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**Ontario Geological Survey
Open File Report 6269**

**Preliminary Results
from the McFaulds Lake
("Ring of Fire")
Area Lake Sediment
Geochemistry Pilot Study,
Northern Ontario**

2012



ONTARIO GEOLOGICAL SURVEY

Open File Report 6269

Preliminary Results from the McFaulds Lake (“Ring of Fire”) Area Lake Sediment
Geochemistry Pilot Study, Northern Ontario

by

R.D. Dyer and H.E. Burke

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Abstract

The Ontario Geological Survey (OGS) carried out a helicopter-supported low-density lake sediment and water geochemical orientation survey over the McFaulds Lake area of northern Ontario in the summer of 2011. The centre of the survey area is located approximately 325 km due north of the town of Longlac. The study area is centred on McFaulds Lake and covers the Ni-Cu-PGE magmatic massive sulphide and chromite deposits currently being explored by a number of mineral exploration companies that has given rise to the more commonly known location name, “Ring of Fire”. A total of 135 water samples and 263 lake sediment samples were collected over an area of approximately 3000 km². All samples are undergoing analysis for the entire spectrum of trace, minor and major elements including gold, platinum and palladium, by the OGS Geoscience Laboratories. In addition, Activation Laboratories was contracted to perform a proprietary soil gas hydrocarbon (SGHSM) analysis on the deep (>15 cm) lake sediment samples. The origin of the samples was completely blind to the laboratory and included quality control samples for independent assessment of data quality. The SGHSM technique is considered a deep penetrating geochemical technique that detects the presence of hydrocarbons in the C5-C17 range which are thought to accumulate in response to underlying mineralization. The SGHSM results were reported on February 10, 2012 and form the basis of this preliminary report. These results indicate, despite the wide spacing of the lake sediment samples and the complexity (and thickness) of the cover material above Precambrian shield bedrock, that the known “Ring of Fire” deposits impart a significant signal that was detected by the SGHSM method and can be identified and interpreted independently as the highest priority target area. These results have profound implications on the assessment of mineral potential and the search for metallic orebodies in the far north utilizing regional lake sediment geochemical surveys.

Preliminary Results from the McFaulds Lake (“Ring of Fire”) Area Lake Sediment Geochemistry Pilot Study, Northern Ontario

R.D. Dyer¹ and H.E. Burke²
Ontario Geological Survey
Open File Report 6269
2012

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Introduction

Field work for a lake sediment and water geochemistry pilot study of the McFaulds Lake area (“Ring of Fire”), in northern Ontario, was carried out between August 13 and August 15, 2011. The study area is centred on McFaulds Lake and covers the Ni-Cu-PGE magmatic massive sulphide (MMS) and chromite deposits currently being explored by a number of mineral exploration companies (Figure 1). The concept of a pilot study or orientation survey of the area was conceived for 2 reasons; 1) to determine the suitability of lake sediment and water geochemistry for mineral exploration over the James Bay Lowland landscape and 2) to create a database of the baseline geochemical and environmental conditions of the area prior to any mine or infrastructure development.

The field operations utilizing a Bell 206B helicopter on floats, were carried out from the Noront Resources Inc. Esker exploration camp located approximately 15 km west of McFaulds Lake. A total of 135 water samples and 263 lake sediment samples were collected over an area of approximately 3000 km². The 263 sediment samples comprise 135 shallow samples (<15 cm sediment depth) and 128 deep samples (>15 cm sediment depth). The total of 135 lake sites visited corresponds to an average density of 1 sample site per 22 km² of survey area. This survey is the first known regional lake sediment and water geochemistry coverage to be completed over the region.

All samples are presently undergoing analysis for the entire spectrum of trace, minor and major elements including Au, Pd and Pt by the Ontario Geological Survey (OGS) Geoscience Laboratories (Geo Labs) in Sudbury. In addition, Activation Laboratories (ActLabs) was contracted to perform soil

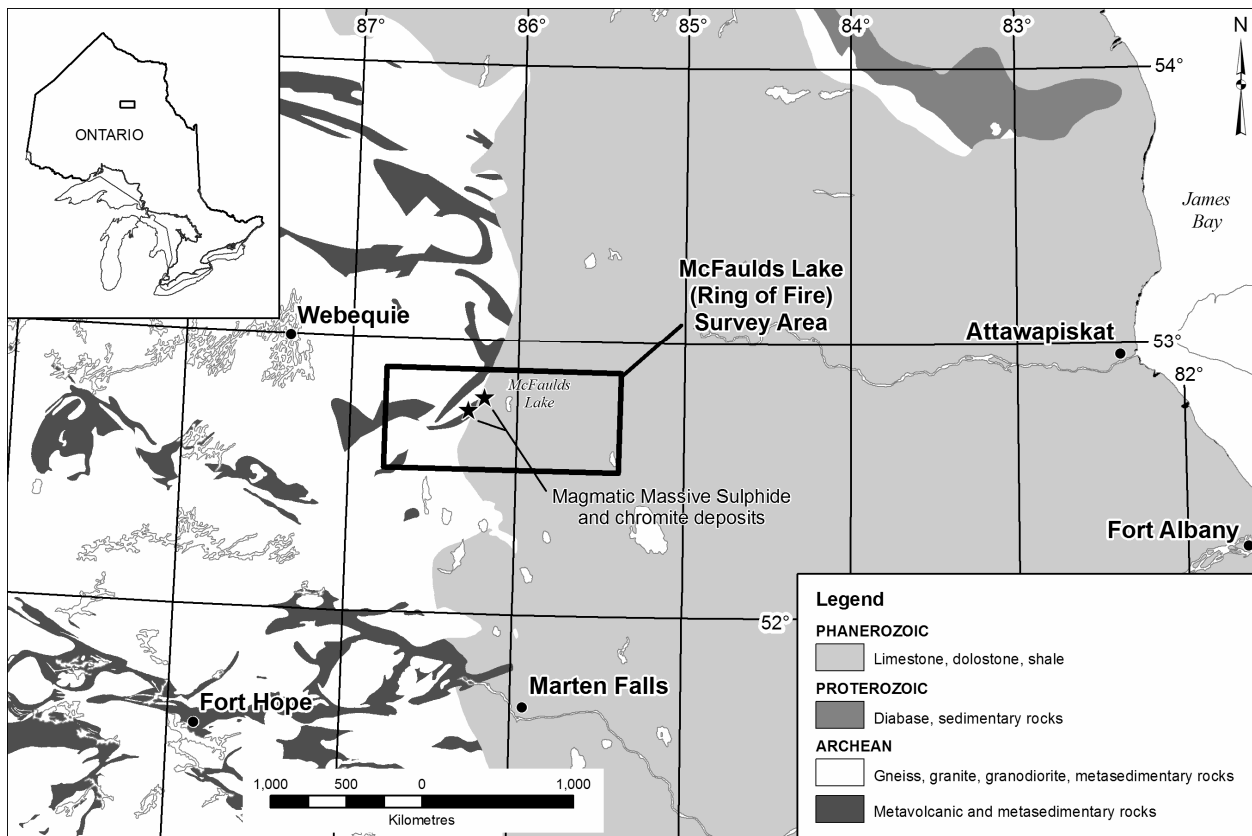


Figure 1. Location map of the McFaulds Lake area lake sediment and water pilot study.

gas hydrocarbons (SGHSM) analysis on the deep (>15 cm) lake sediment samples. The SGHSM technique is considered a deep penetrating geochemical technique that detects the presence of hydrocarbons in the C5-C17 range. The presence of soil gas hydrocarbons have been measured over mineral deposits and these appear to be related to buried mineralization (e.g. Cook and Dunn 2007; Heberlein 2010; Hale 2000). The SGHSM results were reported on February 10, 2012 and form the basis of this preliminary report.

Regional Setting and Geology

The project area straddles the boundary between the Severn upland and the Hudson Bay Lowland physiographic divisions of the Canadian Shield (Bostock 1970). The region is characteristically flat with surface elevation gradually rising from approximately 140 m ASL at the northeast corner to slightly more than 180 m ASL in the southwestern corner of the study area. Relief rarely exceeds 5 m coinciding with either incised rivers or ridges of glaciofluvial deposits such as eskers. However, the landscape of the study area is complex. Abundant string bog and organic deposits (peat) cover the area (Figure 2) and overlie Quaternary deposits up to 76 m thick (e.g., glacial till, sand, clay and marine deposits) (Thomas 2004; Golder Assoc. 2010). Beneath Quaternary cover lies Precambrian bedrock on the western half of the study area and younger Paleozoic rocks on the eastern half (Figure 3). The Ni-Cu-PGE and chromite deposits are contained within the Precambrian McFaulds Lake ultramafic complex, a deformed, layered, largely ultramafic, sill-like intrusion consisting mainly of dunite and peridotite with lesser pyroxenite, chromitite and possibly gabbro (Metsaranta 2010). The bedrock west and northwest of this complex consists primarily of felsic plutonic rocks (OGS 1991) and to the east the underlying Precambrian bedrock is a mix of supracrustals (metavolcanics and metasediments) and granitoids (Metsaranta 2010). The unconformably overlying Paleozoic stratigraphy consists of Upper Ordovician limestone and dolostone and Lower Silurian limestone rocks (OGS 1991). Over the known magmatic massive sulphide and chromite deposits, the Paleozoic cover rocks are intermittently present and typically consist of fossiliferous beige limestone and rare muddy dolostones; this stratigraphy thickens considerably towards the east, where at McFaulds Lake up to 100 m of strata have been observed (Golder Assoc. 2010).

Detailed surficial geology mapping coverage of the McFaulds Lake area does not exist. Several recent mapping initiatives to rectify this basic knowledge gap include the Far North Geoscience Mapping Initiative (FNGMI) (Barnett 2007) and the Far North Information Knowledge Management (FNIKM) Plan Terrain Mapping project (Barnett et al. 2008). A surficial geology map at a scale of 1:100 000 covering the Webeque area, immediately to the west of the present study area, was published in 2008 (Barnett 2008). It is anticipated that the FNIKM project and the OGS “Ring of Fire” surficial sampling project (Gao 2011) will advance the understanding of the Quaternary deposits over the “Ring of Fire” area and result in surficial geology mapping coverage of the immediate McFaulds Lake area.

Some details on the character and thickness of the Quaternary deposits can be gleaned from the exploration activities in the “Ring of Fire” area. For example, diamond drilling by Noront Resources Inc. indicates that thickness of surficial cover ranges from approximately 33 to 76 m (Golder Assoc. 2010). The Quaternary sequence typically encountered in diamond-drill holes in the region consists of 1 to 2 m of sandy till overlain by varved sand grading upward into clays and finally marine clays (Thomas 2004). The limit of marine incursion from the east has been estimated to be a north-south line approximately 5 km west of McFaulds Lake (Prest 1963). Most of the survey area is considered to be in a zone of sporadic permafrost (Brown et al. 1998).

The dominant ice direction of the most recent glaciation, based on bedrock striations and streamlined forms (e.g. flutes), was toward the south-southeast (Barnett, Webb and Hill 2009).

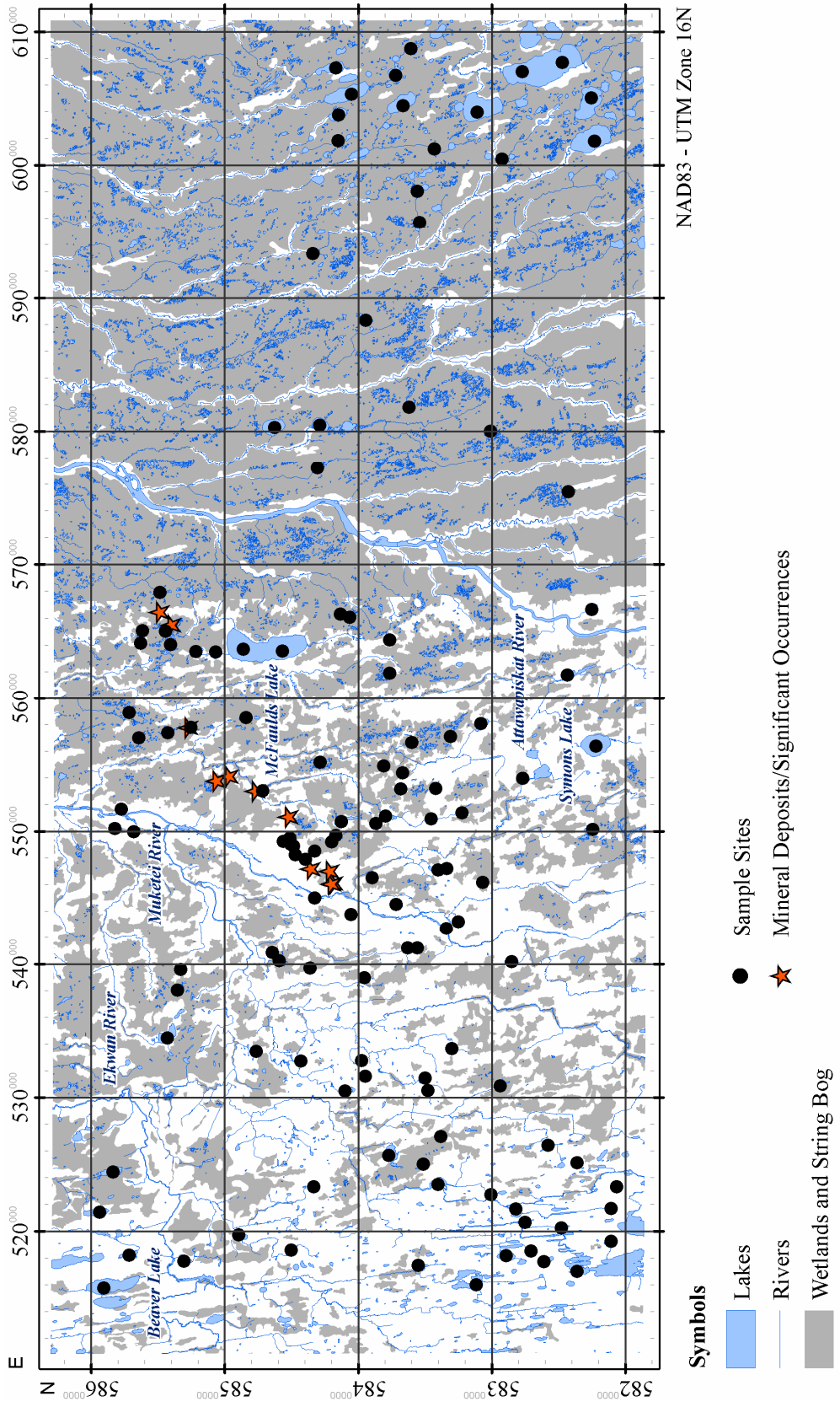
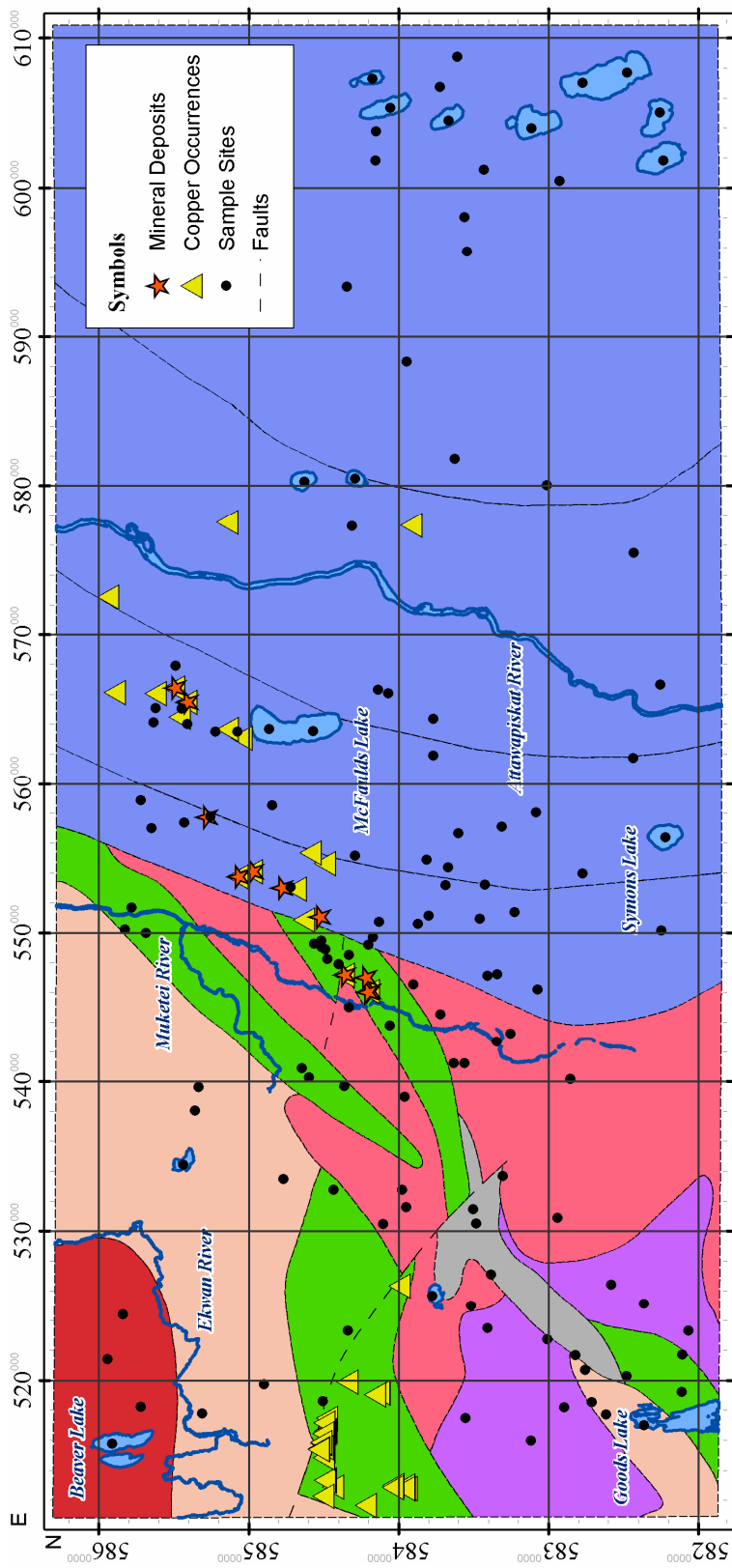


Figure 2. McFaulds Lake study area showing locations of sample sites, mineral deposits and drainage network.



NAD83 - UTM Zone 16N

Figure 3. McFaulds Lake study area showing sample locations, generalized bedrock geology, mineral deposits and significant occurrences (after OGS 2011).

Methodology

SAMPLING METHODS

Organic-rich lake sediment samples were collected from a helicopter float using the OGS-designed gravity corer. Wherever possible, both shallow (0 to 15 cm) and deep (>15 cm) sediment samples were obtained at each sampling site. The expectation that the shallow sample would represent sedimentation during the past ~100 years, and therefore perhaps reflect some airborne anthropogenic component, is based on experience from southern Boreal forest lakes, with an average sedimentation rate of ~1.5 cm per decade (e.g., Hunt 2003; Dickman and Fortescue 1991). Therefore, assuming an undisturbed stratigraphic record, the deep sediment sample would represent sedimentation older than 100 years; and therefore, reflect natural geochemical inputs that may be traced to local geology and landscape.

A global positioning system (GPS) receiver was utilized to record accurate sample site positions and to record each flight track. In addition, a GPS receiver connected to a tablet computer was utilized to provide “heads up” real-time navigation between lake sites.

SAMPLE PREPARATION AND ANALYTICAL METHODS

Lake sediment samples for geochemical analysis were collected in breathable fabric bags and then placed into sealable plastic storage bags to prevent leakage. The samples were shipped to Sudbury where drying was done in ovens at a temperature of <40°C prior to partial pulverization in a ceramic ring and puck pulverizer and sieving to obtain the -60 mesh (<250 µm) size fraction. The samples are currently undergoing aqua regia digestion to be followed by inductively coupled plasma mass spectrometry (ICP-MS) to determine approximately 50 trace elements. Quality control (QC) will be monitored through the use of sample pulp duplicates and certified reference materials. Loss-on-ignition (LOI) is determined at 500°C, using an automated gravimetric technique. The deep (>15 cm) sediment samples underwent further analysis for SGHSM, gold by instrumental neutron activation analysis (INAA) and platinum group elements (PGEs) by fire assay-ICP-MS. At the time of writing, the results on the latter 2 procedures are still pending. A total of 128 deep lake sediment samples were shipped to Actlabs for SGHSM analysis.

After drying the lake sediment samples and prior to pulverization, between 5 and 10 grams of material from each sample was drawn off for submission to Actlabs for proprietary SGHSM analysis. Quality control samples were inserted throughout the sequence (discussed in the next section). This sample submission to ActLabs was entirely blind. The samples were coded to avoid any reference to where they were obtained. Only information on their relative positions to each other were transmitted to Actlabs to assist in interpretation of the resulting patterns.

Details of the SGHSM method are summarized in Sutherland (2009, 2011). The method targets organic compounds adsorbed onto the surface of sediment particles resulting in highly sensitive (part per trillion (ppt) level) analysis of 162 organic compounds in the C5 (Pentane) to C17 (Heptadecane) range. Samples are not digested but undergo a very weak aqueous leach to liberate the hydrocarbons from the sample. The resulting extract is separated using gas chromatography, specifically a high resolution fused silica capillary column, followed by measurement with mass spectrometry. In addition to the 162 individual compounds, Actlabs reports SGHSM pathfinder class summary values; these represent the sums of between 3 and 14 individual compounds that are considered diagnostic (pathfinders) to specific commodities (e.g., nickel, copper, gold). The exact compound groupings that contribute to the pathfinder

class values are not reported but can be deduced relatively easily, *see* “Discussion of Results”. Actlabs was asked to report the SGHSM pathfinder class summary values for the target commodities; massive sulphides (MS), copper (Cu) and gold (Au).

Quality Control Results

METHODS

The submission of blind quality control (QC) samples was considered a very important aspect of the evaluation of the SGHSM method. Analytical geochemical results from solid media such as soils and sediments are usually reported in ppm. The SGHSM analysis reports data 2 orders of magnitude lower in the low ppt level. This level of sensitivity can exacerbate sources of error including those related to environmental contamination, cross-contamination and sample inhomogeneity.

The quality control scheme included the insertion of 9 duplicates and 13 internal OGS lake sediment standards spaced evenly through the sample sequence. The OGS standards (R-1 and Raft-1) originated from 2 Sudbury area lakes and consisted of dried (but otherwise unprepared) lake sediment material which matched the character of the unknown samples. The bulk standard Raft-1 was homogenized while still wet immediately after collection prior to oven drying at 35°C. Nine (9) replicates of this material were inserted within the sample sequence. Four replicates of R-1, a sample of deep lake sediment material from Ramsey Lake in Sudbury, were evenly spaced through the sample sequence. Actlabs internal QC protocols included the analysis of 10 sample pulp splits which were reported and underwent the same assessment as the OGS quality control samples described below.

Data reproducibility was assessed with scatterplots of duplicate pairs and by calculating the average coefficient of variation (%CV), also known as the percent relative standard deviation (%RSD) for each compound. This was done by averaging the results of the equation: $\%RSD = (\text{standard deviation}/\text{mean}) \times 100$ for each compound from each duplicate pair. Actlabs internal QC protocols included the analysis of 10 sample pulp splits which were reported and underwent the same calculations as above. The %RSD results for the key compounds that contribute directly to the SGHSM pathfinder class data or appear to behave similarly based on spatial data plots, are shown in Figures 4 and 5.

Of the 162 compounds reported, 74 compounds returned data for both the unknowns and the QC samples that were entirely below the detection limit of 1 ppt; these compounds were omitted from the data set and therefore the associated QC sample %RSD calculations of zero (0) do not factor into the overall average %RSD calculations. The overall average %RSD for all compounds are as follows: OGS duplicates (34%), Actlabs duplicates (26%), OGS standard Raft-1 (51%) and OGS standard R-1 (36%).

Systematic errors such as analytical drift and batch to batch inconsistencies were assessed by the creation of QC charts which display the standards data in relation to the unknowns; these charts display the analytical concentration data of the OGS standards and unknown samples on the y-axis in the order of analysis lengthwise along the x-axis. Since the primary display of SGHSM data (and therefore interpretation) is focused on the pathfinder class data, which are sums of multiple compounds, an effective method to summarize the performance of multiple compounds are plots of the SGHSM MS, Cu and Au pathfinder class data (Figure 6).

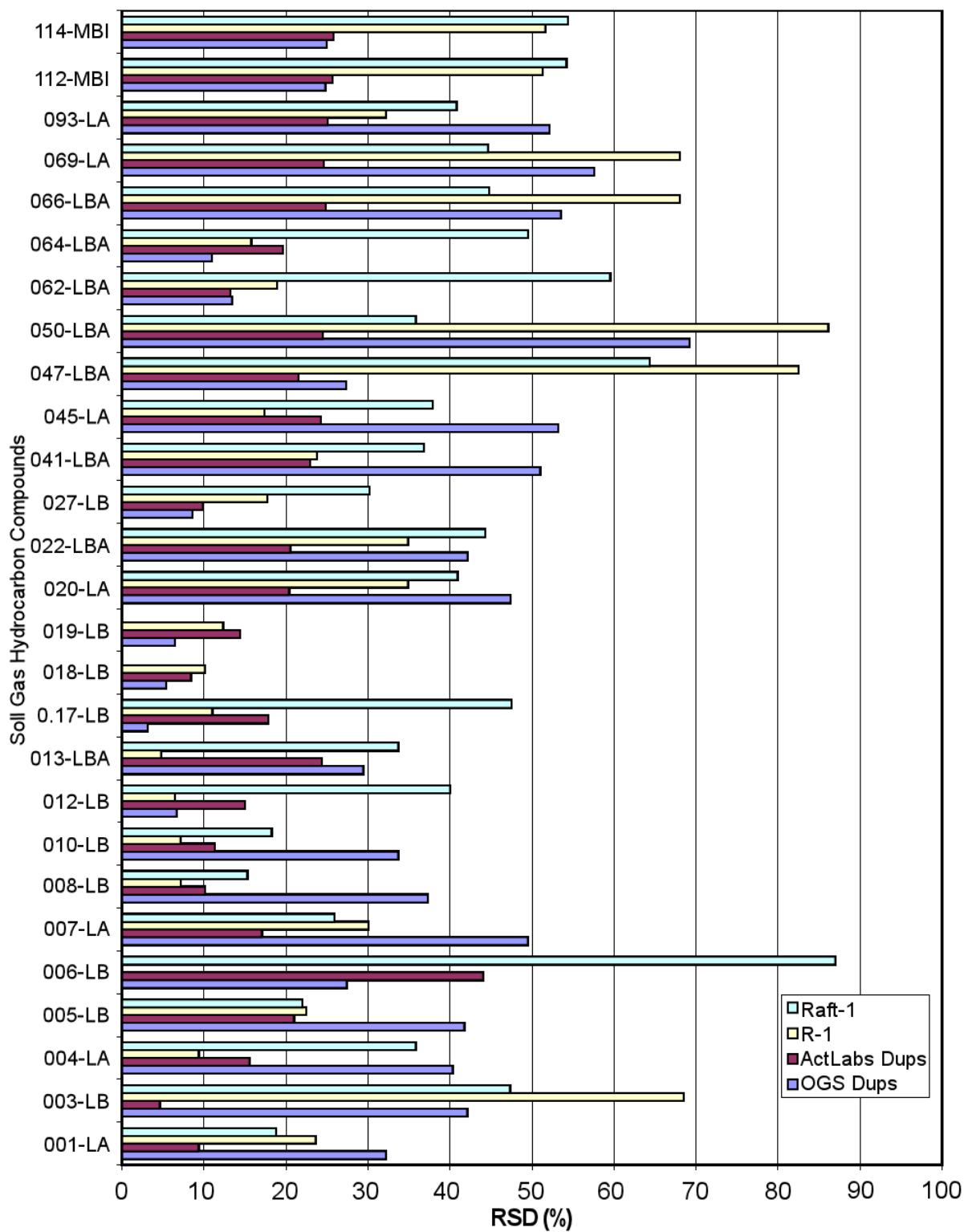


Figure 4. %RSD for key compounds determined in QC samples that inter-correlate or directly contribute to the SGHSM MS, Cu and/or Au pathfinder class values calculated by Actlabs.

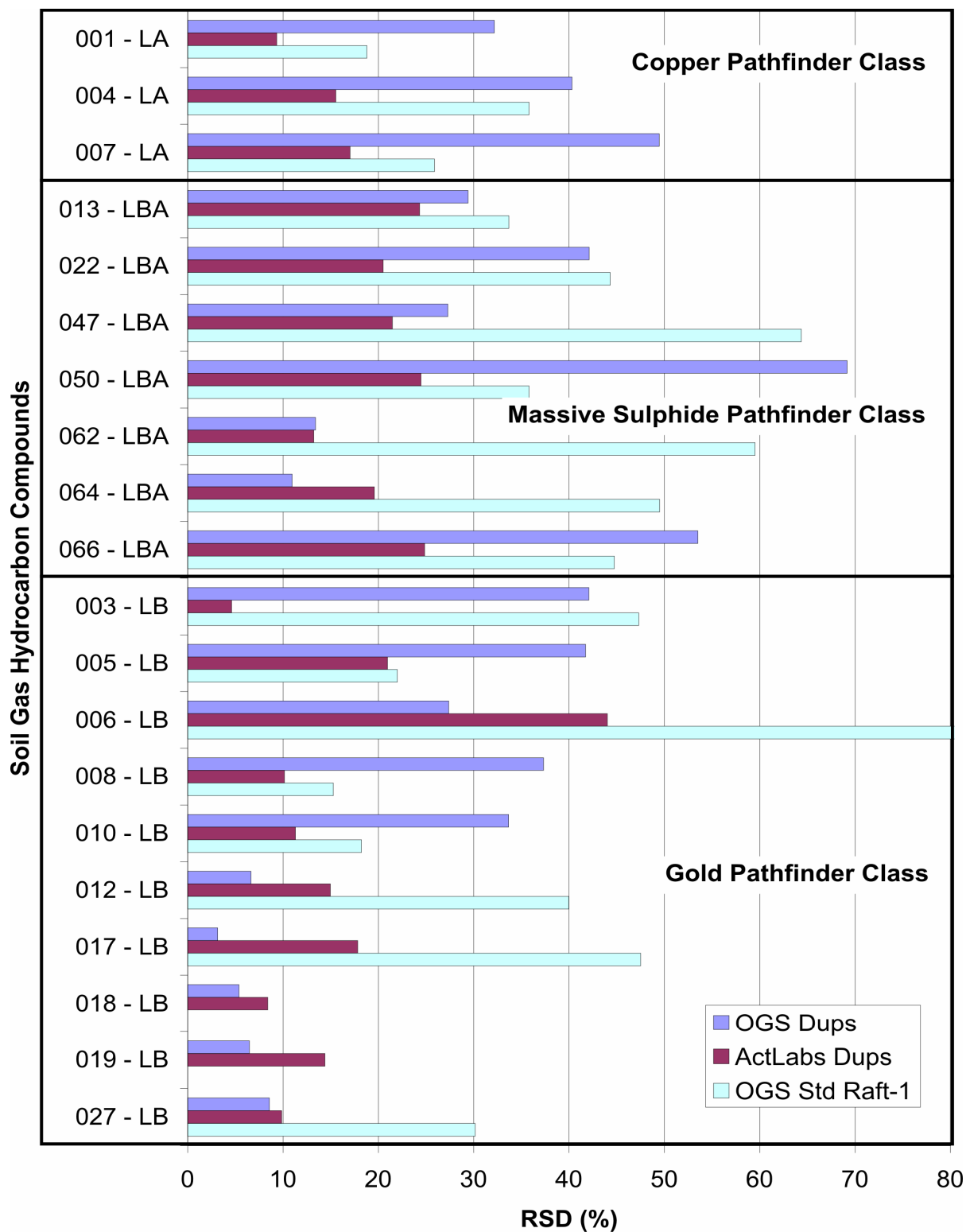


Figure 5. %RSD for compounds determined in QC samples that are the components of the SGHSM MS, Cu and Au pathfinder class values calculated by Actlabs.

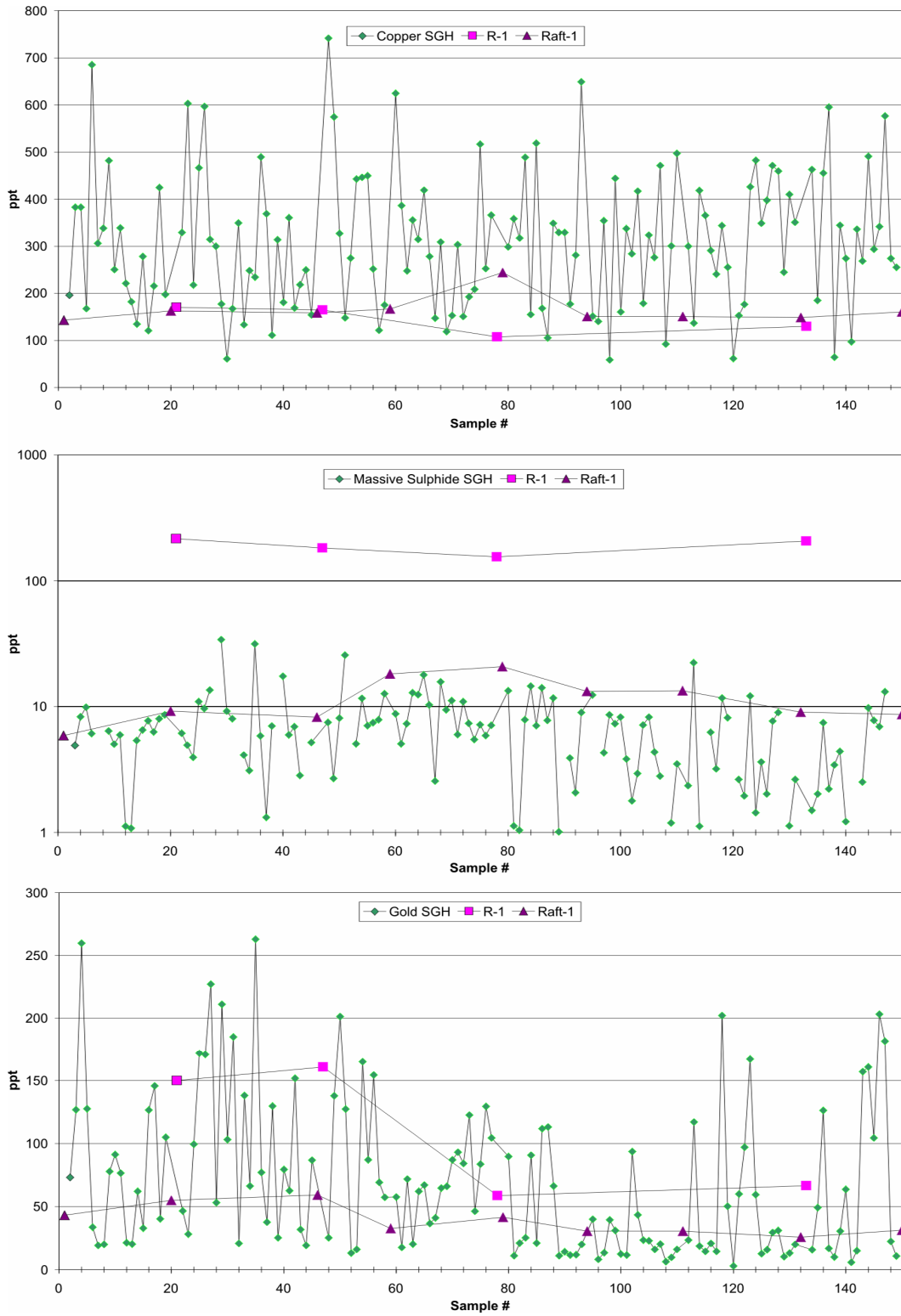


Figure 6. SGHSM copper, massive sulphide, and gold pathfinder class QC charts.

GENERAL ASSESSMENT

It is evident from the %RSD calculations (*see* Figures 4 and 5) that for most compounds, the Actlabs duplicates returned better reproducibility than the OGS duplicates and standards. The likely cause of this is two-fold; 1) the laboratory duplicates were pulp duplicates, split after sample preparation whereas the OGS duplicates were split before sample preparation (therefore can be considered field duplicates). Field duplicates inherently have more variability as they are a measure of the combined sampling, preparation and analytical precision (error), and 2) the back to back position of the Actlabs duplicates during analysis compared to the widely spread out sequencing of the OGS QC samples. Therefore, the Actlabs duplicates are a measure of the instrumental precision, whereas the OGS duplicates and standards also incorporate a measure of systematic errors inherent by being analyzed in a different batch and at a significantly different time.

The QC plots of the SGHSM MS, Cu and Au pathfinder class data (*see* Figure 6) along with the OGS standards serves to illustrate that the variance of the unknowns greatly exceeds the variance in the performance of the standards. The vast majority of the 88 compounds that returned data above detection limit show a similar pattern, therefore, it is concluded that although some of the data variance can be attributed to systematic and instrumental errors the majority of the signal is related to real variations in the concentration of the hydrocarbon compounds in the samples. However, the plot of the SGHSM Au pathfinder data and standards (*see* Figure 6) shows a significant sympathetic “plateau” between samples 25 and 56. This is followed by data with a lower background for the rest of the data sequence. This seems to indicate a systematic error (perhaps a batch to batch inconsistency) that is significant enough to render this data unreliable. Scatterplots of the SGHSM Au pathfinder values from the OGS duplicates also display very poor precision (Figure 7). For these reasons, the SGHSM Au pathfinder data (and component compounds) are not suitable for publication until reanalysis and/or verification have been completed.

The scatterplots in Figure 7 are also a good visual illustration of how the “back to back” analysis of the Actlabs laboratory duplicates has better reproducibility than the OGS field duplicates. Another general observation noted during the work-up of the QC data was that the lighter molecular weight compounds have the lowest %RSD of all compounds reported. This is evident in the SGHSM Cu pathfinder plot in Figure 7; the SGHSM copper pathfinder value is the sum of 3 of the lightest compounds, 001-LA, 004-LA and 007-LA.

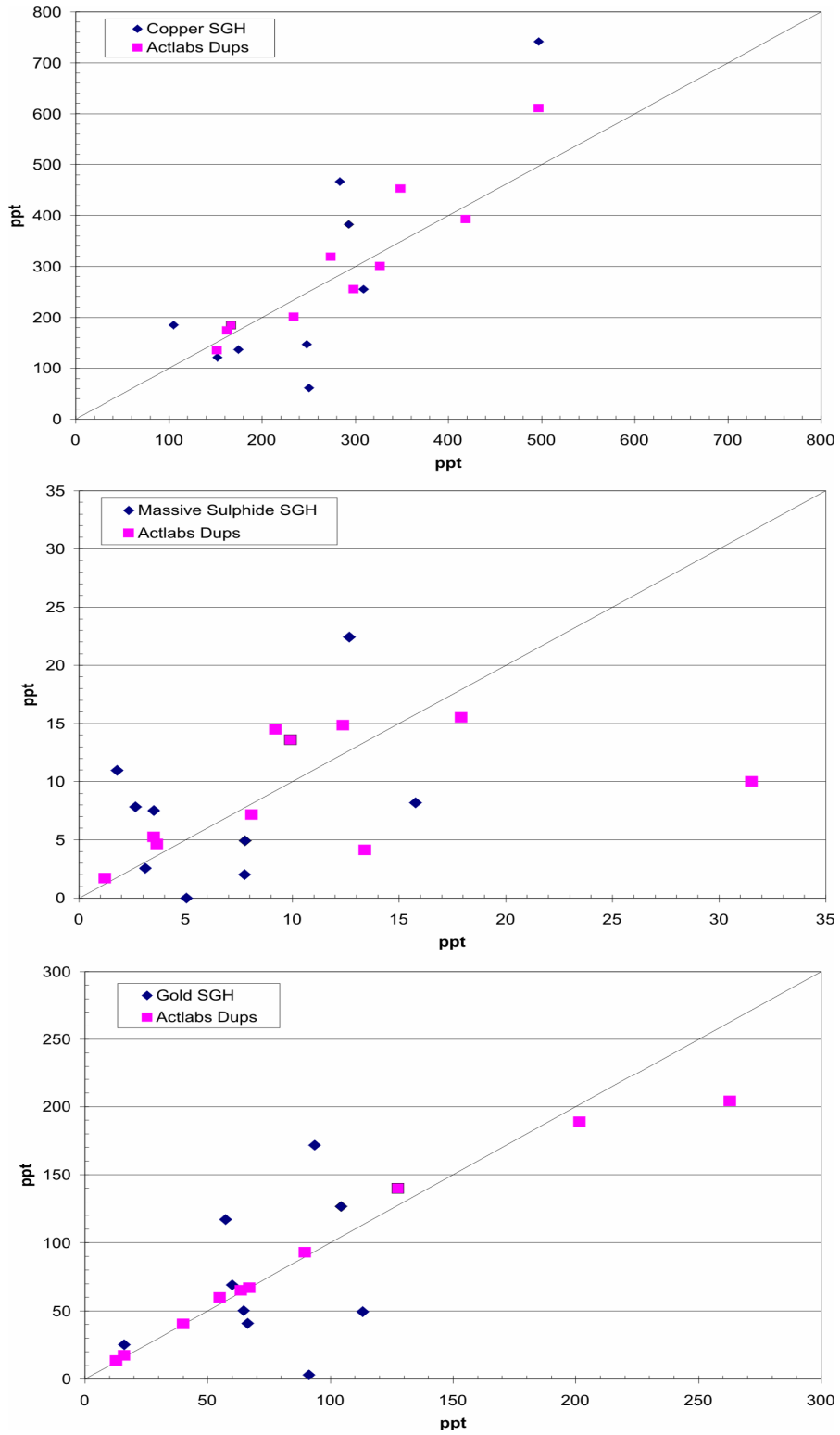


Figure 7. SGHSM copper, massive sulphide, and gold pathfinder class data duplicates scatterplots.

Data Treatment

The analytical results obtained from SGHSM analysis consists of “raw” data for the 162 compounds and pathfinder “class” summary values for the requested target commodity(s). The target commodities communicated to Actlabs were massive sulphides (MS), copper (Cu) and gold (Au) (note: Actlabs does not have pathfinder templates for chromium or PGEs). Therefore their interpretation of the data focused on looking for data signatures that matched their MS, Cu and Au pathfinder class templates and resulted in 3 class summary columns of data in addition to the data for the 162 compounds. These MS, Cu and Au class values represent the sum of between 3 and 14 individual compounds that behave similarly (essentially correlate well together) and collectively are diagnostic (pathfinder) for the possible presence of the target commodity(s). Also provided were colour contour plots of the pathfinder class data using a kriging algorithm.

Of the 162 compounds reported, 74 returned no data above the detection limit of 1 ppt; these were removed from the working data set. This left 88 compounds with at least 1 data point above detection limit and of these, 11 compounds featured all of their data above the detection limit of 1 ppt. Prior to further data treatment, all values of less than 1 ppt were assigned a value of 0.5 ppt (halfway between 0 and the detection limit). These data, along with the pathfinder class summary values, were then matched to their UTM coordinates and brought into ArcGIS for plotting. Kriged colour contour plots were created for the MS, Cu and Au pathfinder class data. These closely matched the plots provided by Actlabs. Plotting the individual compounds focused initially on those with significant data ranges or “relief”; it was determined that a handful of compounds were the main contributors to the observed pathfinder class patterns. Therefore, for massive sulphides (MS) the main contributors were low to medium molecular weight LBA (light branched alkanes) series compounds; for Cu, the main components were the LA (light alkane) series compounds and for Au the main components were the low molecular weight LB (light benzene) series compounds.

The next step in the data treatment involved exploratory data analysis (EDA) (Tukey 1977) which included box and whisker plots, frequency histograms and probability plots. The primary goal of this exercise was to better understand the data distributions prior to engaging in further advanced statistical techniques such as Pearson correlation coefficients and factor analysis. To that end, it was determined that only 4 compounds approximate a normal distribution (001-LA, 047-LBA, 152-HPH and 162-HPH), meaning the remaining compounds would require lognormal transformation prior to the creation of a correlation matrix (Figure 8).

From the combination of data plotting, inspection and correlation analysis, the following compound groupings were found to be the primary contributors to the pathfinder class values calculated by Actlabs:

SGHSM massive sulphide pathfinder class:

Note: compounds in bold are considered the major contributors to the MS pathfinder class summary value

013-LBA	045-LA	064-LBA
020-LA	047-LBA	066-LBA
022-LBA	050-LBA	069-LA
041-LBA	062-LBA	093-LA

	001-LA	003-LB	004-LA	005-LB	006-LB	007-LA	008-LB	010-LB	012-LB	013-LBA	017-LB	018-LB	019-LB	020-LA	022-LBA	027-LB	041-LBA	045-LA	047-LBA	050-LBA	062-LBA	064-LBA	066-LBA	069-LA	
003-LB	-0.02																								
004-LA	0.80	0.23																							
005-LB	0.09	0.88	0.33																						
006-LB	-0.09	0.58	0.11	0.49																					
007-LA	0.71	0.36	0.82	0.41	0.19																				
008-LB	-0.07	0.89	0.20	0.86	0.57	0.36																			
010-LB	-0.15	0.81	0.15	0.75	0.57	0.27	0.90																		
012-LB	-0.07	0.39	0.16	0.23	0.34	0.17	0.47	0.59																	
013-LBA	-0.05	0.10	0.15	0.10	0.08	0.20	0.15	0.14	0.23																
017-LB	-0.14	0.49	0.08	0.36	0.43	0.13	0.55	0.68	0.75	0.28															
018-LB	-0.16	0.36	0.08	0.18	0.29	0.09	0.42	0.55	0.87	0.33	0.74														
019-LB	-0.12	0.43	0.11	0.24	0.37	0.13	0.50	0.63	0.93	0.28	0.85	0.91													
020-LA	0.05	0.63	0.36	0.64	0.45	0.49	0.78	0.77	0.52	0.38	0.56	0.48	0.53	0.99											
022-LBA	0.06	0.63	0.37	0.65	0.46	0.51	0.78	0.77	0.52	0.38	0.57	0.48	0.53	0.99											
027-LB	-0.24	0.52	0.04	0.33	0.09	0.62	0.75	0.73	0.73	0.35	0.81	0.74	0.80	0.63	0.64										
041-LBA	0.04	0.60	0.38	0.63	0.43	0.47	0.74	0.69	0.47	0.51	0.53	0.46	0.50	0.87	0.87	0.60									
045-LA	0.05	0.60	0.38	0.63	0.44	0.48	0.74	0.68	0.47	0.50	0.53	0.46	0.50	0.86	0.86	0.59	0.99								
047-LBA	0.33	0.45	0.39	0.47	0.25	0.49	0.48	0.36	0.19	-0.15	0.09	0.05	0.12	0.46	0.46	0.13	0.40	0.40	0.40						
050-LBA	-0.18	0.49	0.02	0.47	0.35	0.24	0.56	0.52	0.24	0.36	0.40	0.29	0.29	0.61	0.62	0.42	0.61	0.61	0.61	0.25					
062-LBA	-0.22	0.22	0.00	0.17	0.33	-0.07	0.30	0.40	0.64	0.40	0.53	0.66	0.61	0.46	0.46	0.60	0.47	0.47	-0.05	0.28					
064-LBA	-0.27	0.24	-0.01	0.21	0.28	-0.04	0.34	0.45	0.54	0.42	0.44	0.57	0.51	0.51	0.51	0.58	0.50	0.48	-0.09	0.35	0.85				
066-LBA	-0.03	0.61	0.27	0.62	0.40	0.39	0.78	0.72	0.46	0.43	0.52	0.44	0.48	0.90	0.90	0.60	0.92	0.91	0.43	0.66	0.47	0.51			
069-LA	-0.04	0.61	0.28	0.62	0.39	0.40	0.76	0.72	0.46	0.44	0.52	0.44	0.48	0.90	0.90	0.60	0.91	0.91	0.42	0.66	0.47	0.51			
093-LA	-0.02	0.50	0.28	0.55	0.32	0.37	0.68	0.62	0.39	0.45	0.43	0.38	0.40	0.80	0.79	0.50	0.90	0.90	0.39	0.61	0.39	0.45	0.90	0.90	

Figure 8. Pearson product-moment correlation coefficients for the primary components that contribute to the SGHSM MS, Cu, and Au pathfinder class values calculated by Actlabs.

SGHSM Copper pathfinder class:

Note: these compounds are considered the major contributors to the Cu pathfinder class summary value

001-LA

004-LA

007-LA

SGHSM Au pathfinder class:

Note: these compounds are considered the major contributors to the Au pathfinder class summary value

003-LB

010-LB

017-LB

005-LB

012-LB

018-LB

006-LB

014-LB

019-LB

008-LB

016-LB

027-LB

While it was a relatively easy task to determine the contributions to the pathfinder class values, the interpretation of the resulting patterns is not so straightforward. Anomalous patterns are not necessarily the highest values; typical terminology used by the Actlabs interpretation (which accompanies the data set) are “apical” (point highs), “halo” (donut shape with central low), “nested halo” (donut shape with internal apical patterns) and “rabbit ear” (2 apical peaks separated by a low).

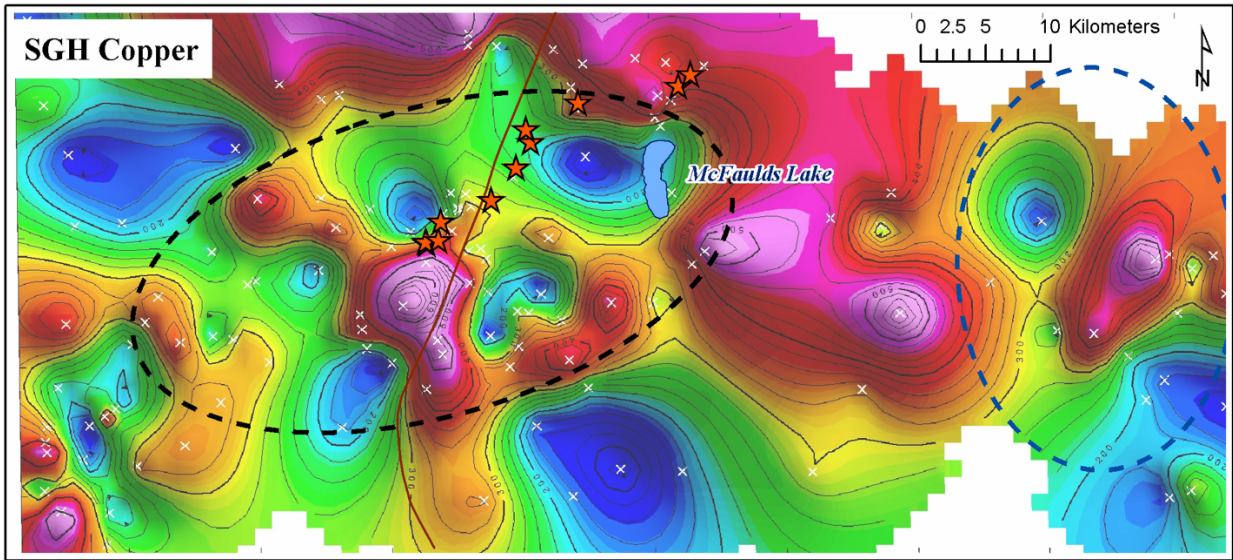
How SGHSM works is not yet entirely understood; the following has been gleaned from several independent studies (e.g., Hall, Hamilton and McClenahan 2005; Hamilton 2007; Kelley, Cameron and Southam 2004) and Actlabs literature. In essence, the detected hydrocarbon signature, at least in part, is thought to represent the presence of bacterial biomass present above or within electrochemical cells/reduced chimneys in the overburden above mineralization; more specifically, SGHSM “anomalies” are a proxy for the detection of near surface redox variations present above deeply buried mineralization due to hydrocarbons produced directly from bacteriological activity.

Discussion of Results

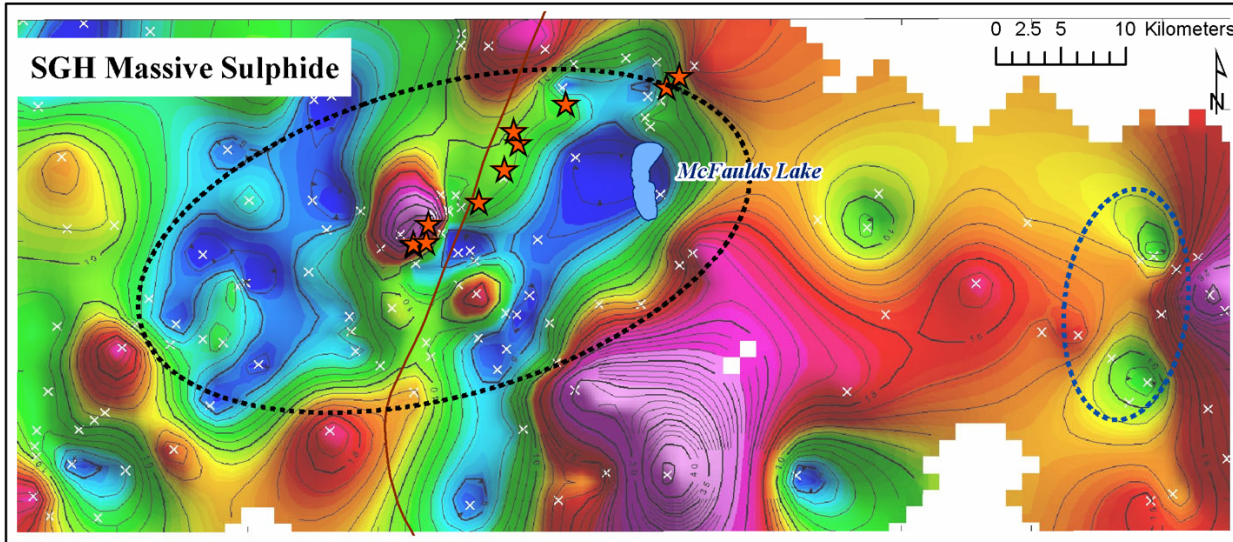
As a preface to this discussion, it is worth restating that the analysis of the “Ring of Fire” lake sediment samples and the subsequent interpretation by ActLabs was done completely blind as to the origin and actual coordinates of the samples. Discussions with Actlabs after the data was received were strictly related to the SGHSM data quality, the patterns of the signature classes and the significance of the different types of anomalous patterns (e.g., apical versus halo, etc.). Also note, the Au pathfinder class data is not discussed in this report as it is felt that the quality of the data is insufficient for publication (*see* “General Assessment”).

The colour contour plots of the massive sulphide and copper pathfinder class data (Figure 9) provided by Actlabs, include interpretation identifying the most significant “anomalies”. These were coded with an SGHSM signature rating which pertains to the confidence level that is assigned to the interpreted anomaly, on a scale from 1 to 6, with 6 being the highest confidence. The interpretation states:

Note that the interpretation of these results is made more difficult due to the highly irregular sample survey and considerable distance between samples, thus all of the ratings have been reduced by 0.5 to recognize the lower level of confidence due to these factors. Also, when mineralization is expected to be deeper, based on the 3D-SGHSM interpretation, the rating is also reduced by another 0.5 to recognize the lower confidence in prediction and delineation of deeper targets.



SGH signature rating relative to copper mineralization
Black Dashed Outline = 4.0 / 6.0
Blue Dashed Outline = 3.0 / 6.0



SGH signature rating relative to massive sulphide mineralization
Black Dashed Outline = 4.5 / 6.0
Blue Dashed Outline = 3.5 / 6.0

Symbols

- ★ Mineral Deposits
- Approximate Paleozoic Boundary

Figure 9. Colour contour map of SGHSM massive sulphide and copper pathfinder class data showing anomalous areas outlined by Actlabs and location of known mineral deposits.

The highest confidence level was interpreted by Actlabs to be the large oval (the black dashed outline on both the MS and Cu pathfinder plots) in the west central portion of the study area which coincides with the McFaulds Lake greenstone belt, associated ultramafic complex and the “Ring of Fire” mineral deposit area. This anomaly is considered a nested halo feature perhaps corresponding to a broad redox cell or zone. Arguably, several smaller target areas could be interpreted within this larger oval, particularly based on the patterns visible in the Cu plot. In fact, the first interpretation from Actlabs (which included the presence of the blind QC samples inserted by the OGS) was more precise in covering the eastern half of this large oval, exactly covering the “Ring of Fire” mineral deposit area.

The apical peaks within this large oval, particularly on the Cu plot, are significant; case studies have demonstrated that compounds related to the Cu signature typically produce apical anomalies directly above or very close to mineralization (D. Sutherland, Director of Research, Activation Laboratories Ltd., personal communication, Feb 16, 2012). In addition, the Actlabs interpretation states, “The 3D-SGHSM interpretation predicts that copper mineralization associated with the black dashed oval and the blue dashed oval is predicted to be quite deep”. This statement is quite accurate as the distance to Precambrian bedrock is likely much greater than 50 m. The confidence levels of the blue oval in the eastern portion of the study area are lower; this, in part, is due to the lack of and irregular distribution of sample points.

Due to the low and uneven sample density, the patterns of concentration peaks and lows are likely not as well constrained as the Kriging trending algorithm displays in Figure 9; this algorithm was not specifically optimized to display such wide spaced and irregular sample points. Therefore, any interpolation between widely spaced points may be exaggerating the areal size of the peak and low areas. With that proviso in mind, 2 transects of lake sites across the McFaulds Lake greenstone belt were selected (Figure 10) to compare the results between the Eagle 1 and 2 deposit area (transect A-B) and a portion of the belt 20 km to the southwest (transect C-D). The concentrations of SGHSM Cu and MS pathfinder class data and several other compounds are displayed on the y-axis of the transects shown in Figures 11 and 12. Although the extent of the data peaks and valleys are not always well constrained, the difference between the 2 sections of greenstone belt are striking, and at least empirically, lend further credence to the use of SGHSM analysis of lake sediments as a diagnostic exploration method.

Conclusions

Mineral exploration in the Far North can be challenging due to the extensive and often thick blanket of organic and glacial drift deposits that predominate. The use of regional lake sediment geochemistry in the “near” north has to date been successful in assisting explorationists to focus efforts in areas with higher probability of success, based on conventional geochemical techniques that are based on the detection of lateral dispersion of metals from source rocks. The application of this technique in the Far North, where the landscape has plentiful water bodies, is very problematic due to thickness of cover which physically disconnects or decouples the potential source (Precambrian) rocks of interest, from the surface media that is typically sampled.

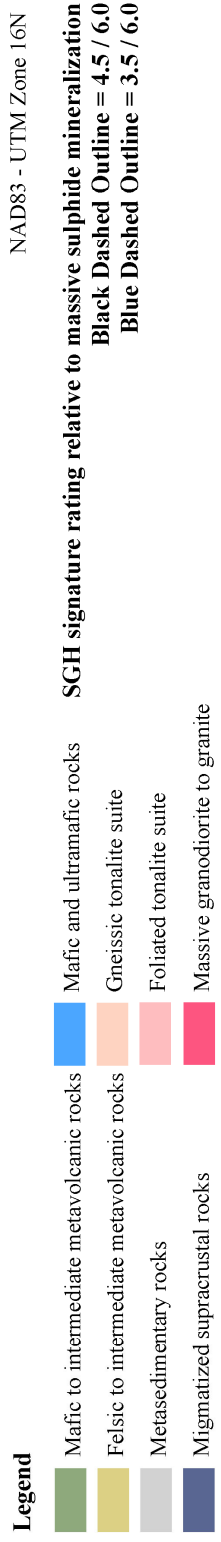
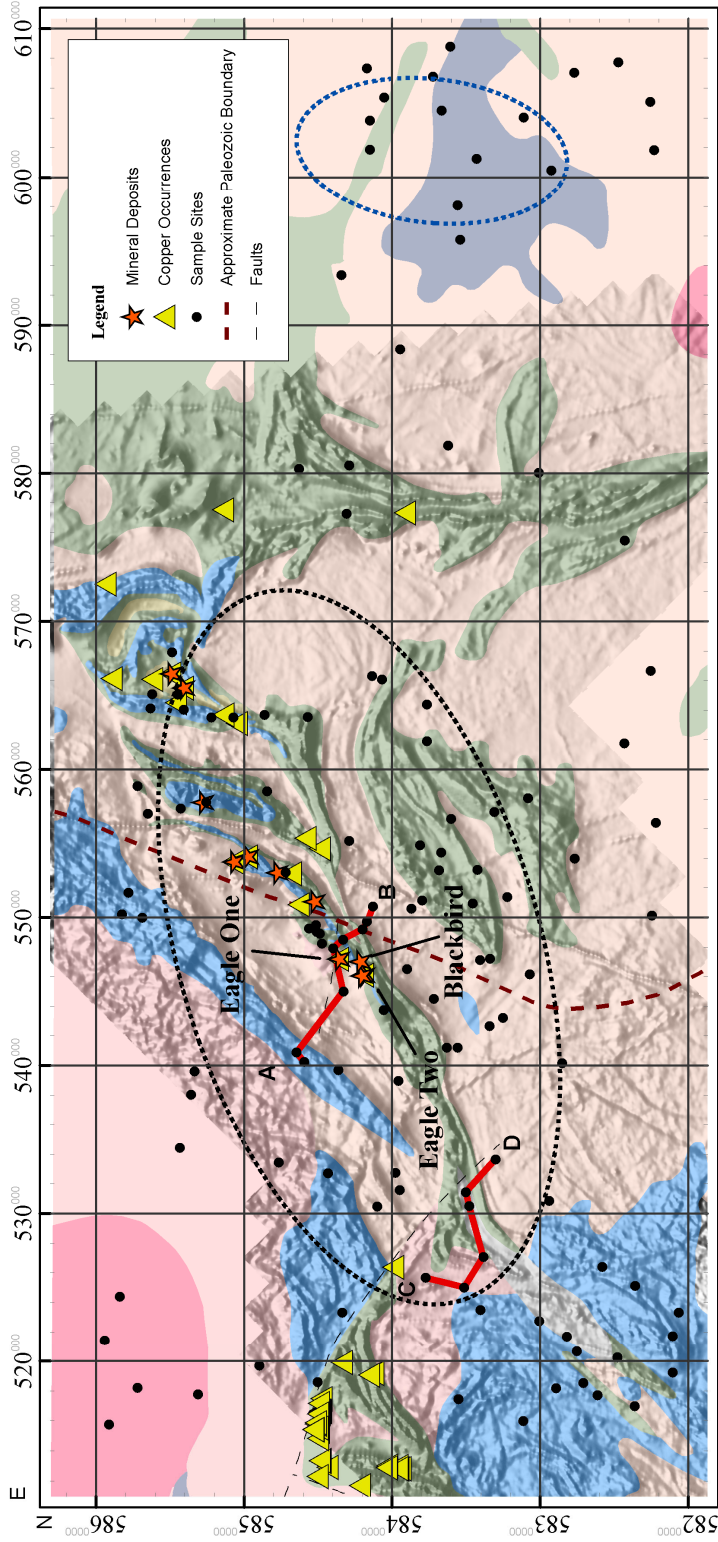


Figure 10. SGHSM anomalous areas, sample sites, mineral occurrences and bedrock geology (from Stott and Josey 2009) draped on hillshaded residual magnetic field image (modified from Rainsford et al. 2011). Transect lines through the McFaulds Lake greenstone belt are shown in red.

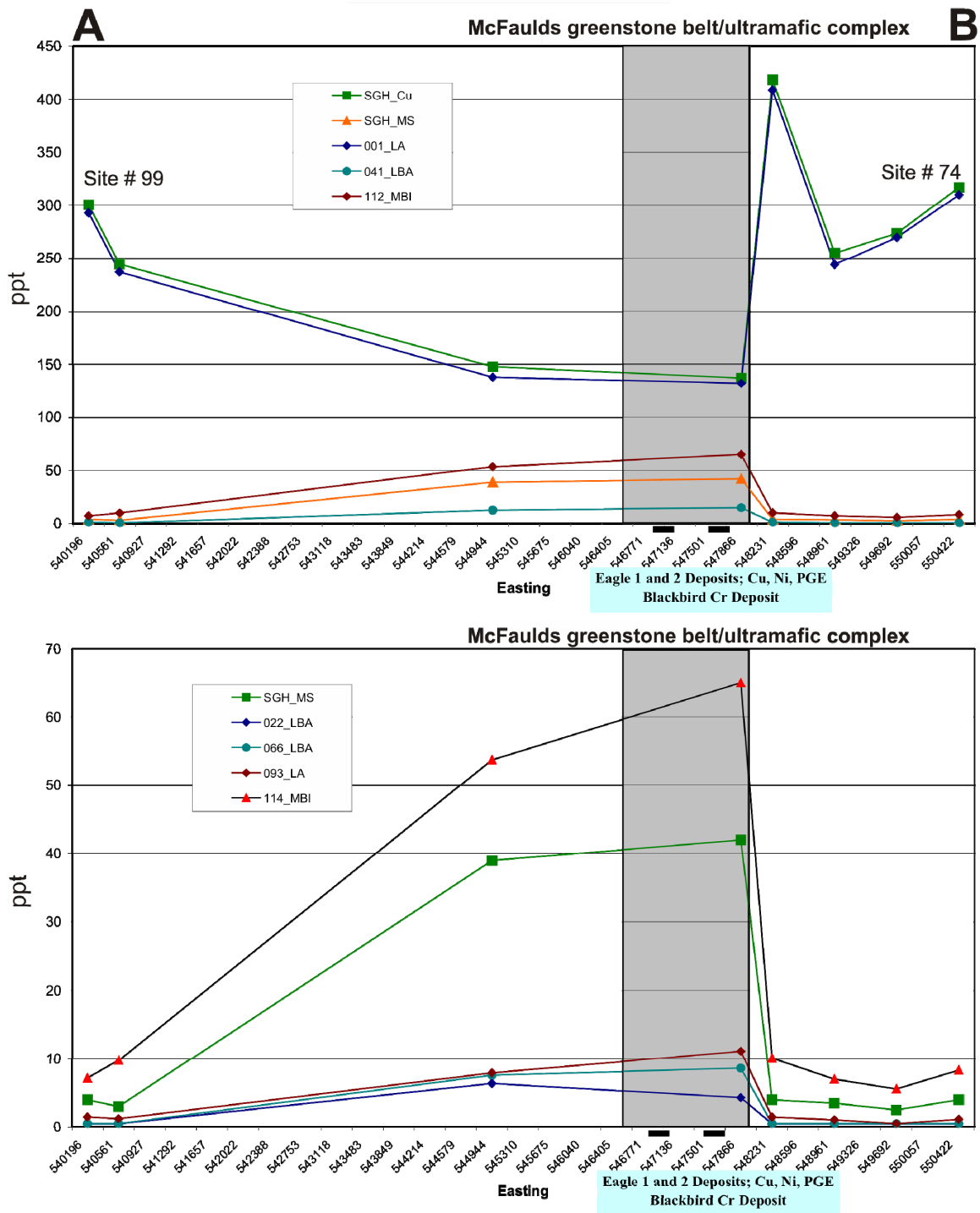


Figure 11. Lake sediment sample transect A-B through the Eagle One, Two and Blackbird deposit area showing concentrations of selected compounds.

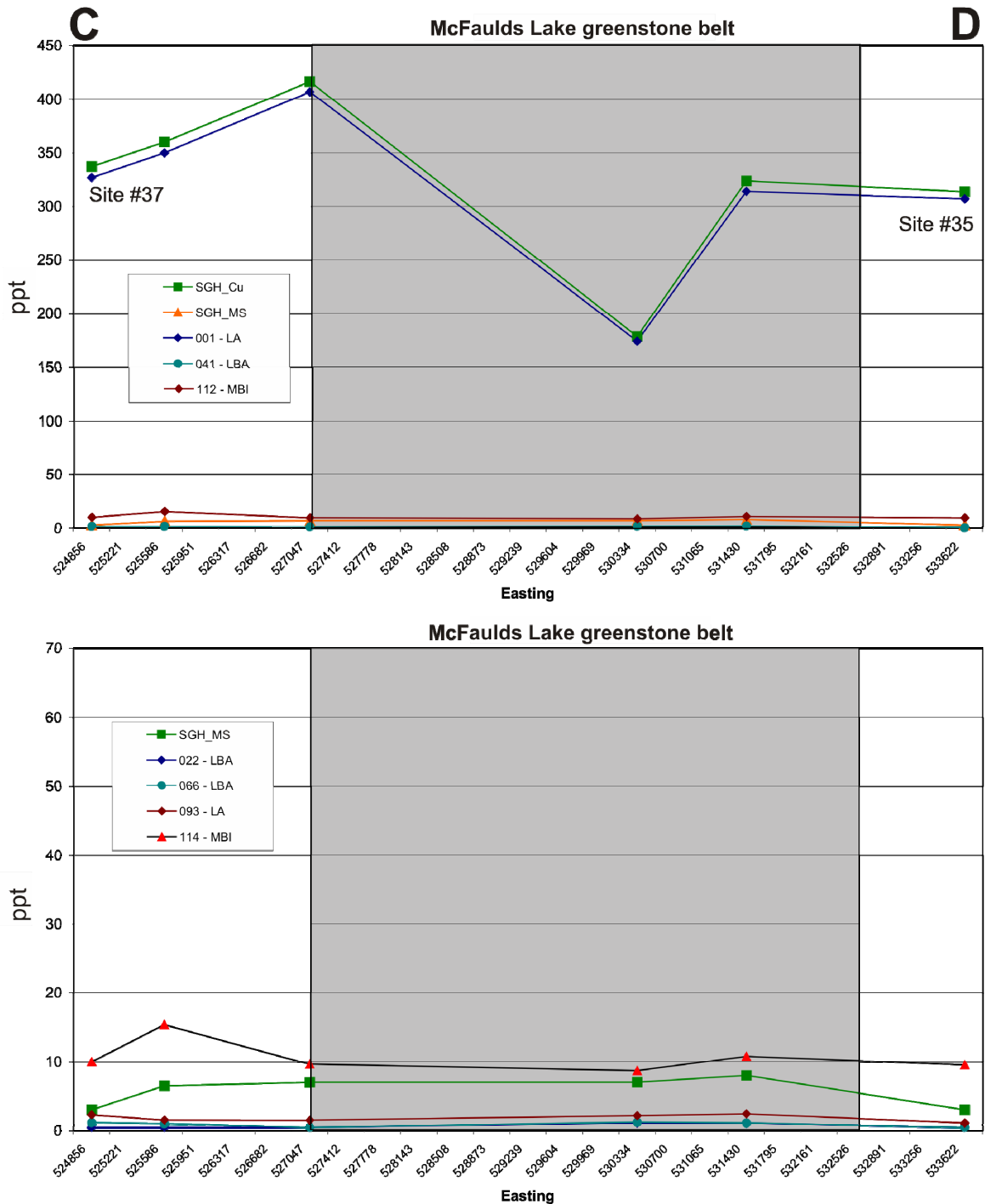


Figure 12. Lake sediment sample transect C-D through the McFaulds Lake greenstone belt approximately 20 km southwest of the Eagle deposit area.

Therefore, the results of this initial experiment indicate that SGHSM analysis of lake sediments are highly promising and have the potential to be a significant advance in Far North exploration techniques. These preliminary results also seem to contradict the hypothesis (e.g., Januszczak et al. 2008) that permafrost conditions may render deep penetrating geochemical techniques such as SGHSM ineffective. This success, if validated by additional infill sampling and follow up by industry explorationists may be a catalyst to an upsurge in more effective mineral exploration in the Far North. The lack of road infrastructure and abundance of water bodies in the Far North make lake sediment sampling a very cost-effective technique for first pass evaluation of mineral potential. It must be emphasized that such regional scale surveys are still primarily a tool to focus more detailed, “feet-on-the-ground” exploration programs.

Finally, the work-up of this SGHSM data set has underscored 5 key points:

1. The confidence in the data and subsequent interpretation is increased with a consistent sampling protocol. In this case the OGS sediment sampler routinely and consistently acquires a deep sample horizon (not a mix of shallow and deep material).
2. A regularly spaced and where possible, high density survey, will contribute to better resolution of patterns and therefore increase confidence levels.
3. Quality control samples are imperative (both duplicate samples and matrix-matched standards) and preferably inserted blind to the laboratory.
4. Multiple lines of evidence should direct follow-up exploration efforts (e.g., geophysics, favourable geology, etc.).
5. The ability to interpret the patterns with confidence requires experience and knowledge from case studies, of which there are currently very few in the published literature.

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Appendix 1

**Lake sample site UTM coordinates,
SGHSM pathfinder class data and associated compounds**

Site Number	Eastings	Northings	Zone	Lake	SGH-Cu	SGH-MS	001-LA	004-LA	007-LA	013-LBA	022-LBA	041-LBA	047-LBA	050-LBA	062-LBA	064-LBA	066-LBA	069-LA	093-LA	112-MBI		
	Method	Depth			GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	
	Units	(m)			ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt
	Det Limit				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
001	563710	5848623	16	1.4	195	<1	190	4	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	5		
002	557804	5852544	16	2.1	383	5	371	9	2	<1	1	2	2	<1	<1	<1	2	2	3	7		
003	557032	5856470	16	2.5	382	8	363	17	2	<1	3	5	3	<1	<1	<1	3	3	4	6		
004	551688	5857783	16	1.7	167	10	160	5	2	3	2	4	<1	2	<1	<1	3	3	5	13		
005	550220	5858240	16	1.3	685	6	662	19	4	2	2	2	1	<1	<1	<1	1	1	2	9		
006	539612	5853333	16	1.3	306	<1	300	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	7		
007	538049	5853554	16	0.5	338	<1	332	5	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	8		
008	534446	5854328	16	2.7	481	6	465	13	3	<1	2	3	3	<1	<1	<1	2	2	3	13		
010	524409	5858377	16	2.4	338	6	331	6	2	1	<1	2	2	2	<1	<1	1	1	2	8		
011	521413	5859403	16	1.2	221	1	215	5	1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	10		
012	518225	5857187	16	1.5	182	1	178	4	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	10		
013	515775	5859092	16	2	134	5	129	4	1	1	1	3	<1	2	<1	<1	1	1	2	15		
014	517783	5853085	16	1.2	278	7	269	7	2	1	<1	2	2	3	<1	<1	1	1	2	11		
015	519721	5848970	16	1.5	120	8	117	3	<1	1	2	4	<1	2	<1	<1	2	2	4	34		
016	518611	5845026	16	1.5	215	6	209	5	1	1	1	3	<1	2	<1	<1	2	2	4	27		
017	517474	5835509	16	1	425	8	412	10	3	2	1	2	2	2	<1	<1	1	1	2	12		
018	515995	5831159	16	1	197	9	190	6	2	1	1	2	2	3	<1	<1	1	1	2	7		
019	518196	5828920	16	1.5	329	6	320	7	2	2	1	2	2	<1	<1	<1	1	1	2	20		
020	517718	5826122	16	2	603	5	588	12	3	<1	1	2	2	<1	<1	<1	1	1	3	25		
021	563566	5845694	16	3	217	4	212	4	1	<1	<1	1	2	2	<1	<1	<1	<1	1	15		
022	577276	5843077	16	1.7	466	11	450	13	4	<1	2	3	3	4	<1	<1	2	2	4	14		
023	581868	5836223	16	1.5	596	10	574	17	5	<1	4	4	4	<1	<1	<1	3	3	3	13		
024	580051	5830097	16	1	314	14	304	8	3	1	2	4	3	3	<1	<1	3	3	5	19		
025	575475	5824290	16	1.5	300	<1	295	4	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	8		
026	566678	5822535	16	2.5	177	34	166	7	4	12	10	16	<1	4	1	2	5	5	5	105		
027	561777	5824336	16	1.2	60	9	58	2	<1	<1	2	3	2	3	<1	<1	2	2	3	23		
028	556403	5822193	16	1.8	167	8	161	5	1	2	2	4	<1	2	<1	<1	2	2	3	24		
029	550155	5822450	16	4	349	<1	340	7	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	10		
030	553981	5827689	16	1.1	133	4	128	4	1	<1	1	2	<1	2	<1	<1	1	1	2	28		
031	558087	5830823	16	1.7	234	32	221	10	3	6	6	22	<1	6	1	2	10	10	11	35		
032	557128	5833105	16	4	489	6	474	12	3	<1	1	2	2	1	<1	<1	1	1	2	13		
033	551384	5832231	16	1.6	369	1	360	7	2	1	<1	1	<1	<1	<1	<1	<1	<1	1	13		
034	543238	5832504	16	1.5	111	7	108	3	<1	1	1	3	2	2	<1	<1	1	1	2	30		
035	533685	5833012	16	1.4	314	<1	307	5	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	10		
036	523484	5834040	16	1.6	181	17	173	6	2	1	3	5	2	3	1	2	4	4	7	63		
037	525669	5837730	16	1.9	360	6	350	8	2	1	<1	2	2	2	<1	<1	1	1	2	16		
038	523332	5843358	16	1.5	169	7	163	5	1	1	1	3	<1	2	<1	<1	2	2	3	22		
039	530489	5841011	16	3	218	3	214	4	<1	<1	<1	<1	1	2	<1	<1	<1	<1	<1	32		
040	532767	5839763	16	1.2	250	<1	243	6	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	11		
041	538974	5839568	16	1.5	154	5	150	3	1	<1	<1	2	2	2	<1	<1	1	1	2	21		
042	544522	5837184	16	1.1	741	8	709	27	5	<1	2	3	2	1	<1	<1	2	2	3	14		
043	546542	5838986	16	0.9	574	3	561	11	2	<1	<1	1	2	<1	<1	<1	1	1	2	14		
044	543772	5840548	16	1	327	8	316	8	2	<1	3	4	3	<1	<1	<1	3	3	4	38		
045	545016	5843287	16	2.9	148	26	138	9	1	4	6	13	<1	4	2	3	8	8	8	54		
046	557382	5854278	16	4	275	<1	271	4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	9		
047	564148	5856311	16	1.5	442	5	429	11	2	<1	1	2	1	1	<1	<1	1	1	2	17		
048	567938	5854858	16	0.9	446	12	429	13	4	<1	3	4	2	3	<1	<1	3	3	4	32		
049	580329	5846270	16	2.3	449	7	431	15	3	<1	2	3	3	<1	<1	<1	2	2	3	23		
050	580525	5842885	16	1.8	251	7	244	6	2	1	1	2	<1	2	<1	1	2	2	3	19		
051	593375	5843426	16	1.3	121	8	118	2	1	1	2	3	<1	2	<1	<1	3	3	3	13		
054	601887	5841506	16	1.4	625	9	603	18	4	<1	2	3	3	2	<1	<1	2	2	3	24		
055	603835	5841486	16	2	386	5	376	8	2	1	1	1	1	<1	<1	<1	1	1	2	17		
056	605391	5840536	16	1.5	248	7	241	6	1	2	1	3	<1	2	<1	<1	3	3	6	43		
057	607342	5841712	16	1.3	356	13	342	11	2	3	2	4	2	3	<1	<1	3	3	7	36		
058	608795	5836067	16	1.8	315	12	304	8	2	3	3	5	<1	2	<1	1	4	4	8	37		
059	606789	5837225	16	1.4	419	18	402	13	4	4	4	10	<1	3	<1	<1	7	7	14	43		
060	604526	5836656	16	2	278	10	270	7	2	2	2	3	2	3	<1	<1	2	2	4	35		
061	604039	5831105	16	2	147	3	143	4	<1	<1	<1	2	1	<1	<1	<1	1	1	3	13		
062	607052	5827710	16	1.9	119	9	113	4	1	2	2	4	2	2	<1	<1	3	3	5	32		
063	607740	5824740	16	1.6	152	11	146	5	1	2	2	4	2	3	<1	<1	3	3	5	28		
064	605088	5822560	16	1.9	303	6	292	9	2	<1	1	4	2	<1	<1	<1	2	2	4	14		
065	601875	5822302	16	2	151	11	143	6	2	2	2	4	2	2	<1	<1	3	3	5	20		
066	600505	5829247	16	1.5	192	7	188	3	1	1	1	2	2	2	<1	<1	2	2	4	32		
067	601276	5834301	16	1.2	208	5	202	5	1	1	1	2	1	<1	<1	<1	2	2	4	23		
068	598100	5835575	16	1	517	7	495	18	4	<1	2	4	2	1	<1	<1	2	2	3	22		
069	595769	5835402	16	1	252	6	242	7	2	<1	2	5	2	<1	<1	<1	2	2	4	16		
070	588369	5839441	16	1.6	366	7	346	15	4	<1	3	4	2	1	<1	<1	2	2	3	9		
072	564404	5837661	16	1	298	13	290	6	2	1	2	4	3	3	<1	1	4	4	7	21		
073	555193	5842882	16	5	358	1	348	9	1	1	<1	1	<1	<1	<1	<1	<1	<1	1	8		
074	550744	5841283	16	4	317	1	310	6	1	1	<1	<1	<1	<1	<1	<1	<1	<1	1	8		
075	550612	5838701	16	1.4	488	8	470	15	3	2	1	3	1	1	<1	<1	1	1	2	18		
076	551152	5837976	16	1.5	155	15	150	5	<1	2	3	7	3	<1	1	2	5	5	6	23		

Site Number	Eastings	Northings	Zone	Lake	SGH-Cu	SGH-MS	001-LA	004-LA	007-LA	013-LBA	022-LBA	041-LBA	047-LBA	050-LBA	062-LBA	064-LBA	066-LBA	069-LA	093-LA	112-MBI
	Method	Depth		GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS	GC/MS
	Units	(m)		ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt
11-ROF					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Det Limit																			
077	547135	5834055	16	1.1	519	7	502	14	3	2	2	3	1	<1	<1	<1	2	2	3	18
078	540180	5828527	16	1.6	168	14	160	6	2	4	2	5	2	3	<1	<1	3	3	4	28
079	526416	5825802	16	1.5	349	12	339	8	2	2	1	3	2	3	<1	<1	3	3	6	12
080	530877	5829386	16	3	329	1	322	6	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	7
081	525131	5823607	16	1.3	329	<1	319	8	2	<1	<1	1	<1	<1	<1	<1	<1	<1	1	8
082	521713	5821063	16	1.1	177	4	171	5	1	1	<1	1	1	<1	<1	<1	1	1	2	15
083	523318	5820650	16	0.9	281	2	273	7	1	2	<1	1	<1	<1	<1	<1	<1	<1	1	7
084	519237	5821072	16	1.1	649	9	632	14	3	2	2	3	2	2	<1	<1	2	2	3	21
086	517001	5823627	16	1	151	12	140	9	2	3	3	5	<1	3	<1	1	3	3	4	21
087	520269	5824786	16	1.3	140	<1	138	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	9
088	518530	5827078	16	2.5	354	4	343	9	2	2	1	2	<1	<1	<1	<1	1	1	2	13
089	520678	5827518	16	1.7	59	9	55	4	<1	<1	2	3	1	2	<1	1	2	2	3	73
090	521683	5828199	16	0.9	444	7	429	13	2	2	1	2	2	1	<1	<1	1	1	2	13
091	522735	5830066	16	1	160	8	153	5	2	<1	2	4	2	2	<1	<1	2	2	4	16
092	525004	5835136	16	3.5	337	4	327	9	2	2	<1	2	1	<1	<1	<1	1	1	2	10
093	527095	5833823	16	3	417	3	407	8	1	2	<1	2	1	<1	<1	<1	<1	<1	2	10
094	530533	5834803	16	1.7	178	7	174	3	1	1	1	2	2	2	<1	<1	1	1	2	9
095	531462	5835018	16	2	324	8	314	8	2	2	1	2	2	2	<1	<1	1	1	2	11
096	531613	5839475	16	1	276	4	266	8	2	2	<1	2	1	<1	<1	<1	1	1	3	12
097	532753	5844319	16	1.4	471	3	459	10	2	2	<1	1	1	<1	<1	<1	<1	<1	2	11
098	533472	5847661	16	2	92	<1	90	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	16
099	540263	5845937	16	1.4	300	1	293	6	1	1	<1	1	<1	<1	<1	<1	<1	<1	1	7
102	548258	5844727	16	1.3	299	2	295	4	<1	1	<1	2	1	<1	<1	<1	<1	<1	1	6
103	547923	5843969	16	1.8	137	22	132	5	<1	3	4	15	<1	3	2	2	9	9	11	65
104	548525	5843293	16	4.5	418	1	409	8	2	1	<1	1	<1	<1	<1	<1	<1	<1	1	10
105	548915	5844863	16	1.5	365	<1	357	7	1	<1	<1	2	<1	<1	<1	<1	<1	<1	2	13
106	549046	5845087	16	2.6	290	6	282	7	1	2	1	2	2	<1	<1	<1	1	1	3	19
107	549268	5845613	16	2	240	3	234	5	1	<1	<1	1	1	2	<1	<1	<1	<1	2	18
108	549491	5845148	16	2.5	344	12	334	8	2	2	2	3	2	3	<1	<1	2	2	4	24
109	553049	5847183	16	1.3	255	8	248	6	2	1	1	2	1	2	<1	<1	2	2	4	22
110	558548	5848426	16	1.5	62	<1	62	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	12
111	563518	5850714	16	1.1	176	2	172	3	1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	13
112	563532	5852195	16	1.2	426	12	409	13	4	<1	3	3	3	4	<1	<1	3	3	4	28
113	564059	5854070	16	2.2	482	1	467	12	3	1	<1	1	<1	<1	<1	<1	<1	<1	1	7
114	565068	5854464	16	3.1	349	4	338	9	1	<1	<1	2	1	1	<1	<1	1	1	2	17
115	565094	5856179	16	2	397	2	386	10	2	<1	<1	1	1	<1	<1	<1	1	1	2	10
116	558905	5857167	16	1.6	471	8	454	14	4	2	1	2	2	1	<1	<1	1	1	2	13
117	550000	5856852	16	1.2	459	9	443	13	3	2	2	2	2	3	<1	<1	1	1	3	32
118	540891	5846440	16	3	244	<1	237	6	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	10
119	539704	5843614	16	2.5	410	1	400	8	2	1	<1	1	<1	<1	<1	<1	<1	<1	2	15
120	541226	5836308	16	1.7	350	3	341	8	1	2	<1	1	1	<1	<1	<1	<1	<1	1	17
121	541230	5835576	16	3.5	462	2	452	9	2	2	<1	2	<1	<1	<1	<1	<1	1	2	11
122	542695	5833422	16	1	185	2	182	3	<1	<1	<1	1	1	<1	<1	<1	1	<1	2	13
123	546193	5830706	16	2.4	455	7	439	13	3	<1	2	3	2	2	<1	<1	2	2	3	19
124	547216	5833390	16	1.5	595	2	583	10	2	1	<1	2	<1	<1	<1	<1	1	<1	2	11
125	550960	5834570	16	1.4	64	3	64	<1	<1	<1	<1	<1	1	2	<1	<1	<1	<1	2	17
126	553232	5834227	16	3	345	4	333	10	2	2	1	<1	2	<1	<1	<1	<1	<1	1	10
127	553193	5836834	16	1.7	274	1	266	7	1	1	<1	1	<1	<1	<1	<1	<1	<1	2	15
128	554911	5838125	16	5.4	97	<1	94	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	7
129	554398	5836678	16	8	336	<1	330	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	13
130	556667	5836010	16	2.4	268	3	258	9	2	<1	1	2	1	<1	<1	<1	<1	<1	2	7
131	561915	5837654	16	1	491	10	473	14	4	<1	2	2	3	3	<1	<1	2	2	3	13
132	566082	5840670	16	1.5	342	7	323	16	3	<1	2	3	3	<1	<1	<1	2	2	4	14
133	566334	5841354	16	1.2	576	13	554	18	5	<1	4	4	4	3	<1	<1	3	3	5	20
134	549722	5841692	16	2	274	<1	270	4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6
135	549224	5841991	16	2	255	<1	244	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	7

Notes:

SGHSM-Cu is Soil Gas Hydrocarbon copper pathfinder class summary value
 SGHSM-MS is Soil Gas Hydrocarbon massive sulphide pathfinder class summary value
 GC/MS is gas chromatography/mass spectrometry
 ppt is part per trillion

Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
<i>SI Unit</i>	<i>Multiplied by</i>	<i>Gives</i>	<i>Imperial Unit</i>	<i>Multiplied by</i>	<i>Gives</i>
LENGTH					
1 mm	0.039 37	inches	1 inch	25.4	mm
1 cm	0.393 70	inches	1 inch	2.54	cm
1 m	3.280 84	feet	1 foot	0.304 8	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	1.609 344	km
AREA					
1 cm ²	0.155 0	square inches	1 square inch	6.451 6	cm ²
1 m ²	10.763 9	square feet	1 square foot	0.092 903 04	m ²
1 km ²	0.386 10	square miles	1 square mile	2.589 988	km ²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
VOLUME					
1 cm ³	0.061 023	cubic inches	1 cubic inch	16.387 064	cm ³
1 m ³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m ³
1 m ³	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m ³
CAPACITY					
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	4.546 090	L
MASS					
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	31.103 476 8	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	0.453 592 37	kg
1 kg	0.001 102 3	tons (short)	1 ton(short)	907.184 74	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	0.907 184 74	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	1016.046 908 8	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	1.016 046 9	t
CONCENTRATION					
1 g/t	0.029 166 6	ounce (troy) / ton (short)	1 ounce (troy) / ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights / ton (short)	1 pennyweight / ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	<i>Multiplied by</i>	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

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