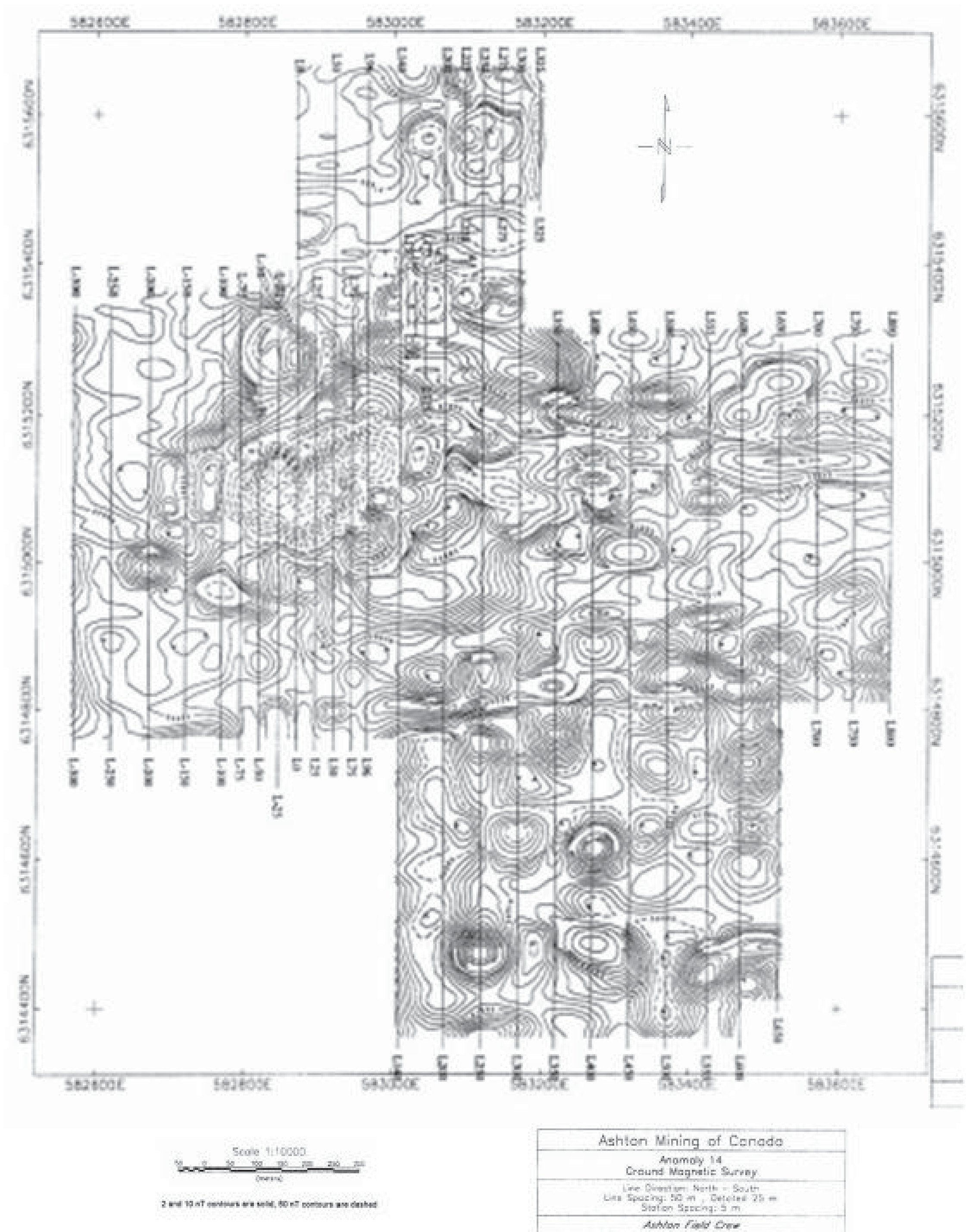
I) Buffalo Head Hills: K8 pipe



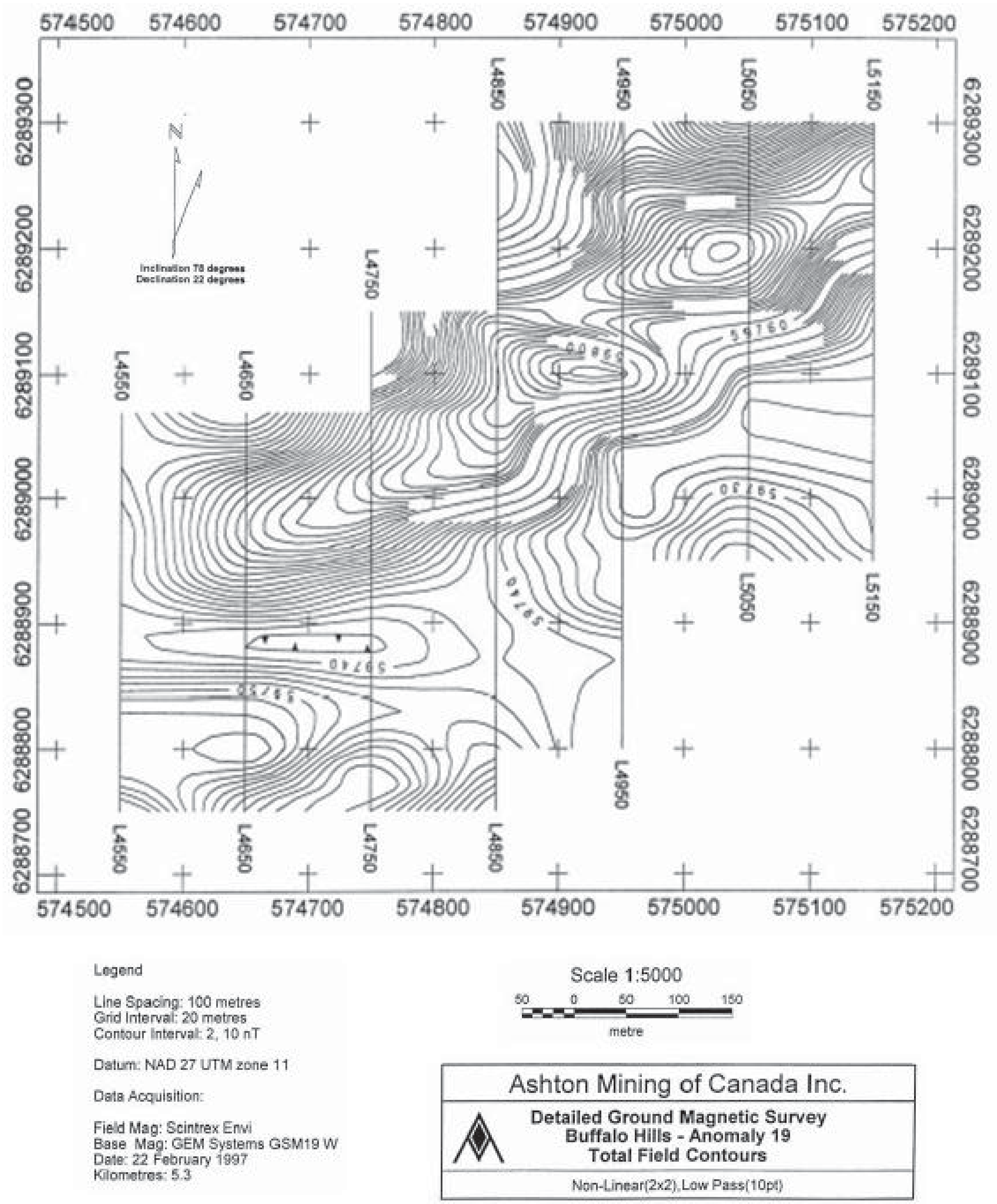
J) Buffalo Head Hills: K11 pipe



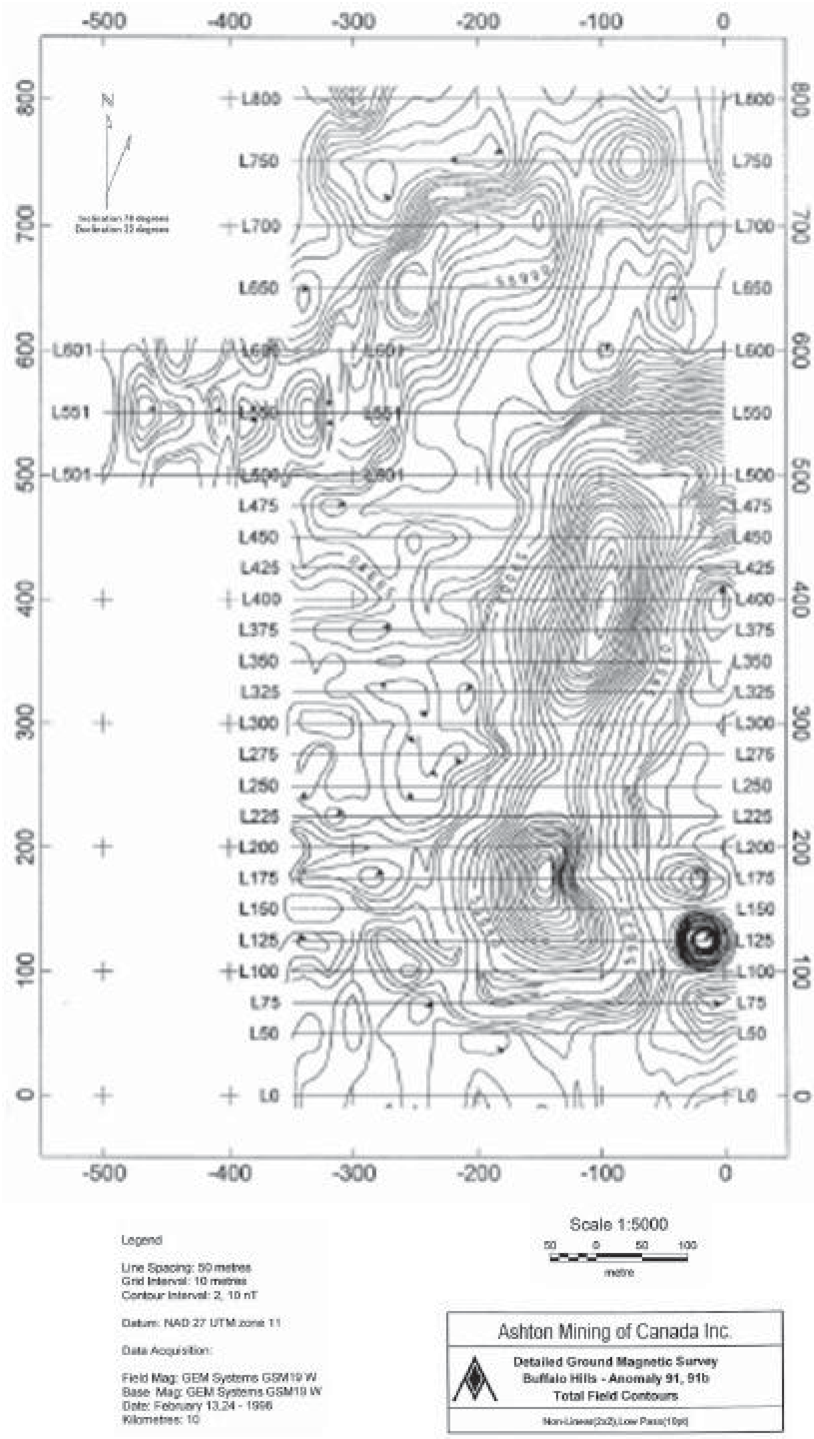
K) Buffalo Head Hills: K14 pipe



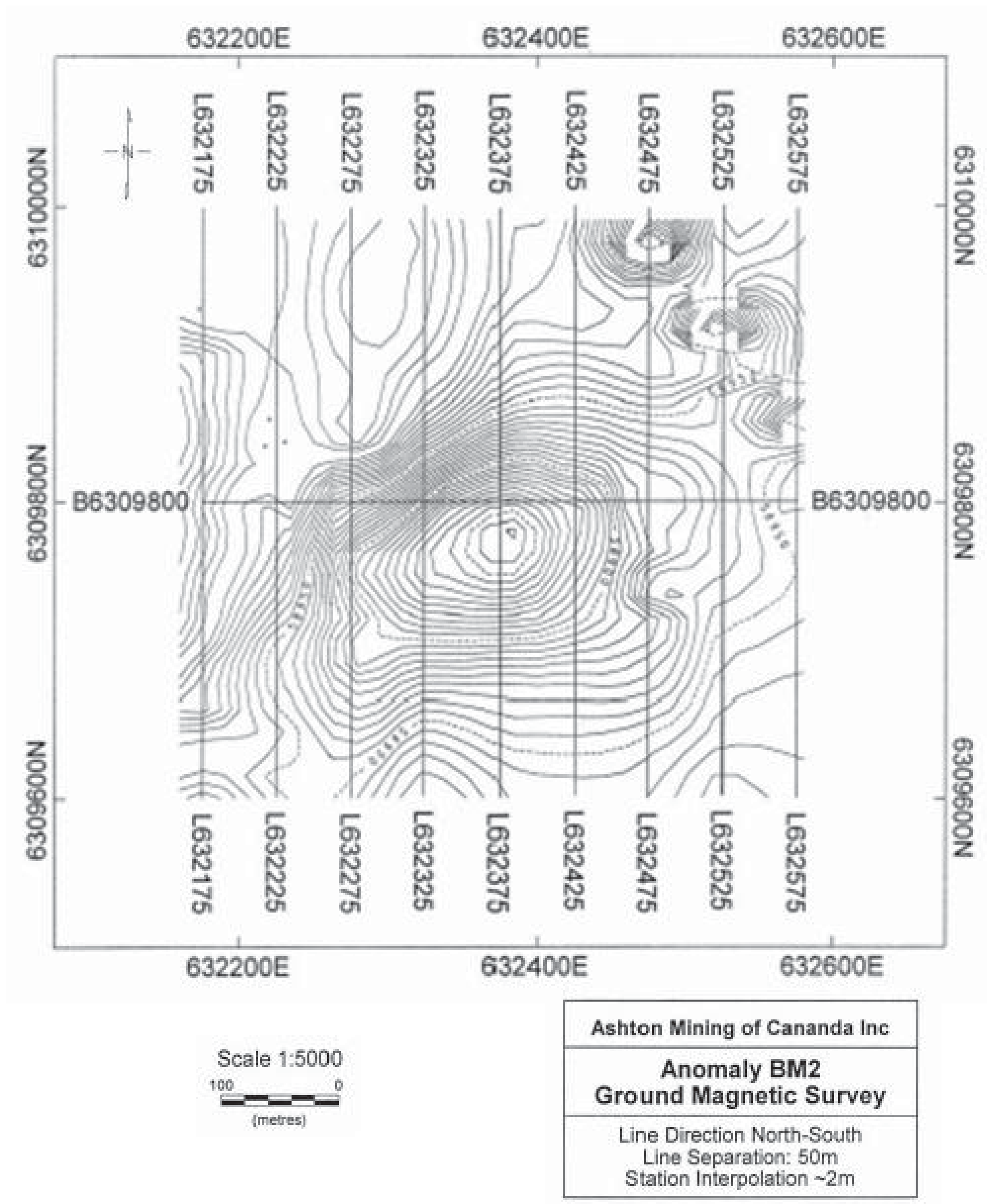
L) Buffalo Head Hills: K19 pipe



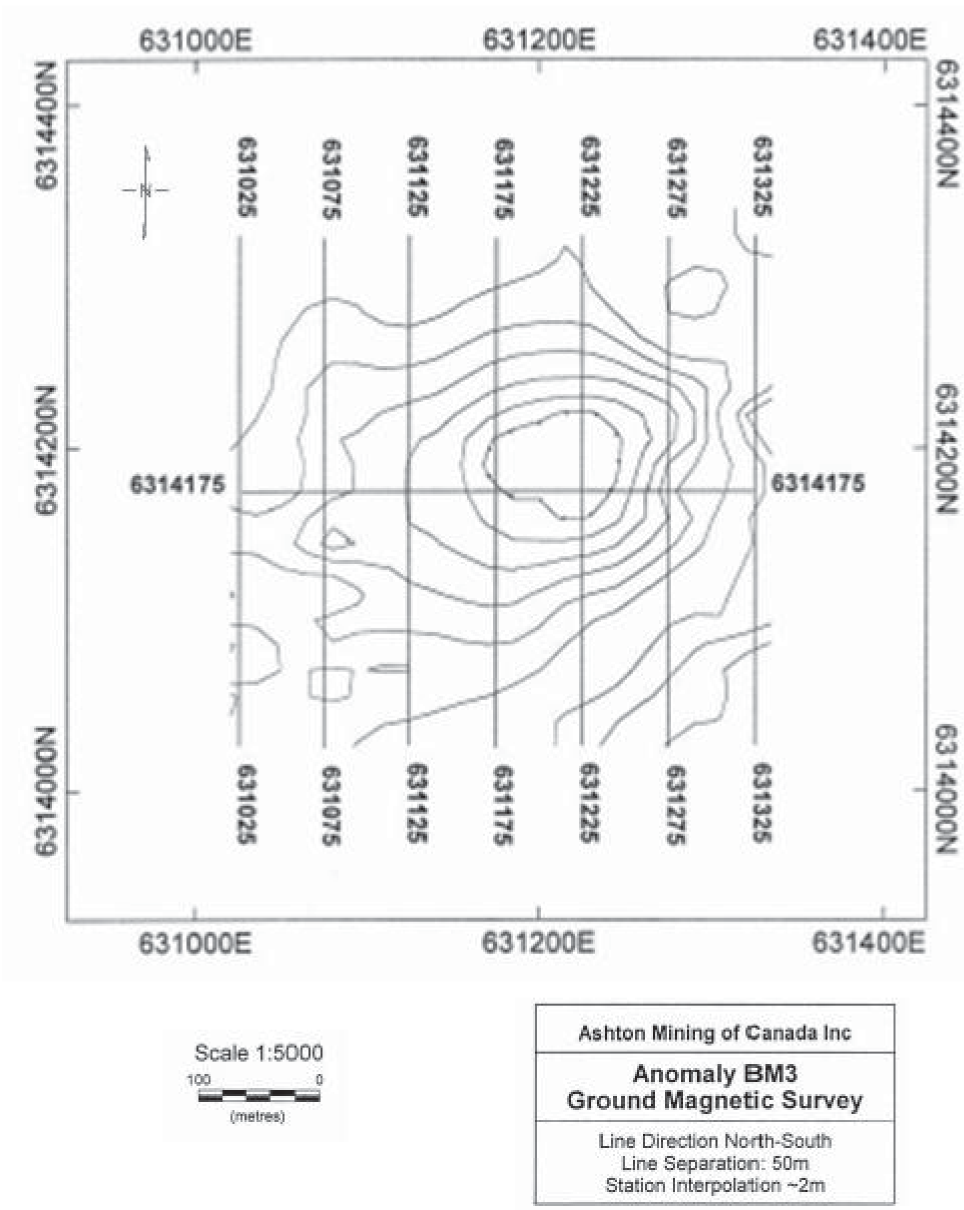
M) Buffalo Head Hills: K91 pipe



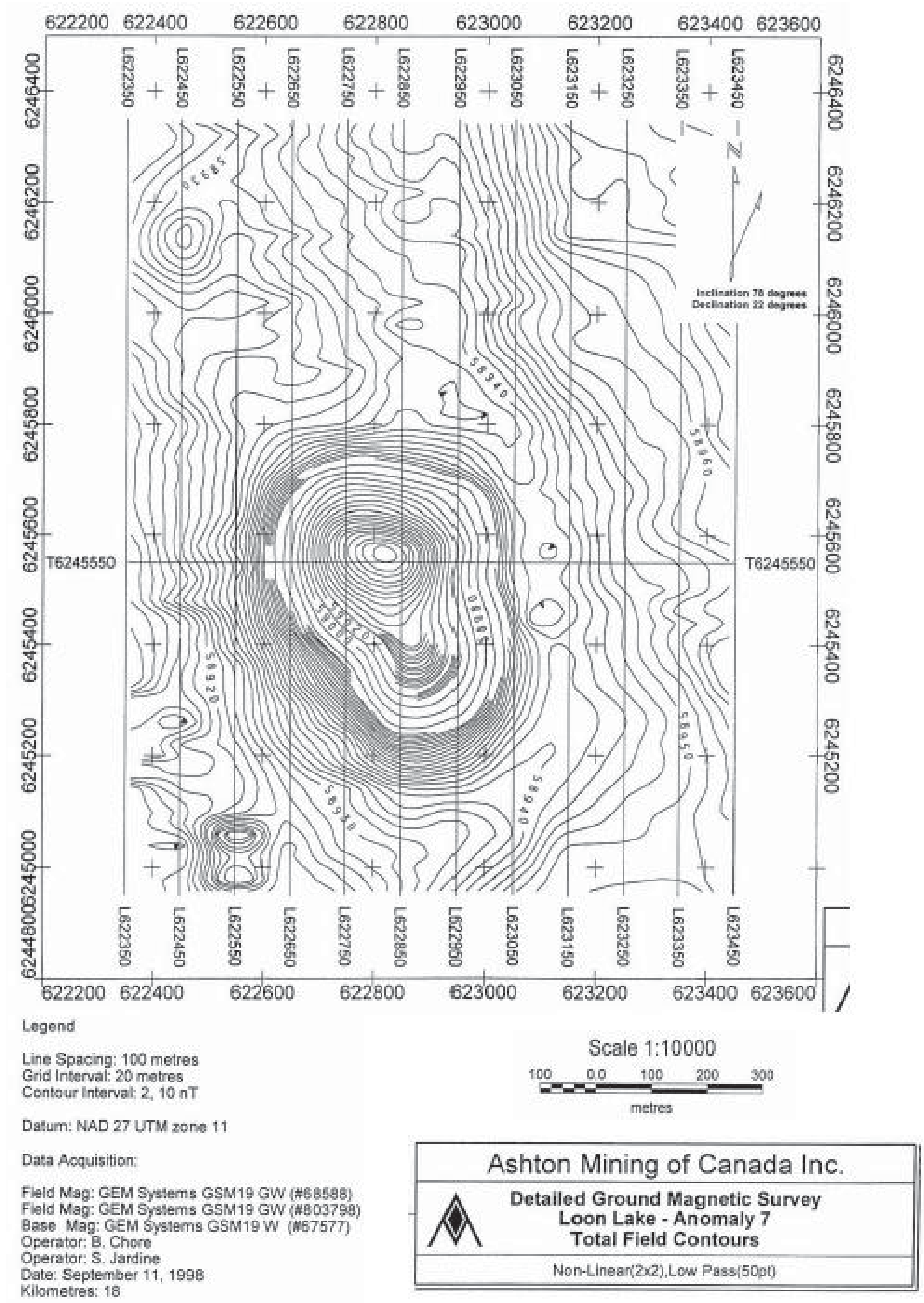
N) Buffalo Head Hills: BM2 pipe



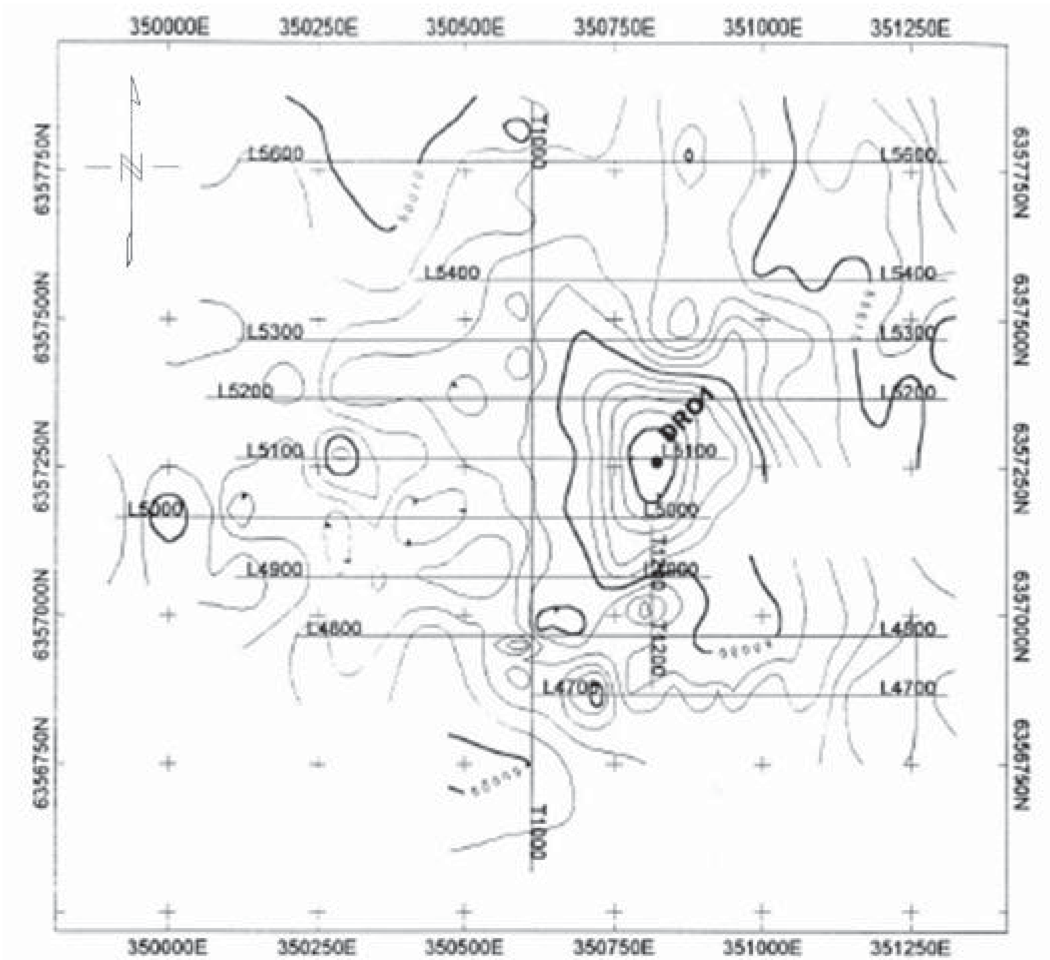
O) Buffalo Head Hills: BM3 pipe



P) Buffalo Head Hills: LL7 pipe

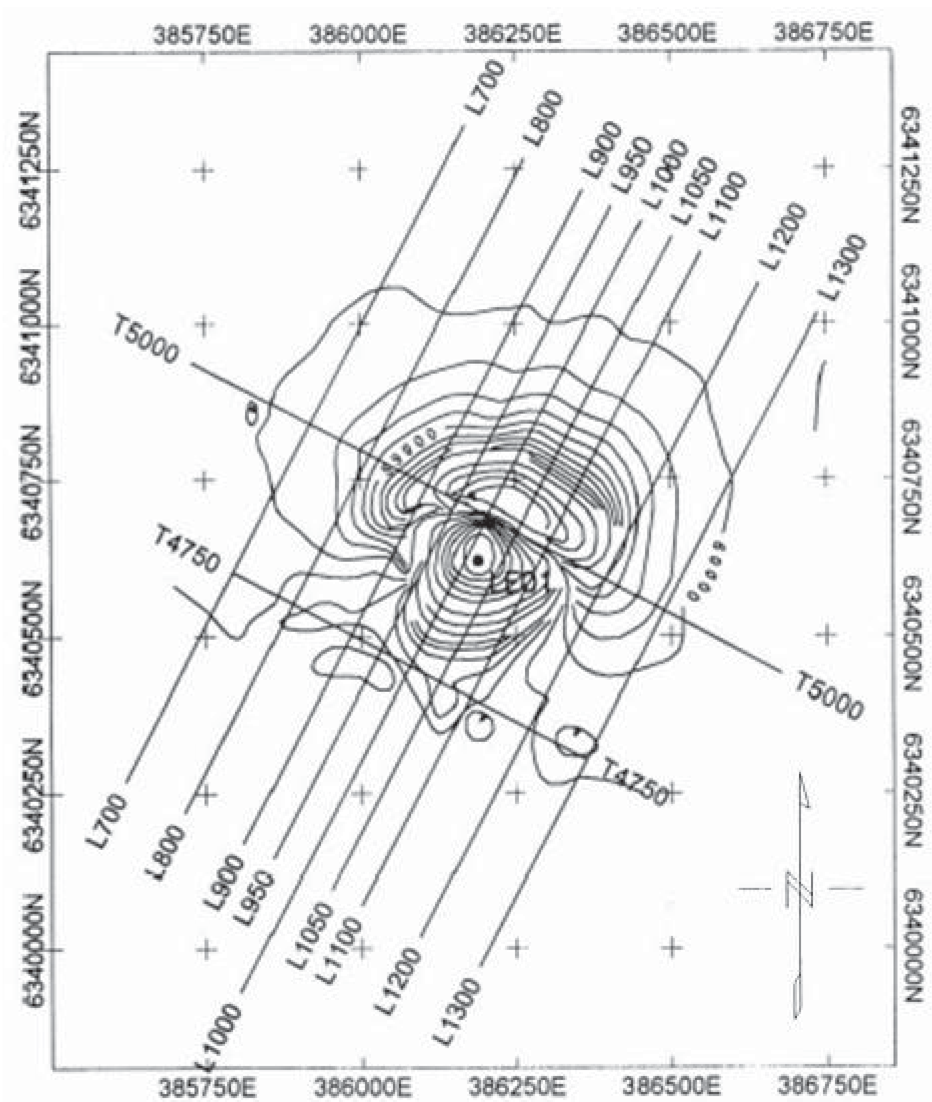


Q) Birch Mountains: Dragon pipe



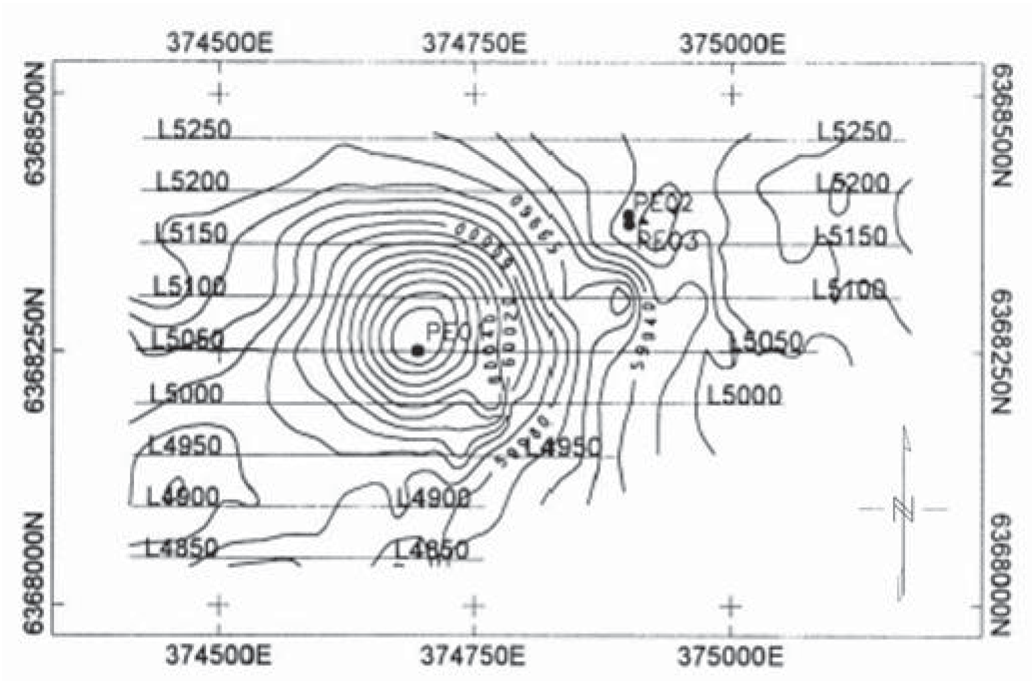
Kennecott Canada Exploration Inc. **KCEI/Montello Resources Ltd. JV**
LEGEND PROPERTY **DRAGON** **Total Field Magnetics**
contour interval = 5, 25 nT **filters: none**
October, 1998

R) Birch Mountains: Legend pipe



Kennecott Canada Exploration Inc. KCEI/Montello Resources Ltd. JV
LEGEND PROPERTY LEGEND_PROSPECT Total Field Magnetics
contour interval = 25, 100, 500 nT filters: none
November, 1998

S) Birch Mountains: Pegasus pipe



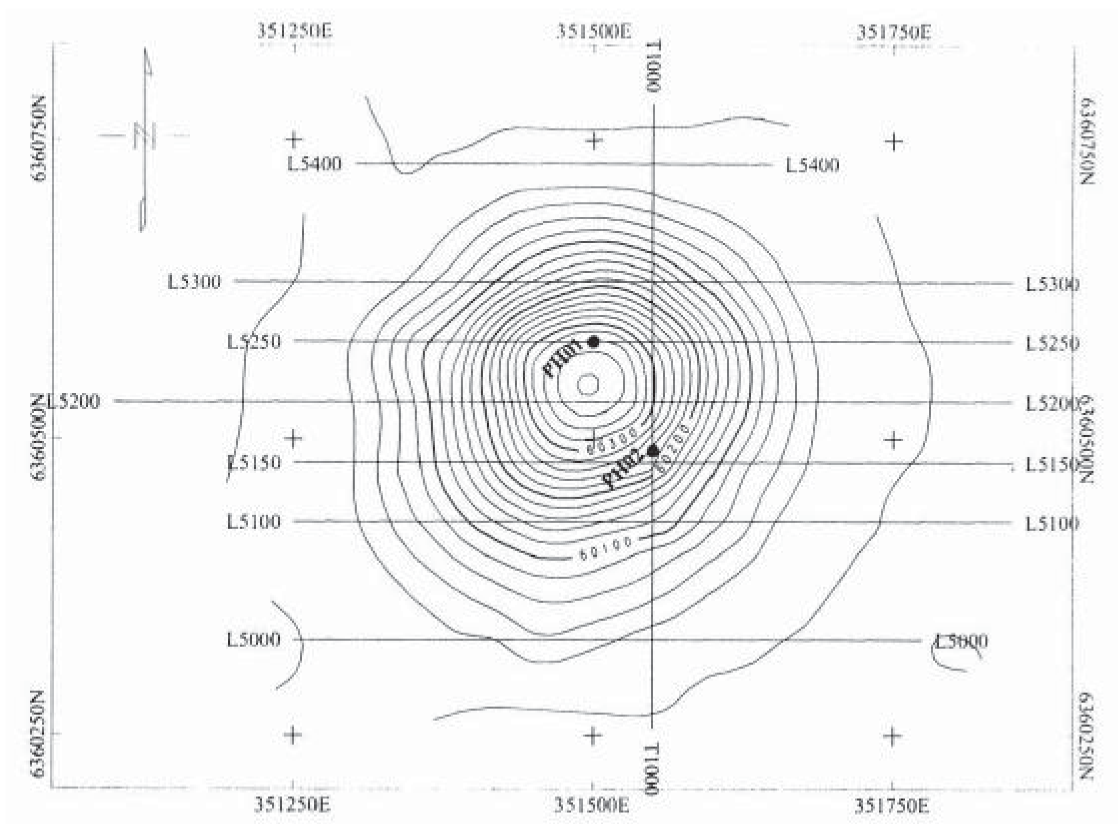
Kennecott Canada Exploration Inc.
KCEI/Montello Resources Ltd. JV

LEGEND PROPERTY
PEGASUS
Total Field Magnetics

contour interval = 10, 20, 120 nT
filters: none

February, 1999

T) Birch Mountains: Phoenix pipe



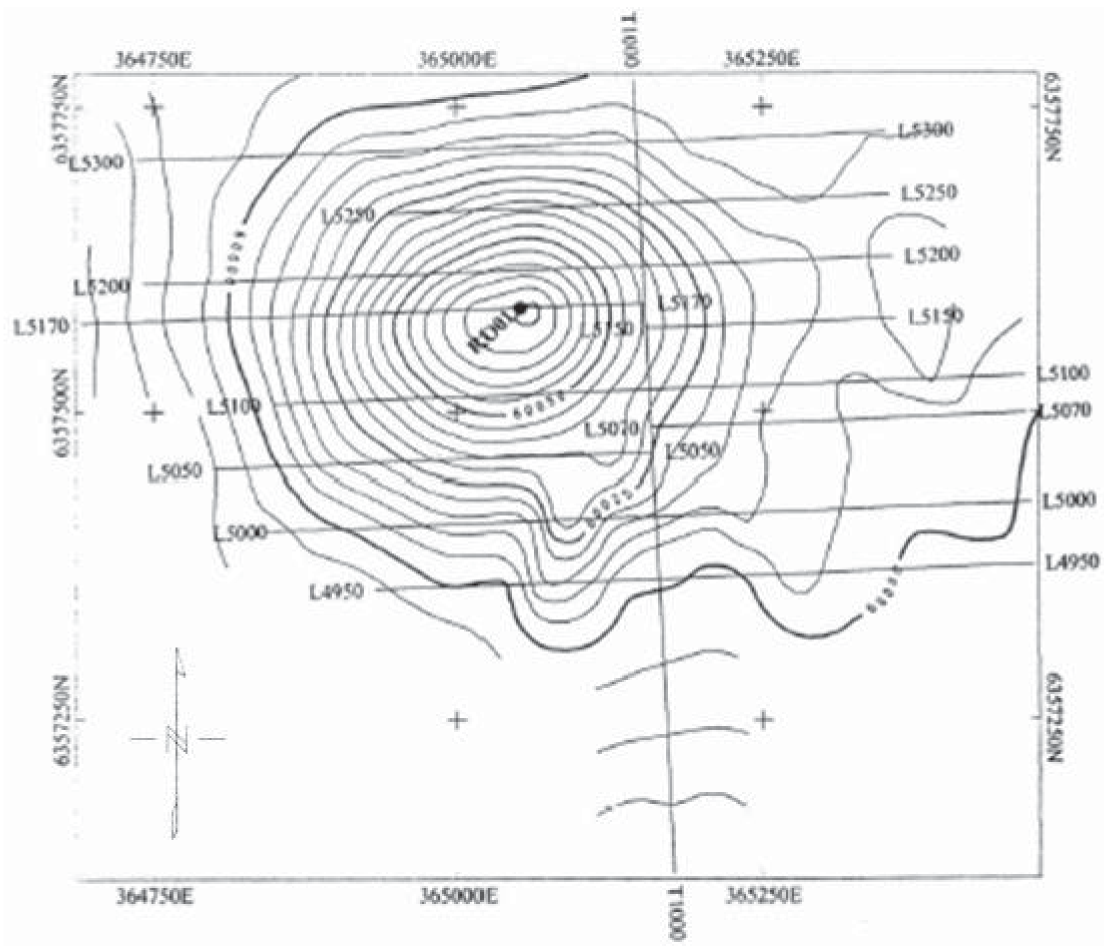
Kennecott Canada Exploration Inc.
KCEI/Montello Resources Ltd. JV

LEGEND PROPERTY
PHOENIX
Total Field Magnetics

contour interval = 20 & 100 nT
filters: none

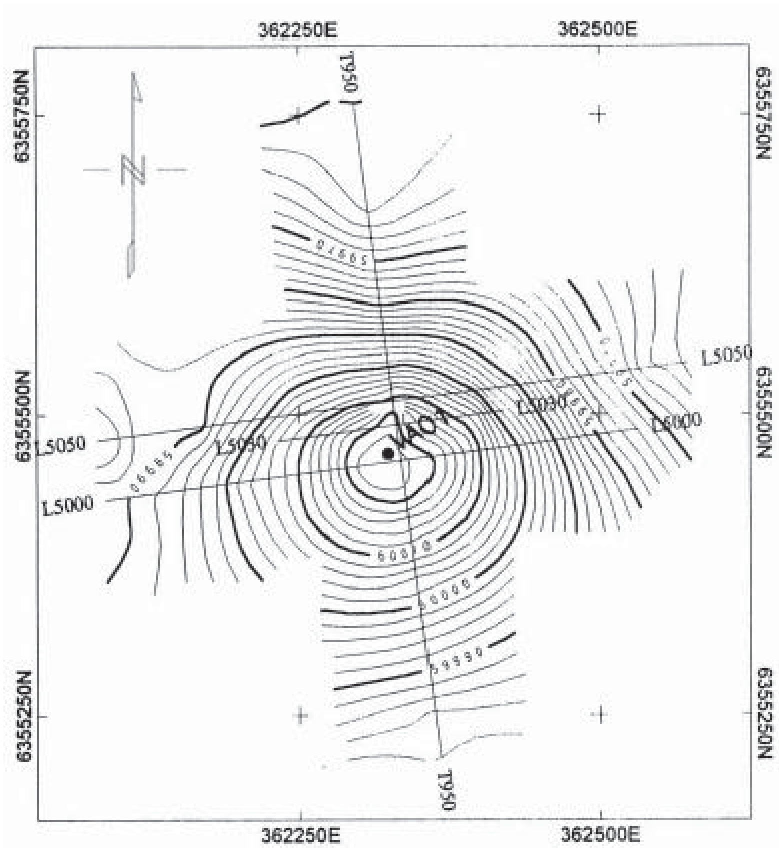
October, 1998

U) Birch Mountains: Roc pipe



Kennecott Canada Exploration Inc. KCEI/Montello Resources Ltd. JV
LEGEND PROPERTY ROC Total Field Magnetics
contour interval = 5, 25 nT filters: none
October, 1998

V) Birch Mountains: Valkyrie pipe



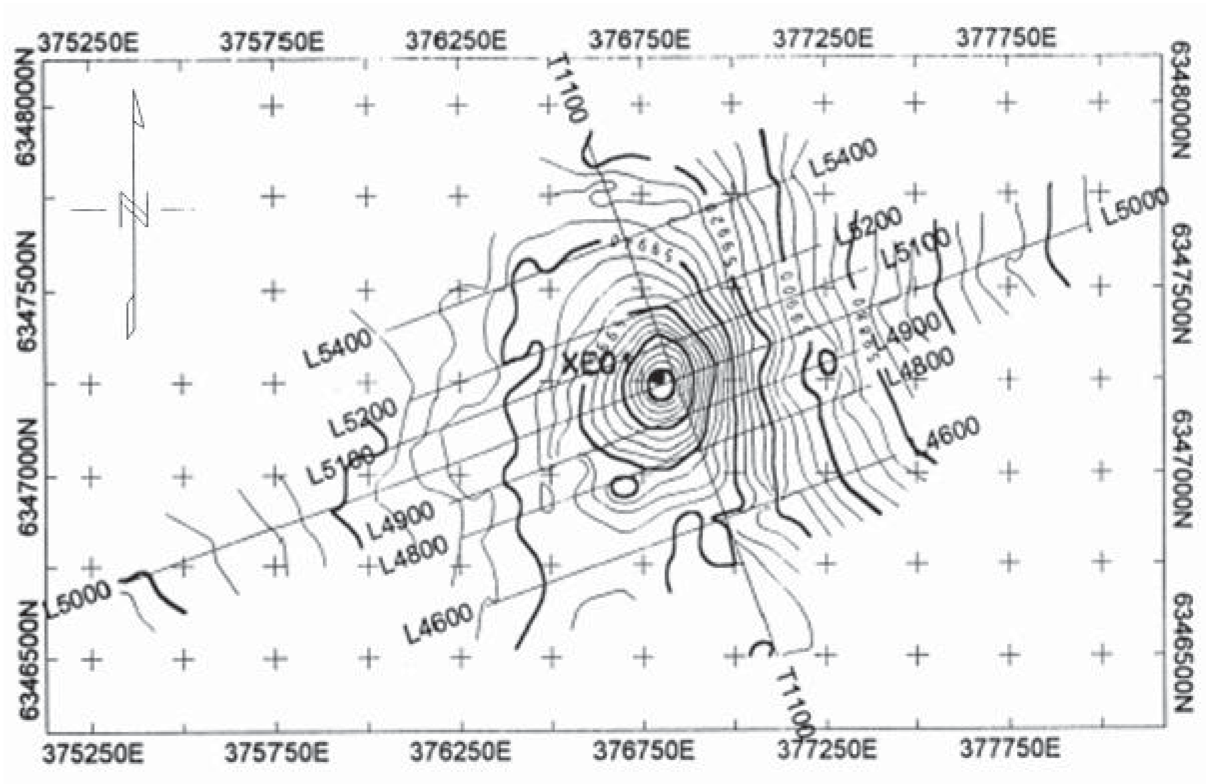
Kennecott Canada Exploration Inc.
KCEI/Montello Resources Ltd. JV

LEGEND PROPERTY
VALKYRIE
Total Field Magnetics

contour interval = 2, 10 nT
filters: none

October, 1998

W) Birch Mountains: Xena pipe



Kennecott Canada Exploration Inc. KCEI/Montello Resources Ltd. JV
LEGEND PROPERTY XENA Total Field Magnetics
contour interval = 5, 20, 120 nT filters: none
October, 1998