Soil from the Yellowknife, NT Region: Spatial Distribution of Arsenic, Characterization of Solid Phase Arsenic Hosts, and Distinguishing Giant and Con Mine Contamination

By

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Abstract

Historical gold mining in the Yellowknife, Northwest Territories region has led to a legacy of arsenic contamination in the region. Roasting of arsenopyrite hosting gold ore released arsenic trioxide (As_2O_3) via airborne emissions. Recent studies have highlighted the persistence of As_2O_3 in local sediments and surface waters. However, questions remain regarding the regional extent and nature of arsenic in soils from the region. The main objective of this research is to report the concentration and speciation of arsenic in 311 near-surface soil samples collected within 30 km of Yellowknife. Soil samples were cored from locations that were undisturbed by recent human activities to minimize the influence of recent post-mining activities and to examine the effect of natural processes and the legacy of airborne emissions from former ore roasting. Analyses in this study focused on the Public Health Layer (PHL), which is defined as the top 5 cm of material. The arsenic concentrations for the region varied widely, ranging from 1.0 to 4,700 mg/kg. Statistical analysis indicates the distance from former ore roasters, soil horizon depth, terrain unit, and the relative direction the sample was collected from Giant Mine are the most significant factors on arsenic concentrations in the PHL. The dominant arsenic species in the soil samples are roaster-derived iron oxides containing arsenic, As_2O_3, and natural iron oxides. Of the samples completed for detailed mineralogy, 57% (n = 44) of samples analyzed contain 80% or greater anthropogenic arsenic (i.e. a combination of roaster-derived iron oxides and arsenic trioxide). These data suggest the current background arsenic value of 150 mg/kg (GNWT, 2003), which is over 12 times the Canadian Environmental Quality Guideline of 12 mg/kg for soil (CCME, 2015), should be revisited. Additionally, the remediation guidelines of 160 and 340 mg/kg for residential and industrial areas, respectively, (GNWT, 2003) should also be revisited. This study provides data that can support future risk assessments to human and ecological health from arsenic-derived stack emissions.

Co-Authourship

A parallel study by Maitland (2018) has been on-going in coordination with this project. Arsenic results from this study and Maitland (2018) were combined in Jamieson et al. (2017), an Open File Report aimed at bringing awareness of arsenic concentrations in surface soils. The City of Yellowknife will be using these data to relay potential health risks to the public.

This study was conceived by Heather Jamieson and Mike Palmer (formerly with the Government of the NWT, currently PhD student, Carleton University). Heather Jamieson provided a supervisory role and reviewer of the entire project, contributed to geochemical interpretation, coordinating the project, and synchrotron data interpretation. Mike Palmer reviewed the entire project, provided field assistance, and aided in statistical analysis.

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List of Abbreviations

°C	degrees Celsius
AM	automated mineralogy
ANCOVA	analysis of covariance
APS	Advanced Photon Source
As	arsenic
As_2O_3	arsenic trioxide
ASU	Analytical Services Unit
BSE	back-scatter electron
Cm	centimetre
CM	Con Mine
CO_2	carbon dioxide
DEM	digital elevation model
EDS	energy-dispersive X-ray spectroscopy
Eh	redox potential
EMPA	electron microprobe analysis
ESP	electrostatic precipitator
eV	electron volt
FD	field duplicate
FeAsS	arsenopyrite
FEG	field emission gun
Ga	billion years ago
GIS	Geographic information systems
GLM	general linear model
GMOB	Giant Mine Oversight Board
GNWT	Government of Northwest Territories
G-SIT	Grid south Ingraham Trail
G-WGM	Grid west of Giant Mine
ICP-MS	inductively coupled plasma-mass spectrometry
ICP-OES	inductively coupled plasma-optical emission spectrometry
IDW	inverse distance weighted
INAC	Indigenous National Affairs Canada
ISO	International organization for standardization
K	Kelvin
Km	kilometre
kV	kilovolts
LCF	Linear combination analysis
LD	lab duplicates
m/s	metres per second
masl	metres above sea level
MCML	Miramar Con Mine Limited

mg/kg	milligrams per kilogram
MIDW	multifractal inverse weighted distance
MLA	mineral liberation analysis
Mm	millimetre
MVEIRB	Mackenzie Valley Environmental Impact Review Board
mV	millivolts
N	number of samples
nA	nanoamperes
P	parent sample
PHL	Public Health Layer
QAQC	Quality assurance and quality control
RPD	Relative percent difference
SCWG	Soil Classification Working Group
SEM	scanning electron microscope
SPL-Lt	sparse phase liberation
SS	split sample
SS-1	standard sample 1
SS-2	standard sample 2
TC	total carbon
TOC	Total organic carbon
UTM	Universal Transverse Mercator
WBF	West Bay Fault
WDS	wavelength-dispersive mode
WGS	World Geodetic System
wt. %	weight percent
XANES	X-ray absorption near edge spectrometry
YGB	Yellowknife greenstone belt
YK	Yellowknife
μg/L	microgram per litre
μm	micrometre

Chapter 1

Introduction and Background

1.1 Introduction

The Yellowknife Greenstone Belt hosts a long history of gold mining, producing 13 million ounces of gold since the 1930's (Bullen and Robb 2006; Moir et al. 2006). Giant Mine, located approximately 6 km north of Yellowknife, Northwest Territories, and Con Mine, located approximately 2 km south of Yellowknife, were the two main producers of gold. The gold ore was either refractory or free-milling. Refractory gold ore refers to microscopic to sub-microscopic gold that is encapsulated, primarily, by arsenopyrite (FeAsS) and not susceptible to direct cyanidation (Siddorn et al., 2006). Free-milling gold ore is native gold, or gold-metal assemblages that are amenable to cyanidation (Siddorn et al., 2006). Processing of the refractory ore led to the release of arsenic (As) through roaster stack emissions in the form of arsenic trioxide (As_2O_3). Roasting the gold-bearing ore was done for the duration of Giant Mine operations (1949-1999). Roasting ceased in 1970 at Con Mine because the refractory ore became exhausted and only free-milling remained (Hocking et al., 1978). There were no emission controls when the mines first began operations (INAC, 2007). Upgrades to the roaster, the addition of two electrostatic preciptators (ESPs), and a baghouse reduced emissions, but little legislation restricting arsenic emissions were enacted. For the life of Giant Mine, approximately 20,000 tonnes of arsenic-bearing dust was released through roaster stack emissions and 237,000 tonnes of dust is currently being stored underground. At Con Mine, 2,500 tonnes of arsenic dust was released through roaster emissions. Dust that was captured was treated on site, integrated with tailings, or sold (Hocking et al., 1978; Hauser et al. 2006; Wrye, 2008). Free-milling gold ore at Con Mine did not directly produce emissions. However, in the early 1990's, processing of the free-milling tailings led to windblown dust (MCML, 2007). Although Giant and Con mines are geographically close (less than 10 km), the nature of the ore dictated the ore processing methods at each mine. This has become a crucial part of the story to the legacy of arsenic contamination in the Yellowknife area (Walker et al., 2015).

Previous studies have indicated the presence of As_2O_3 in soils on the Giant Mine property (Wrye, 2008; Bromstad, 2011; Bromstad et al., 2015; Bromstad et al., 2017), in lake sediments near Giant Mine (Galloway et al., 2015; Van Den Berghe et al., 2018; Schuh et al., 2018), and in lake waters up to 20 km from Giant Mine (Palmer et al., 2015). The evidence suggest that As_2O_3 contamination not only extends beyond the Giant Mine property but has persisted in the environment since deposition from when roasting operations began. Thus, it is crucial to understanding the extent of As_2O_3 contamination within the Yellowknife region. Soils outside the Giant Mine property are the remaining piece of this puzzle to understanding the extent of contamination and the potential risks to human and ecosystem health. This understanding would provide the basis for comprehensive risk assessments. The evaluation of risk, however, requires information beyond the presence of As_2O_3.

Arsenic trioxide is the most toxic and bioaccessible form of solid-phase arsenic (Plumlee and Morman, 2011). Bioaccessibility is a measure of arsenic's solubility in body fluids, providing an indication of risk (Plumlee and Morman, 2011). Several parameters, including exposure pathways, particle size, and the mineralogy of arsenic all influence the bioaccessibility of arsenic (Ruby et al., 1999; Meunier et al., 2010; Plumlee and Morman, 2011). Understanding the widespread contamination, therefore, lays the foundation for risk assessments to human health.

The research objectives of this thesis focuses on soils beyond Giant and Con mine properties that have been impacted by the release of arsenic trioxide through mining operations. Soil samples were collected within 30 km around the City of Yellowknife in undisturbed locations. Samples were collected by coring, with a focus on the top 5 cm of material, defined as the Public Health Layer (PHL) (Renz et al., 2011). Specific objectives include:

- Determine the arsenic concentrations in the Public Health Layer within 30 km of the City of Yellowknife;
- Determine factors affecting arsenic concentrations in the PHL on a regional and local scale;

- Determine whether arsenic concentrations in the PHL are due to roaster emissions, natural weathering of bedrock, or a combination; and,
- Define the signature of arsenic contamination from Giant Mine versus arsenic contamination from Con Mine.

The objectives of this study will build upon previous regional soil studies by Hocking et al. (1978) and Hutchison et al. (1982) by adding spatial coverage of the region and detailed mineralogy that will determine whether the arsenic present in soil samples is anthropogenic or geogenic. Furthermore, the Giant Mine property is currently owned by the federal government, whereas Con Mine is owned by a private mining company. If remediation of contaminated areas off the mine properties is completed, distinguishing between Giant and Con contamination will determine who is ultimately responsible for the costs of remediation.

1.2 Background

1.2.1 Physiographic setting

The study area (Figure 1-1) is located within the Taiga Shield High Boreal Ecoregion in the Northwest Territories (Ecosystem Classification Group, 2008). This ecoregion is defined by exposed bedrock terrain separated by peat and forested areas. The exposed bedrock is often elevated and refered to as the Great Slave Uplands whereas the forest and peat areas are commonly at lower elevations and referred to as the Great Slave Lowlands. Silt and clay were deposited during the last period of glaciation (8000 to 12 000 years ago) when Glacial Lake McConnell covered most of the study region (Wolfe et al., 2014). The Great Slave Lowlands consists of spruce, Jack pine, and tamarak trees, small shrubs, and grasses. The Great Slave Uplands contain little vegetation, mainly Jack pines, small shrubs, grasses, and the outcrop hosting mosses and lichens.

Wind measurements recorded at the Yellowknife Airport between 1953 and 1999 shows the dominant prevailing wind direction from east to west (inset in Figure 1-1; Environment Canada, 2017). East winds are dominate for most of the year except in the summer when winds come from the South

(Environment Canada, 2017). Pinard et al. (2008) reports mean annual wind speed measured at the Yellowknife airport as 3.28 m/s, measured over ten years. As shown in previous studies, prevailing wind direction has an influence of roaster emissions throughout the study area (Palmer et al., 2015; Galloway et al., 2015; Bromstad et al. 2017). Average temperatures in the study area range from -26°C to -1.7°C in the winter (October to April) and 4.6 °C to 17°C in the summer (May to September), with an annual average of -4.3°C. Precipitation is low, receiving an average of 289 mm annually and evaporation is high.

1.2.2 Regional Geology

The regional geology of the study area, similar to that described by Palmer et al. (2015), Galloway et al. (2015), and Jamieson et al. (2017), lies within the southern edge of the Archean Slave Structural Province (Canam, 2006; Ootes et al., 2011). The Giant and Con mine deposits reside within the Yellowknife Greenstone Belt (YGB), a linear, north-south trending belt primarily composed of tholeiitic basaltic flows, granitoid intrusions, and steeply dipping metavolcanics and metasediments (Figure 1-2) (Canam, 2006; Siddorn et al., 2006). The YGB is bound by Western Plutonic Complex of the Defeat Plutonic Suite (2.64 to 2.58 Ga) to the west and metaturbidites of the Duncan Lake Group conformably overlie the YGB to the east (Siddorn et al., 2006). The YGB consists of an assemblage of rock units, overlying a Mesoarchean gneissic basement, that formed over several tectonic events (Siddorn et al., 2006; Ootes et al., 2011). First, rifting and mafic volcanism occurred leading to the formation of the northeast-striking, southeast-dipping homocline Kam Group (~2.73 to 2.7 Ga). Arc rifting and turbidite deposition approximately 2.66 Ga formed the Banting Group. Finally, sandstones and conglomerates were tectonically placed between the Kam and Banting groups, forming the Jackson Lake Formation, 2.60 Ga (Helmstaedt and Padgham, 1986; Siddorn et al., 2006). Gold of the Giant and Con deposits are hosted within multiple Archean deformation zones that crosscut the Kam Group.

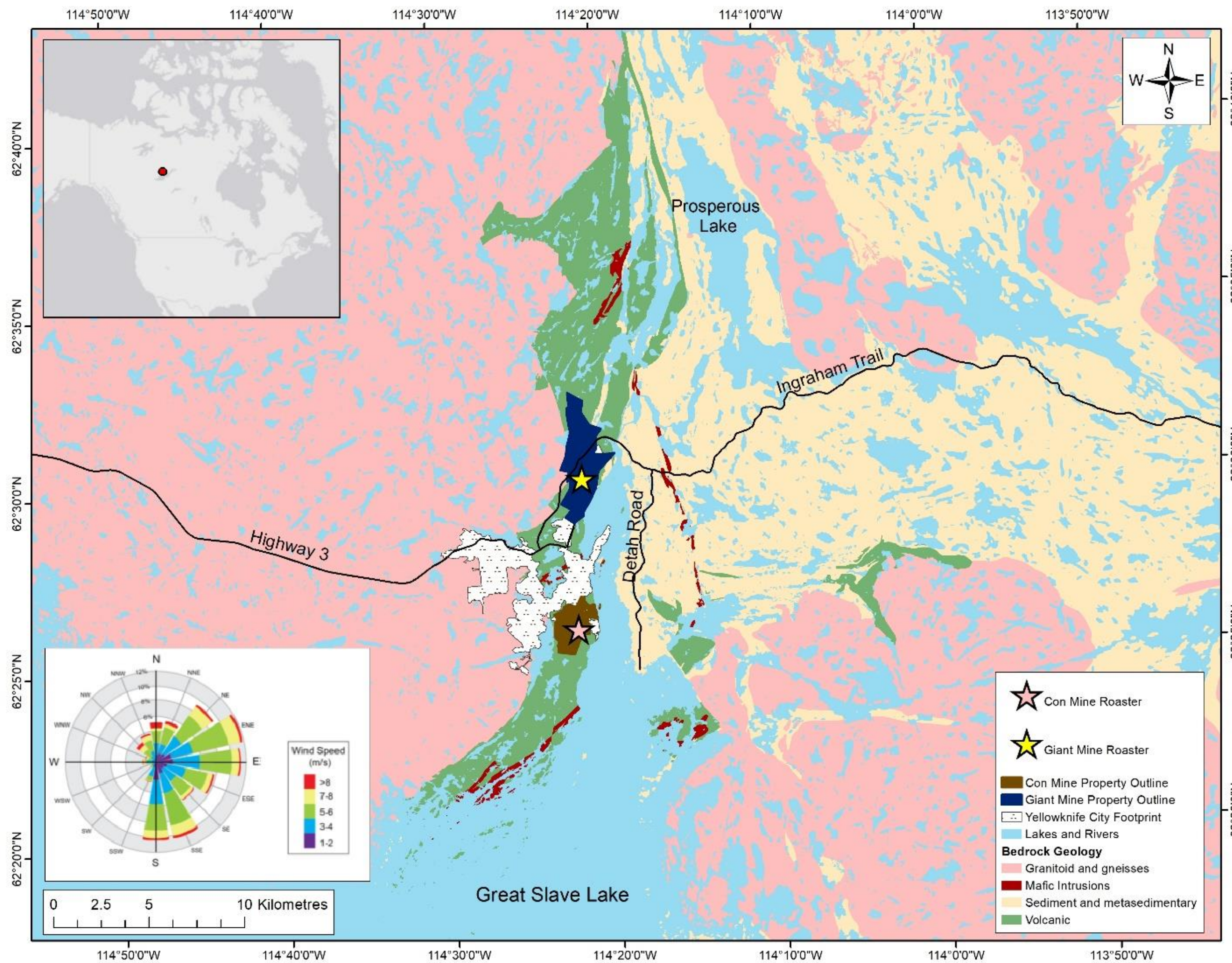

Figure 1-1: Study area, showing the relative locations of the Giant Mine and Con Mine roasters with respect to the City of Yellowknife. Giant Mine property outline from INAC, 2007; Con Mine property outline from MCML, 2007; City of Yellowknife outline drawn based on Google Earth Imagery (August 8, 2017); wind rose diagram modified from Bailey, 2017. Geology from Helmstaedt and Hounsel, 2006.

Four deformation events occurred, three of which lead to mineralized veins of the YGB. The first (D_1) was extensional deformation (2.66 to 2.63 Ga) (Siddorn et al., 2006). Three types of gold mineralization were associated with this event at both Giant and Con deposits: quartz-ankerite-paragonite schist (V_{1A}), white laminated quartz veins (V_{1B}), and quartz breccia veins (V_{1C}) (Siddorn et al., 2006). All gold during this event was refractory (Siddorn et al., 2006). The second deformation event, D_2, occurred ~2.596 Ga, was characterized by compression. Free milling gold was associated with D_2, hosted in three mineralization types: grey-white laminated quartz veins (V_{2A}), white non-laminated quartz veins (V_{2B}), and pink-white non-laminated quartz veins (V_{2C}) (Siddorn et al., 2006). V_{2A} occurred at both Giant and Con deposits, while the V_{2b} and V_{2c} occurred at Con Mine only (Siddorn et al., 2006). A fourth type of veins (V_{2D} - extensional quartz-calcite-epidote) during D_2 and veins produced during deformation event 4 (D_4 – quartz-hematite-stibnite-calcite) occur at both Giant and Con deposits but do not contain any gold (Siddorn et al., 2006). The third deformation event, D_3, did not produce any veins. A series of Proterozoic faults occurred in the YGB, the most significant of which was the West Bay Fault (WBF). The WBF offsets the Con and Giant deposits. Theories have evolved since the discovery of the Giant and Con deposits as to whether they are related. It is now accepted that the Giant deposit is an upward extension the Con zone (Siddorn et al., 2006). Based on the deformation history creating faults and fractures, greenschist to amphibolite facies metamorphism, and quartz-carbonate veins, the Giant and Con mine deposits display typical characteristics of an orogenic lode gold deposit, also known as greenstone belt quartz-carbonate deposits (Dubé and Gosselin, 2007).

1.2.3 Giant Mine

1.2.3.1 Geology and Mineralization

Giant Mine gold is mainly within the Yellowknife Bay formation of the Kam Group, with a minor amount of gold found in the Townsite Formation (Canam, 2006). The mineralized zones are structurally bound: to the west and south by the West Bay Fault, to the north by the Akaitcho Fault, and to the east by Jackson Lake Formation and/or Banting Group (Canam, 2006). Mineralization occurs in alternating quartz-sulphide and sericite-carbonate schist veins (Canam, 2006). Typical minerals associated with these ore bodies include pyrite, arsenopyrite, sphalerite, chalcopyrite, stibnite, sulphosalts, pyrrhotite; quartz varies from 30 to 90%, with sulphides and sulphosalts (jamesonite, berthierite, bournonite, and tetrahedrite) ranging from 0 to 15% (Canam, 2006). Gold at Giant Mine is mainly refractory, with minor free-milling gold occurring in the western portion of the Giant Mine property (Canam, 2006).

Mineralization occurred in three phases, characterized by varying amounts of sulphides. The first phase occurred before deformation and was defined by pyrite and arsenopyrite. The second occurred during deformation and was characterized by sphalerite, chalcopyrite, and pyrrhotite. Finally, the third phase, produced after deformation events, was characterized by sulphides and sulphosalts (Canam, 2006).

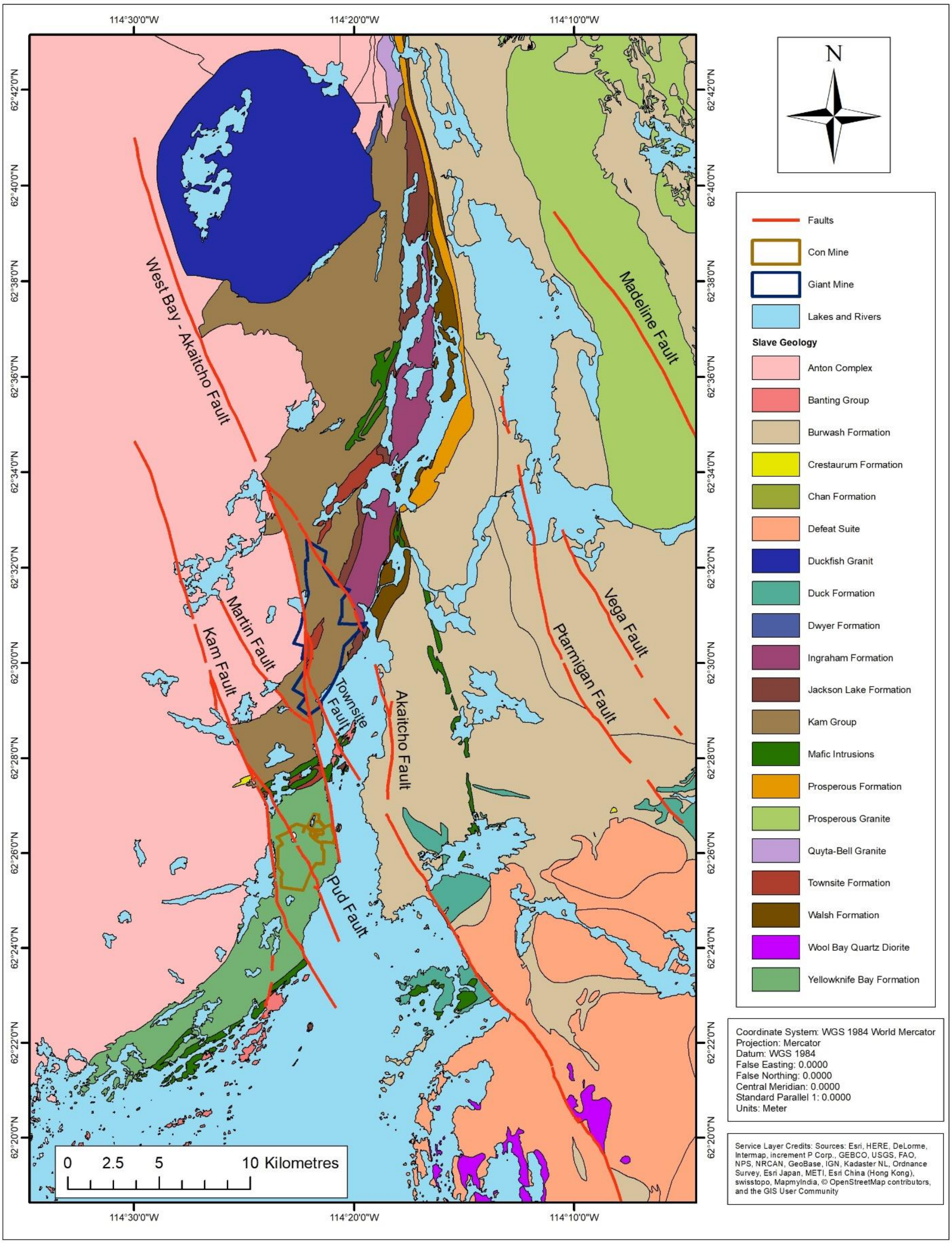

Figure 1-2: Detailed regional geology of the Yellowknife area (modified after Hubbard et al., 2006).

1.2.3.2 Operational History

The first gold brick poured at Giant Mine was August 24, 1948 (Moir et al., 2006). Roasting began in 1949 and ceased in 1999. Giant Mine operated until 2004. Over its 55-year history, Giant Mine produced more than 7 million ounces of gold, earning 2.7 billion dollars (Bullen and Robb, 2006). Giant Mine fell into receivership in 1999 and thus remediation became the responsibility of the federal government. In 2012, Indigenous and Northern Affairs Canada (INAC[1]) estimated that remediation costs were approaching 1 billion dollars (AANDC, 2012). The presence of refractory gold associated with arsenopyrite lead to roasting as a pre-treatment method are the underlying reasons for the high cost. Roasting resulted in the release of approximately 20,000 tonnes arsenic trioxide dust through emissions and the subsequent contamination of soil, sediment, and water (Wrye 2008; Palmer et al., 2015; Bromstad et al., 2017; Schuh et al., 2018).

From 1949 to 1951, stack emissions exceeded 7,900 tonnes of As_2O_3 dust (Wrye, 2008). In October 1951, a cold Cottrell Electrostatic precipitator was installed reducing emissions of As_2O_3 to ~1,900 tonnes per year and increasing gold recovery (More and Pawson, 1978). By 1963, approximately 86% of the 20,000 tonnes of As_2O_3 emissions were released (Wrye, 2008). By the 1990's, stack emissions were reduced to 4 tonnes per year (Wrye, 2008).

1.2.3.3 *Ore Processing History*

Ore extracted from the underground mine passed through several stages of processing, including crushing, grinding, flotation, roasting, cyanidation, washing, and refining, before the final gold bars were produced. First, crushing began underground with a 0.9 m x 1.2 m jaw crusher (Figure 1-3) (More and Pawson, 1978). The ore was then transferred to the surface and was subjected to three more stages of

[1]Prior to 2018, Indigenous and Northern Affairs Canada was the branch of the federal government related to all policies relating to the Indigenous population. This department was previously known as Aboriginal Affairs and Northern Development Canada and Indian and Northern Affairs Canada. In 2018, this branch of government was divided into two: Crown-Indigenous Relations and Indigenous Services.

crushing. Grinding was completed in primary and secondary circuits composed of 2.4 m by 3.0 m ball mills with 1.8 m high-weir Simplex spiral classifiers (More and Pawson, 1978). Primary flotation consisted of twelve No. 24 Denver cells (More and Pawson, 1978). Flotation feed was at 55% -200 mesh and 42% solids at a constant temperature of 21°C. Temperature was tightly controlled or else recovery would drop 2 to 3% (More and Pawson, 1978). Flotation was the first step in which arsenopyrite and other sulphides are concentrated. The flotation concentrate material was taken to three 0.3 m cyclones and then two secondary ball mills; one ball mill was 1.8 m by 3.7 m and the other was 1.5 m by 2.4 m (More and Pawson, 1978). Overflow from cyclones, along with surface material from primary flotation, was sent to secondary flotation (More and Pawson, 1978). Bulk concentrate from the secondary flotation process was thickened before roasting (More and Pawson, 1978).

Roasting began in 1949 as a pre-treatment method to liberate the gold prior to cyanidation (More and Pawson, 1978). A detailed history on the changes and upgrades to the roasting process is provided below. Roasting produced the following reaction, shown in Equation 1:

$$2FeAsS + 5O_2 = Fe_2O_3 + As_2O_3 + 2SO_2 \quad \text{Equation 1}$$

Roasting created a calcine product and a gas stream (More and Pawson, 1978). The calcine product made the refractory gold previously associated with the arsenopyrite amenable to cyanidation and contained a mixture of gold bearing iron oxides with some residual sulphides (MCML, 2007). The cyanidation process produced a precipitate, which was subsequently refined and gold bars were produced (More and Pawson, 1958). The gas stream was composed primarily of As_2O_3, sulphur dioxide (SO_2), fine dust including iron oxides (More and Pawson, 1978).

Tailings were deposited directly into Back Bay when processing started in 1948 (INAC, 2010). In February 1951, a mixture of calcine and flotation tailings was deposited into Bow Lake, which was on the Giant Mine property. Continuous dumping in this lake, and the construction of engineered dams beginning in 1955 produced the north, central, and south tailings ponds (Moir et al., 2006; INAC, 2010).

Before sedimentation controls were emplaced, tailings would flow over the tailings dams during the freshet and settle at the upstream end of Baker Pond (Fawcett and Jamieson, 2011).

1.2.3.4 Roasting History

An Edwards-type flat-hearth roaster was installed in January of 1949 (More and Pawson, 1978). The concentrate was coarse and thus the roasting was not efficient due to the small surface area (Thomas and Cole, 2005). In 1951, a cold Cottrell electrostatic precipitator (ESP) was installed to control As_2O_3 emissions (More and Pawson, 1978). The ESP dust was collected and subjected to carbon in pulp batch leaching to extract gold that would have otherwise been lost. Arsenic trioxide dust was stored in underground stopes and chambers, beginning in 1952 (Walker et al., 2005). The stopes and chambers were in solid permafrost. However, the permafrost has recently regressed. This has become a focus of current remediation efforts, discussed in Section 1.2.3.5 A Dorrco fluosolids roaster was installed in 1952 to operate in parallel with the flat-hearth roaster (More and Pawson, 1978). Production was increased from 400 to 700 tonnes per day (Moir et al., 2006). The Dorrco roaster consisted of two-stages within the single unit. The two-stage Dorrco roaster was a prototype for two-stage fluosolids roasting (More and Pawson, 1978).

Full two-stage fluosolids roasting was the main operation at Giant Mine, beginning in 1958 and operated until the mine closed. The two-stages of roasting were in separate units, dissimilar to the Dorrco roaster (More and Pawson, 1978; Walker et al., 2005). Two-stage fluosolids consisted of a fine-grained slurry-mixture (Thomas and Cole, 2005). The surface area of the slurry was larger and therefore more efficient than Edwards-type hearth roasting. The first stage volatized the arsenic to arsenic trioxide and the second was to oxidize sulphur (Thomas and Cole, 2005). Both steps were done at 500°C (More and Pawson, 1978). Each step of roasting was autogenous, in that the source of heat was provided from the sulphur in the ore (Thomas and Cole, 2005). At peak production, Giant Mine processed 1200 tonnes of ore per day and 220 tonnes per day was passed through the roaster (Canam, 2006).

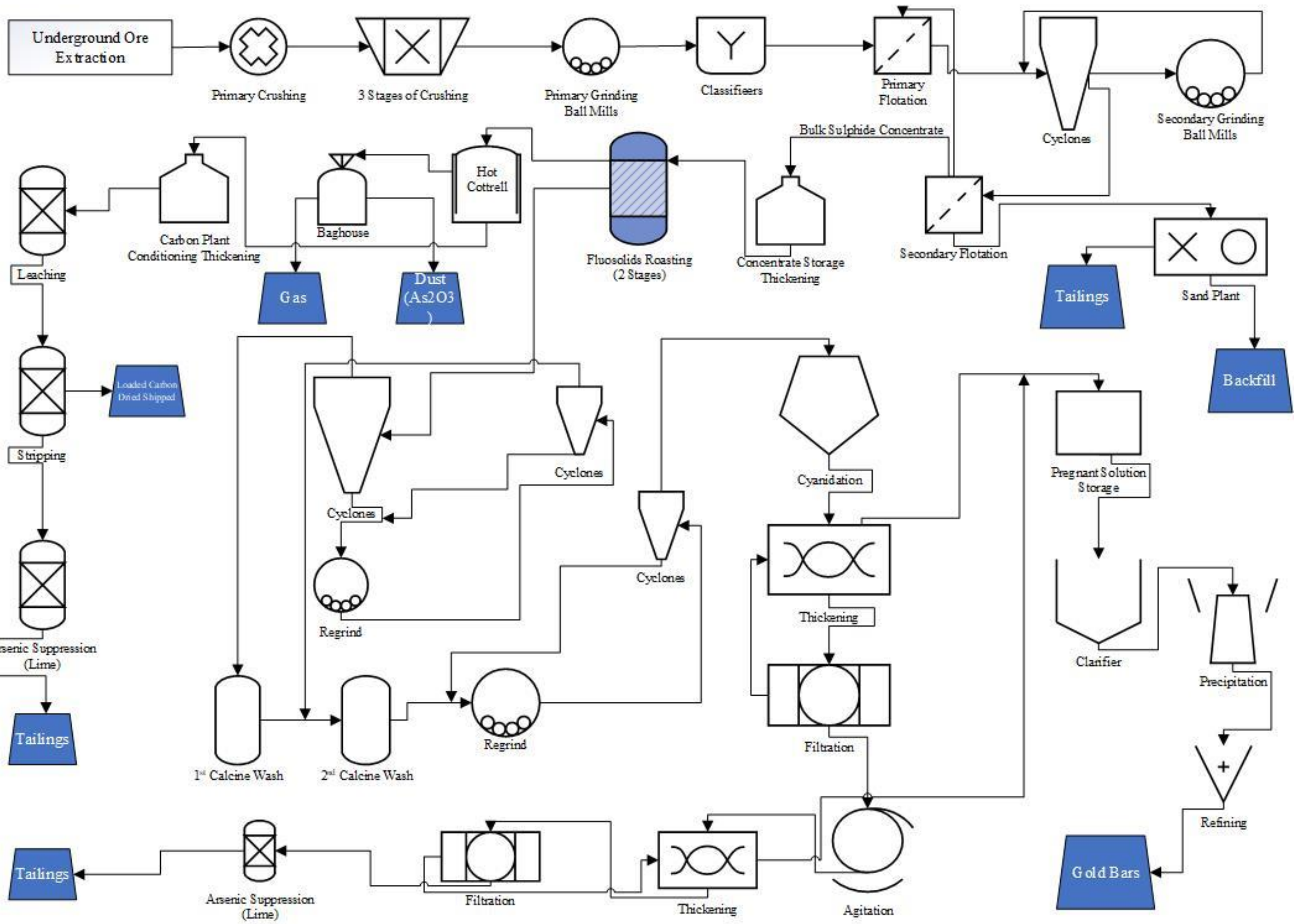

Figure 1-3: Giant Mine flowsheet for processing gold refractory ore (modified after More and Pawson, 1978).

Fluosolids roasting created more dust than Edwards-type hearth roasting because the slurry was fine-grained. In 1963, two hot Cottrell ESP came into operation to process the dust created (Wrye, 2008). The dust and gases produced from fluosolids roasting was separated at high temperatures and then cooled by gas stream resulting in deposition of the As_2O_3 in a bag-house (More and Pawson, 1978; Thomas and Cole, 2005). The collected dust was sent to underground storage stopes and chambers.

1.2.3.5 Remediation

Past studies estimate the total release of As_2O_3 through air emissions at Giant Mine was 20,000 tonnes (Wyre, 2008). The bulk of the emissions were released in the early years of roasting, when emission regulations were not in place. In addition to the roasting emissions, 237,000 tonnes of As_2O_3 dust are stored underground at the Giant Mine site. Recent studies on soil, lake water, and lake sediment geochemistry on the Giant Mine property, and up to 20 km away, show arsenic trioxide to be persisting and stable in the environment (Walker et al., 2005; Wyre, 2008; Bromstad, 2011; Palmer et al., 2015; Jamieson et al., 2017; Schuh et al., 2018). On-going studies at Wilfred-Laurier University provide evidence for arsenic contamination in lake sediments coinciding with the period of roasting at Giant Mine as far as 190 km away (Telford et al., 2017).

Arsenic trioxide is the most bioaccessible forms of arsenic (Plumlee and Morman, 2011). Exposure to As_2O_3 through either ingestion or inhalation is therefore a major concern for the community of Yellowknife. In the 1950's, two children died after eating snow laced with As_2O_3 (Hutchison et al., 1982; MVEIRB, 2012 p. 394; Sandlos and Keeling, 2012; Sandlos and Keeling, 2016). There are no plans to remediate any contaminated lands that are not on the Giant Mine property. On-going studies are determining how best to remediate the contaminate lands on Giant Mine property (INAC, 2018a). One topic of large debate is what to do with the As_2O_3 stored in underground chambers. Five underground cavities were originally created to store As_2O_3 dust (INAC, 2010). Currently, there are 9 underground chambers and 5 underground stopes storing As_2O_3 dust (INAC, 2010). Stopes are underground spaces that have been mined out (INAC, 2018b). Chambers were built specifically to store As_2O_3 dust (INAC, 2018b). The current plan is to freeze these cavities in-place. However, many residents of Yellowknife are not in favour of this plan because it will require on-going maintenance for the foreseeable future (MVEIRB, 2012, p. 164). The main reason the frozen block method was chosen was because the As_2O_3 is too dangerous to remove from the underground cavities (INAC, 2018b). Additionally, the frozen block method was deemed the most appropriate by an Environmental Assessment (INAC, 2010; INAC, 2018b).

The frozen block method consists of thermosyphons that surround each underground chamber (INAC, 2013). A super-cooled carbon dioxide (CO_2) liquid is originally pumped through the pipes, freezing rock it encounters. As the CO_2 liquid descends through the thermosyphons, the liquid turns into a gas. The gas will rise to the surface, where it transforms into a liquid and thus will descend through the thermosyphon once again. This passive, self-sustaining system continuously removes heat from underground and transports cold air below (INAC, 2013; Figure 1-4). This method has been shown to work in the Canadian arctic; for example, Ekati Diamond mine uses this method to maintain frozen dams (INAC, 2018b).

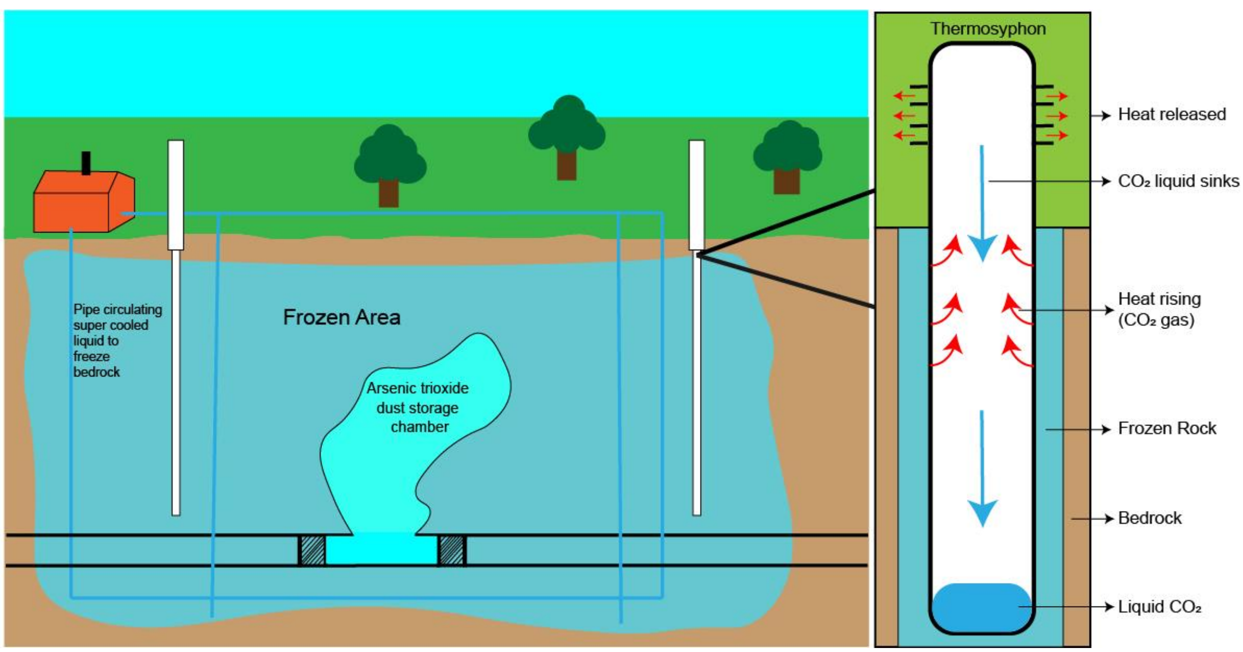

Figure 1-4: Frozen block method for long-term storage of arsenic trioxide dust underground. Red arrows show CO_2 gas heat rising and exiting through the top of the thermosyphons, blue arrows show CO_2 liquid sinking through the thermosyphon. Modified from INAC, 2013.

Several alternative methods for treating the As_2O_3 dust were considered, including pressure oxidation. SRK Consulting (2002) examined the feasibility of either constructing a new autoclave or using the autoclave that was employed at Con Mine as an alternative to treat the As_2O_3 dust and recover gold. Iron is required in the autoclave process so that a stable iron arsenate product can be produced. However, the As_2O_3 dust has little iron content, and therefore an additional iron source would be required (SRK Consulting, 2002). Not only did this increase the cost, the iron would have to be mixed with the As_2O_3 dust prior to treatment. Given the dust is highly toxic and exposure to As_2O_3 is likely to occur through mixing, this method was not selected (SRK Consulting, 2002).

The Giant Mine Oversight Board (GMOB), implemented in 2015 to oversee the remediation of Giant Mine, produced a report on treatment methods for As_2O_3 (GMOB, 2017). The report concluded the frozen block method is the best current method, but more detailed studies may reveal a better long-term solution. The report suggested this may involve a combination of removing the As_2O_3 dust from underground, encasing the dust in glass, cement stabilization, and mineral precipitation. The Mackenzie Valley Environmental Impact Review Board (MVEIRB) approved the frozen block method for a maximum of 100 years (GMOB, 2017). Therefore, research into a long-term solution is still required.

The pH of the tailings at Giant Mine are near neutral, a result of the abundant calcite, dolomite, chlorite, and muscovite (Canam, 2006; Walker, 2006). However, environmental concerns surrounding tailings still exist. Walker et al. (2005) showed the persistence of arsenic bearing iron-oxides derived from roaster emissions on the Giant Mine tailings ponds. Maghemite (γ-Fe_2O_3) was identified as the main iron oxide host in the tailings, containing up to 7 weight percent (wt.%) arsenic (Walker et al., 2005; Walker et al., 2015). Arsenic was identified in two oxidation states: As (III) and As (V) (Walker et al., 2005; Walker et al., 2015). The presence of As (III) in roaster generated iron oxides suggests the oxides are stable in an oxic environment (Walker et al., 2005). A recent study by Bailey (2017) determined the speciation of arsenic in dust generated from tailings. Her findings indicated that As_2O_3 is mostly absent from the dust but other dust particles, such as calcium-iron arsenates, may still pose a risk. Based on community consultation, tailings will be covered with a combination of coarse waste rock and gravel material (INAC, 2018c).

Water treatment on the Giant Mine property actively treats water from the underground mine and surface runoff that has encountered tailings. The water is treated for arsenic and iron removal before it is released back to the environment (INAC, 2007).

1.2.4 Con Mine

1.2.4.1 Geology and Mineralization

Gold ore at Con Mine was found in parallel shear zones hosted in massive and pillow basalts from the Yellowknife Bay Formation (Helmstaedt and Padgham, 1986). Three shear zones host the gold deposits: Campbell Shear, providing much of the gold ore; Con Shear, the first to be developed; and Rycon-Negus shears. The shears zones strike north and dip slightly to the west (Hauser et al., 2006).

The Campbell Shear is estimated to be 2 km thick and over 10 km long, though it has been truncated to the northeast by the West Bay Fault (Hauser et al., 2006). This shear zone contains chlorite-carbonate and sericite-chlorite-carbonate schist zones, all of which are strongly foliated. To the south of the West Bay Fault, the shear zone cuts through the Townsite Formation and extends into the Kamex Formation. In the Campbell Shear, gold is hosted in quartz-ankerite-sericite veins within sericite-ankerite schist. Above the 326 m level in the Campbell Shear, gold is refractory. Below the 326 m level gold is free-milling. As shown in drill core, the change from refractory to free-milling is gradual and random, indicative of two ore forming fluids in two separate events (Hauser et al. 2006). The differences in refractory and free-milling ore is summarized in Table 1-1***:*** *Comparison of free-milling and refractory ore in the Campbell Shear Zone (Armstrong, 1997; Hauser et al., 2006).*.

Table 1-1: Comparison of free-milling and refractory ore in the Campbell Shear Zone (Armstrong, 1997; Hauser et al., 2006).

Category	Free-milling	Refractory
Alteration degree (comparatively)	Less intense	More intense
Alteration mineralogy	Phlogopite and albite	Sodium-rich paragonitic muscovite
Quartz content (comparatively)	High, gold occurs within quartz or at vein margins	Low, quartz occurs in quartz veins and sericite carbonate schist
Sulphide content	1 to 2%	3%
Dominant sulphide mineral	Pyrrhotite	Pyrite and arsenopyrite
Additional sulphide minerals	Arsenopyrite and sulphosalts	Sphalerite, galena, chalcopyrite, and sulphosalts
Relative age	Younger	Older
Depth	Below 326 m below the surface	Above 326 m below the surface

The Con Shear is 35 metres wide, extending one kilometre below the surface. To the south, the shear zone is traced over 10 km in strike length, similar to the Campbell Shear. Shears are strongly foliated, containing chlorite-carbonate and sericite-chlorite-carbonate schist. Gold ore in the Con Shear is refractory, with similar characteristics to the refractory ore found in the Campbell Shear zone. Higher grade ore was constrained to quartz-carbonate veins whereas carbonate-sericite-quartz schist had lower grade ore and higher sulphide content (Hauser et al., 2006).

The Rycon-Negus Shear zones consists of several discontinuous shears, between the Con and Campbell shear zones. The shears are 2 km in strike length and extend 540 metres below the surface. Ore was free-milling, with similar characteristics to the free-milling ore in the Campbell Shear zone.

1.2.4.2 Operational History

Consolidated (Con) Mine is located approximately 2 km south of the Yellowknife downtown area, on the western shore of Yellowknife Bay, and east of Kam Lake. Gold was first discovered on the Con claims in 1935, followed by intense drilling, trenching, prospecting, and the formation of the town of Yellowknife (Moir et al., 2006). In 1937, construction of the C1 shaft into the Con Shear commenced, leading to the first gold bar in the Northwest Territories being poured on September 5, 1938 (Moir et al., 2006). In the first year of production, the mill at Con Mine had a capacity of 100 tonnes of ore per day (Egli and MacPhail, 1978). The following autumn, extra grinding and filtering equipment increased production to 175 tonnes per day (Egli and MacPhail, 1978). Free gold in the Con Shear was quickly depleted and arsenopyrite became the main source of ore. In 1942, an Edwards-type hearth roaster was installed, similar to the one installed seven years later at Giant Mine (Egli and MacPhail, 1978). Roasting was in operation from April to November 1942 when it had to be shut down due to a labour shortage from the war (Moir et al., 2006). With the addition of the roaster, a Hadsel mill, cyanidation, floatation, and filtration equipment, production reached 300 tonnes per day (Egil and MacPhail, 1978). During the war period, production decreased but operations continued, including the deepening of shafts and continued exploration, ultimately leading to the discovery of the Campbell Shear zone and turning Con Mine into a world-class deposit (Moir et al., 2006). Following the end of the war, roasting began again at Con Mine in 1946 (Moir et al., 2006). By the end of 1955, production was increased to 465 tonnes per day due to the replacement of the Hadsel mill by a CAC ball mill (Egil and MacPhail, 1978). Tonnage was increased to 500 tonnes per day in 1956 with additional cyanidation capacity. This output continued until 1966, when capacity decreased to 470 tonnes per day, as the ball mill was taken out of service (Egil and MacPhail, 1978). By 1970, roasting and its related processing equipment was discontinued as free-milling gold became the predominant ore again at greater depths (Egil and MacPhail, 1978). Over this thirty-year period, an estimated 2,500 tonnes of As_2O_3 emissions were produced (Hocking et al., 1978). In 1972 construction of the Robertson Shaft began, which was 1.7 km deep, and the Robertson Headframe, which was 76 m high. The shaft came into use in 1974, allowing for ore extraction to increase in efficiency, expansion of the Campbell Shear zone, and expanded exploration (Moir et al., 2006). By 1984, the shaft was further deepened to 1.9 km.

Cominco sold Con Mine to Nerco in 1986, bringing new investment to mine development and underground exploration. The C1 headframe, originally constructed in 1937, was replaced with metal headframe, increasing capacity to 1,200 tonnes of ore per day (Moir et al., 2006). In addition, one of the first pressure-oxidation (autoclave) treatment of gold ores in Canada was installed. The autoclave was used to extract gold from refractory ore, and to process As_2O_3 bearing waste (MCML, 2007). Nerco sold Con Mine to Miramar Mining in 1993. Miramar continued underground exploration for the next decade;

despite discoveries of gold, economical ore was not found and resulted in the closure of Con Mine. Con Mine operated from 1938 to 2003, with total production from Rycon-Negus, Con, and Campbell shears, was 12,071,642 tonnes at 0.48 ounces of gold per tonne for a total of 5,801,303 ounces of gold.

1.2.4.3 Ore Processing History

The roasting operations employed at Con Mine lasted from 1942 to 1970. Roasting consisted of two heating stages. The first stage was at 500°C under a slightly reducing environment to volatize arsenopyrite, removing As from the ore and producing As_2O_3 gas. The second stage of roasting, at 550°C under an oxidizing environment, converted pyrite to hematite and magnetite (MCML, 2007; Walker et al., 2015). Arsenic trioxide gases were released directly to the environment until 1948 when a baghouse and scrubber were installed (MCML, 2007). It is important to note that Con Mine employed the Edwards-type roaster throughout the roasting operations and did not use fluosoilds roasting. This may have led to less As_2O_3 emissions and different calcine chemistry (Walker et al., 2015).

Ore extracted by hand in underground operations was brought to the surface and passed through a 0.3 m by 0.5 m Traylor jaw crusher (Figure 1-5) (Egil and MacPhail, 1978). The ore was then fed through a Tyrock screen, finer material passing through onto secondary crushing and coarser material sent for re-crushing in a TY gyratory crusher (Egil and MacPhail, 1978). Fine material was stored in a bin before the grinding step, which occurred in a CAC ball mill, 2.4 m by 3.7 m, in closed circuit with 1.8 m Akins Classifier (Egil and MacPhail, 1978). A solution containing cyanide and lime was continuously added to the grinding step. Next, the slurry passed through a wood-chip tromel screen into a distributor, which splits the slurry into three equal bins (Egil and MacPhail, 1978). The slurry was thickened sent to a pregnant-liquor storage tank (Egil and MacPhail, 1978). The waste material, or underflow from the thickening stage, was passed through seven agitators. In between agitator number 3 and 4, the waste was fed through an Oliver drum filter (Egil and MacPhail, 1978). From the final agitator, the slurry passed through a Northern Foundry drum filter and then an Oliver drum filter; washing and repulping occurring at each of these final filtering steps. The waste material was then either sent to underground and used as backfill or sent to tailings ponds. The gold-bearing solution was transferred from the Merrill-Crowe tank to the Perrin presses, where the gold product is precipitated (Egli and MacPhail, 1978).

Pressure oxidation was first researched by Nerco Minerals in 1989 and put into operation by Mirarmir in 1992. Pressure oxidation, often referred to as "autoclave", treated flotation concentrate of refractory ore produced during comminution, crushing, and grinding; the flotation concentrate was mixed with previously stockpiled calcine and As_2O_3 waste products produced from roasting operations before 1970 (MCML, 2007). Mixing was done prior to treatment for two reasons: achieve temperature requirements and maintain an iron to arsenic molar ratio 1.2:1 (MCML, 2007). Acid was added to the mixture as well to neutralize the carbonates (MCML, 2007). The result was a stable iron arsenate, shown by the reaction in Equation 2 (SRK, 2002):

$$2FeS_2 + 8.5O_2 + 6H_2O + As_2O_3 \rightarrow 2FeAsO_4 \cdot 2H_2O + 4H_2SO_4 \qquad \text{Equation 2}$$

The likely stable iron arsenate produced was scorodite and hematite (Fe_2O_3) was also likely produced during the autoclave process (MCML, 2007). Emissions created were captured in a scrubber in a more efficient manner than during roasting operations. Waste products were deposited in tailings ponds; the gold-bearing slurry was leached with cyanide. The autoclave treated 15 tonnes of As_2O_3 waste per day. The autoclave was taken out of service, dismantled and disposed in landfills, after all the As-bearing sludges were treated in 2007 (MCML, 2007).

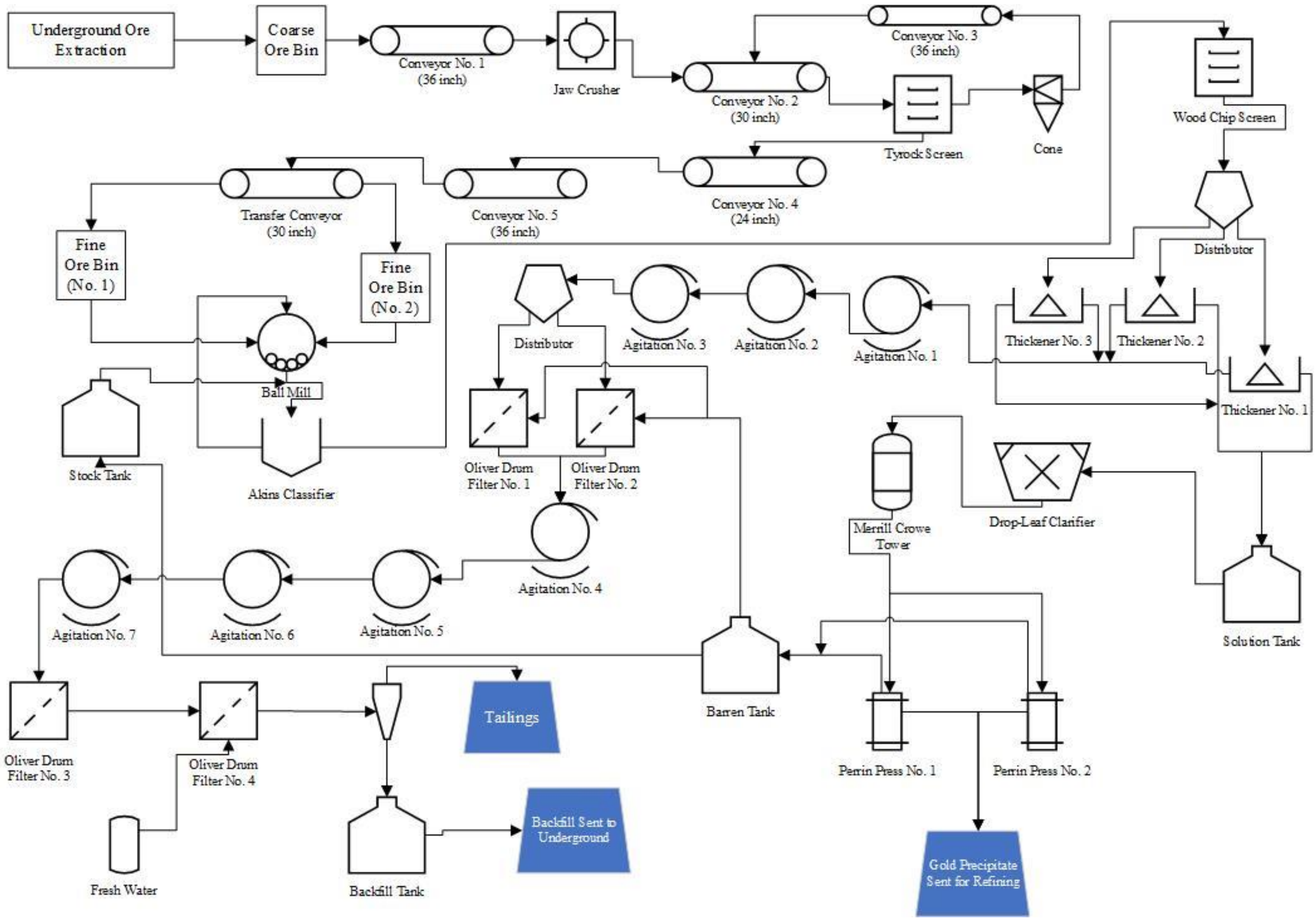

Figure 1-5: Con Mine flowsheet for processing free-milling gold ore (modified after Egil and MacPhail, 1978).

1.2.4.4 Remediation

Research on reclaiming the Con Mine property began in 1995; the final Closure and Reclamation Plan submitted in 2007 was primarily based on these original studies (MCML, 2007); an update on progress of reclamation was provided in 2014 (MNML, 2014). The plan focused 8 areas of reclamation (Table 8). This section will focus on remediation of contaminated soils; the reader is referred to MCML (2007) for a complete description of the list provided in Table 1-2.

Table 1-2: The focus of the Closure and Remediation Plan for Con Mine (MCML, 2007).

Reclamation Areas	Specifics
Site Infrastructure and facilities	• Roberston shaft complex • Mill complex • Blend Plant Facilities and operations • Water treatment plant and operations • On-site housing • Loading dock facilities
Underground	• Backfill operations
Rat Lake Surface Water Drainage	• Rat Lake drainage basin • Rat Lake – Crank Lake surface water drainage
Con Pond and Negus Pond	• Arsenic sludges and calcines • Hazardous sites
Tailing Containment areas	• Chemical characterization of the tailings • Historic deposition • Upper and Middle Pud
Contaminated Soils	• Arsenic contaminated soils
Water Management	• Water Treatment Plant Operations • Surface and groundwater closure remediations plans and issues
On-going Site Monitoring	• Monitoring during closure and post-closure

Remediation of contaminated soils was focused on soils with elevated As; the reclamation plan stated that remediating As contaminated soils will also successfully remediate soils contaminated in other metals, such as copper, nickel, lead, and zinc (MCML, 2007). Remediation was focused on identifying contaminated soil, excavating the soil, and disposing it in a hazardous material disposal area, either off site or in the tailing containment area (MCML, 2007). The remediation plan referred to contaminated soils as any soil-like material, including calcine, sludges, or tailings, not already in the tailings containment area (MCML, 2007). Soils contaminated by hydrocarbons with no As were also removed and disposed in a hazardous material site. Based on recommendations from third party consultants, Health Canada, and the Government of the Northwest Territories, the Closure and Reclamation Plan aimed to remediate soils below 340 mg/kg; this value is also the industrial guideline for As for the Yellowknife area (GNWT, 2003). It should be noted that contaminated soils were identified on the Con Mine property only. Most of soil samples collected off the Con Mine property were below the 340 mg/kg guideline and therefore were not addressed (MCML, 2007).

Remediation of As contaminated soils focused on Zone 3 as defined by MCML (2007), which includes the main mine lease and incorporates the C-1 Mill, Robertson Shaft, the area between the mill and Robertson Shaft, and area around tailings ponds. Only soils with As concentrations above 340 mg/kg were remediated. For soils above 340 mg/kg, a risk-based remediation plan was developed based on GNWT, 2003. The soils focused on for remediation were used to cover tailings ponds. Soils near or above 340 mg/kg were used in direct contact with the tailings ponds, as a "lower layer"; soils below 340 mg/kg were used as a middle and upper layer cover (MCML, 2007). Soil remediated was up to 1 metre in depth (MCML, 2007). According to the Closure and Reclamation Plan, As contamination on site was either from roaster emissions, windblown dust particles, or spills from the Blend Plant. Thus, the Closure and Reclamation Plan did not anticipate As contamination at a greater depth of 1 metre (MCML, 2007).

1.3 Thesis structure

Chapter 2 provides a literature review of arsenic behaviour in soil environments of this thesis. Chapter 3 presents methods employed for this research, including field, bulk geochemistry, speciation, and data analysis. Chapter 4 presents the results and a discussion on arsenic in the PHL, including controlling factors, evidence for a signature in contamination from Giant and Con Mine roasting, and distinguishing geogenic and anthropogenic arsenic. Chapter 5 provides an overview of conclusions from this study, implications of this work, and recommendations for future work.

Chapter 2

Literature Review

2.1 Characteristics of Arsenic

Arsenic is a metalloid, residing in group 15 on the periodic table (IUPAC, 2018). Arsenic is widely distributed throughout Earth's crust, appearing in over 568 minerals and is the 47th most abundant element (Bowell et al., 2014). Common arsenic minerals are listed in Table 2-1. Average As concentration in the upper continental crust is 5.7 mg/kg and higher in zones associated with hydrothermal ore deposits (Hu and Gao, 2008; Bowell et al., 2014). Arsenic is a chalcophile element and portrays typical chalcophile behaviors, including released by sulphide oxidation, adsorbs and precipitates with iron minerals, clays and organic matter, and modified by biogeochemical processes (Bowell et al., 2014). Arsenic exists in several oxidation states: As (+V), As (+III), As(+II), As (0), As (-I), and As (-III) (Plant et al., 2014). Arsenic (+V) and arsenic (+III) species are able to substitute for P (V), Si (IV), Al (III), Fe (III), and Ti (IV) in several mineral structures. Arsenic can therefore appear in many minerals and accumulate in plant tissues (Bowell et al., 2014).

The electron configuration of arsenic is $[Ar]3d^{10}4s^{2}4p_x^{1}4p_y^{1}4p_z^{1}$; this structure has 5 valence electrons available for chemical bonding and empty *p* orbitals available for electrons to fill (O'Day, 2006). Arsenic readily bonds to an assortment of ligands resulting in metal arsenides species in an electronegative state (e.g. domeykite [Cu_3As], nickeline [NiAs], and safflorite [$CoAs_2$]) and oxo-anions species in an electropositive state (e.g. H_3AsO_3 and H_3AsO_4) (O'Day, 2006). Arsenic most often forms covalent bonds with sulphur and oxygen (O'Day, 2006). A list of arsenic properties is presented in Table 2-2.

Arsenic is still used in production of glass, as an alloy, pigments, textiles, metal adhesives, ammunition, and as a wood preservative (WHO, 2017). Historically, arsenic has been used as a poison in warfare and domestic disputes, pigmentation for paints and wallpaper, curative, and pyrotechnics (O'Day, 2006).

Arsenic is known to have toxic effects to humans, including cancer, deformities, DNA damage, and death (Bissen and Frimmel, 2003; Plumlee and Morman, 2011). It also crucial for survival of many organisms (Oremland and Stolz, 2003). Therefore, understanding the speciation and mobility of arsenic becomes critically important. A common term to describe toxicity is bioaccessibility, which measures how easily a toxic substance is released into the body's fluids and available for uptake (Plumlee and Morman, 2011). Plumlee and Morman (2011) list the following arsenic substances from highly toxic, to least toxic: calcium iron arsenate, lead arsenate, arsenic trioxide > amorphous iron arsenates, arsenic-bearing iron-(oxy)hydroxides > arsenic-rich pyrite and simple arsenic sulphides > arsenopyrite, and scorodite. Many of these arsenic species are present in waste from ore processing, such as arsenic trioxide, arsenopyrite, arsenic-bearing iron-(oxy)-hydroxides, and scorodite (Walker et al., 2009). Therefore, if mining companies do not implement measures to capture arsenic during processing, toxic arsenic species can be released to the environment through smelter emissions or tailings drainage.

Table 2-1: Selected common arsenic-bearing minerals (Craw and Bowell, 2014; Nazari et al., 2016).

Mineral Name	Chemical Formula	Arsenic Oxidation State
Arsenopyrite	$FeAsS$	-1
Cobaltite	$CoAsS$	-1
Gersdorffite	$NiAsS$	-1
Pyrite/arsenian pyrite	FeS_2 /$Fe(As,S)_2$	-1
Enargite	Cu_3AsS_4	-1
Realgar	AsS	+2
Arsenolite	As_2O_3	+3
Claudite	As_2O_3	+3
Leiteite	$ZnAs_2O_4$	+3
Orpiment	As_2S_3	+3
Proustite	Ag_3AsS_3	+3
Trippkeite	$CuAs_2O_4$	+3
Austinite	$CaZnAsO_4OH$	+5
Conichalcite	$CaCuAsO_4OH$	+5
Erythrite	$Co_3(AsO_4)_2 \cdot 8H_2O$	+5
Oliverite	$Cu_2(AsO_4)OH$	+5
Scorodite	$FeAsO_4 \cdot 2H2O$	+5

Table 2-2: Physical properties of arsenic (Nazari et al., 2016).

Property	Value	Unit
Atomic number	33	
Atomic weight	74.92	Grams
Density (metallic arsenic)	5.72	g/cm3
Density (yellow arsenic)	2.03	g/cm3
Melting point at 3.7 MPa	817	°C
Boiling point at 0.1 MPa	613	°C
Heat of fusion	370.3	Kj/kg
Heat of vaporization	426.77	Kj/kg
Linear coefficient of thermal expansion	5.6 x 10-6	1/K
Specific heat at 25°C	328	J/(kg·K)
Electrical resistivity at 0°C	26x10-6	Ω.cm

2.2 Arsenic Production in Roasting Operations

Arsenic is an important constituent of several kind of ore deposits (Cohen and Bowell, 2014). If arsenic is retained in the ore through processing, the economic value of the commodity is lowered. Thus, mining operations attempt to remove arsenic early in the treatment process. Since arsenic is a volatile element and therefore many arsenic oxides and sulphides are volatile as well, roasting is a common practice to remove the arsenic (Chakraborti and Lynch, 1983). Roasting creates two arsenic processes: production of arsenic vapours and reaction of arsenic vapours with other mineral-bearing vapours, such as iron oxides (Chakraborti and Lynch, 1983). Arsenic vaporizes in four forms: As_4, As_3, As_2, and As (Chakraborti and Lynch, 1983). Many conditions influence the arsenic vapour concentrations, as well as other minerals, including roasting temperature, pressure, reducing/oxidizing conditions, grain size, duration of roasting, and composition of roasting (Chakraborti and Lynch, 1983).

Only two solid oxides exist and only one is found in the vapour state. The trioxide, As_2O_3, exists in two crystalline polymorphic forms: arsenolite is the most common, and the other is claudetite. Transition between these two forms does not readily occur, and most investigators have examined the properties of arsenolite as it is stable over a much broader temperature range. The other solid oxide species is the pentoxide As_2O_5. The pentoxide, a more stable solid existing at temperatures well above the normal boiling point of the trioxide, decomposes at approximately 1,000K forming As_2O_3 vapour and O_2.

At P_{O_2} values above 10^{-21} atm at 798 K, or at P_{O_2} values greater than 10^{-15} at 973 K, As_2O_3 is the major vapour species and $P^{As\text{-}O}_T$ can be approximated as $P_{As_2O_3}$

Chakraborti and Lynch (1983) conducted a thermodynamic study on arsenopyrite and revealed three main conclusions. First, as temperature is increased, removal of arsenic increased (Figure 2-1). However, if the temperature is increased too high, the partial pressure of oxygen is also increased, limiting arsenic removal (Figure 2-1). Second, arsenopyrite grains of -200 mesh roast in half the time as those grains of -115 mesh size. Finally, an oxidizing environment resulted in the greatest removal of arsenic from arsenopyrite-bearing ore.

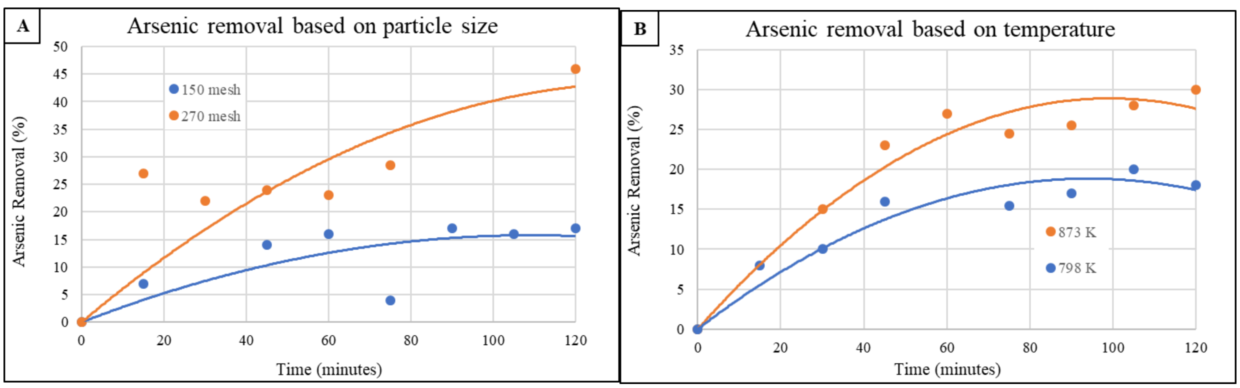

Figure 2-1: Arsenic removal based on mesh size (A) and temperature (B). Figures are based on data presented in Chakraborti and Lynch (1983). Experiments conducted for arsenic removal based on particle size was completed at 798 K and $Pco_2/Pco = 20$. Experiments conducted for arsenic removal based on temperature was completed with a particle size of 200 mesh and $Pco_2/Pco = 50$. Both experiments used natural arsenopyrite.

2.3 Arsenic in the Environment

Arsenic speciation in the environment is primarily controlled by the redox potential (E_h) and the pH of the system. Each species of As has different behaviors, such as mobility and toxicity. The mobility of As must be understood to predict whether As will be harmful to the environment and distinguishing anthropogenic As from and geogenic As.

Arsenic mobility is dependent on several factors, including pH, redox potential, biological activity, particles on which arsenic can adsorb, weathering reactions, and volcanic emissions (Bissen and

Frimmel, 2003; DeSisto, 2008; Bowell et al., 2014). With respect to soil, mobility of As refers to how effectively As moves through the soil column by converting from one species to another. Properties of soil change with depth, such as the redox potential, pH, and dissolved oxygen. Redox potential is the measure of the tendency of a species to acquire electrons and thus become reduced. The pH is the measure of hydrogen ions activity, indicating if the media is acidic or alkaline. Dissolved oxygen is the amount of oxygen in the media column. The redox potential and pH of the system not only controls the arsenic speciation, but the concentration as well. Figure 2-2 shows a redox potential (pe) - pH stability diagram for aqueous and solid arsenic species with iron. At acidic (pH ~4 to 5) and oxidizing conditions (pe >10), scorodite is the dominant arsenic species. At neutral to alkaline (pH ~7 to 10) and slightly reducing conditions ferrous arsenate is the dominant arsenic species. At reducing conditions across all pH, arsenopyrite is the dominant species. Bissen and Frimmel (2003) note As (V) forms stronger adsorption bonds and thus less mobile than As (III). Arsenic preferentially adsorbs to oxides and hydroxides of iron, manganese, and aluminum, as well as particles of calcium, magnesium, organic matter, and clay minerals in soils (Bissen and Frimmel, 2003; Fendorf et al., 2010).

Ascar et al. (2008) show at a redox condition of 200mV and a pH of 6.7, at room temperature, As (V) adsorbed to the surfaces of iron and aluminum oxides, and that arsenate was the sole arsenic species present. Under reducing conditions (-200mV), arsenic was in the arsenite form. However, the authors noted As (V) was still present under these conditions. Therefore, an additional process was controlling the transition from As (V) to As (III). Ascar et al. (2008) added biosolids rich in sulphur to their experiment, decreasing the inorganic arsenic species and solubility. The formation of arsenic-sulphides then dominated (realgar, AsS, and orpiment, As_2S). Increase in insoluble arsenic species was observed with increase in redox potential. The conversion of As sulphides and slow conversion of As (V) and As (III) are suggested to be a result of microbiological activity. They concluded that the pH and redox potential controlled the solubility of As: solubility and mobility was high under reducing conditions and decreased as the redox potential increased. Further, they concluded the highest organic As species was found under reducing conditions, indicating methylated species effectively increased the rate of conversion of As (V) to As (III). Bissen and Frimmel (2003) note As compounds adsorb to humic material in soils. Humic soil material can create reducing conditions if pores in the humus become saturated with water. Given the information presented above provided by Ascar et al. (2008), mobility of As (V) and As (III) will therefore increase under reducing conditions and there is potential for the leaching of arsenic deeper into the soil column.

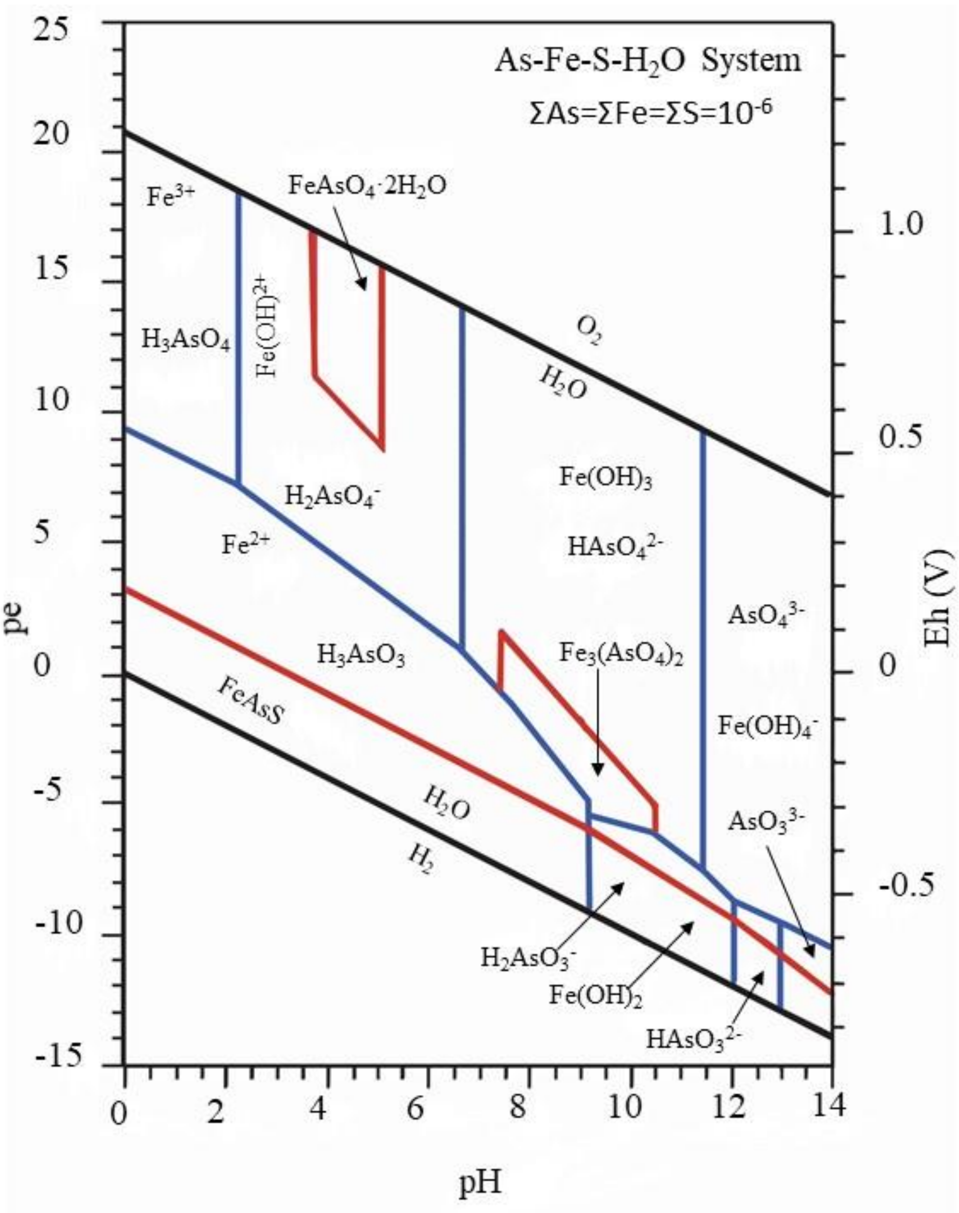

Figure 2-2: Eh-pH diagram for the As-Fe-S-H_2O system at 25°C. Aqueous species are outlined in blue and solids in black (modified from Zhu and Merkel, 2001).

2.4 Arsenic in Mineral Exploration

Anomalous As concentrations have been used as an indicator mineral for gold deposits, including orogenic lode gold in the Yellowknife area (Kerr, 2006) and Carlin type gold in Nevada (Theodore et al., 2003). While arsenic can be used as an indicator for gold deposits, it is important to note, however, the absence of arsenic does not indicate the absence of gold mineralization. Several known deposits, including the Deer Cove and Stog'er Tight gold deposits on the Baie Verte Peninsula in Newfoundland and Labrador, are associated with pyrite and have a distinct lack of arsenic (Patey and Wilton, 1993; Ramezani et al., 2000).

Kerr (2006) showed that despite the legacy of airborne contamination in soil, arsenic can be used to identify halos of mineralization in the Yellowknife area. Arsenic concentrations in the humus layer, along with gold and antimony, were reported to be significantly higher than in the mineral soil. Recent studies have highlighted that roaster oxide emissions from Giant and Con mines have persisted in the region (Palmer et al., 2015; Bromstad et al, 2017; Schuh et al., 2018). Therefore, the elevated values can be attributed to this contamination source. Kerr (2006) notes, however, samples collected in the direction opposite to the predominant wind show slightly elevated Au and As, which are inferred to be geogenic in source as opposed to anthropogenic. Furthermore, in till samples collected near known gold deposits, the highest Au and As values are reported in samples underlain by volcanic rock directly associated with the deposit (Kerr, 2006). Mineralization in the Yellowknife greenstone belt influences the Au and As till concentrations and thus, As in till can be an effective exploration tool (Kerr, 2006). It is crucial to account for ice flow history, especially in Canada given much of the country was covered in ice until approximately 10,000 years ago, when interpreting geochemical data. Kerr (2006) highlighted that detailed reconstruction of ice-flow history is vital because till material can be transported up to hundreds of kilometres. While pathfinder elements such as arsenic can still be used, if it is not identified that the source of the pathfinder elements is from some distance away, rather than a local source, major mistakes can be made including not identifying the deposit. Parsons and Little (2015) showed that glacial transport was a main factor in the dispersion of arsenic in the B and C soil horizons downstream of known gold deposits in Nova Scotia. Their results indicate that arsenic was remobilized from soil-forming processes, leading to elevated arsenic in the B and C soil horizons (Parsons and Little, 2015). Thus, in-depth knowledge of local ice-flow history and arsenic soil concentrations can be a valuable tool in gold exploration.

Nevada is home to many Carlin-type gold deposits. Carlin-type gold deposits are defined by sedimentary hosted, often silty carbonates, high angle faults related to tectonic doming of autochthonous rocks, 200 - 300°C ore formation, low salinity, high carbon dioxide and high hydrogen sulphide fluids (Berger and Bagby, 1991). In the Carlin-type gold of the Nevada region, Paleozoic to early Mesozoic sediments have been affected by three orogenic events: Antler Thrust, Permian Sonoma Thrust, and late Jurassic to Cretacous thrusting. The gold mineralization in the northern part of the Carlin Trend was associated with multiple igneous dyke swarms (Theodore et al., 2003). The dykes provided a pathway for fluids bearing gold. The gold was sub-microscopic, encapsulated in pyrite, arsenic-rich pyrite, and arsenopyrite grains (Berger and Bagby, 1991). In the Nevada Carlin district, arsenic was used in stream sediments as a pathfinder element for deposits (Theodore et al., 2003). Elevated arsenic concentrations were shown to correlate with sedimentary hosted gold-silver deposits. Arsenic was present in several forms, including rims on pyrite grains, arsenopyrite in carbonate veins, and arsenopyrite layering on top of pyrite grains (Theodore et al., 2003). Scanning electron microscope and bulk XANES analysis determined arsenic was present as (V). The As (V) was found associated with gibbsite, amphorous aluminum oxy-hydroxides, and aluminum bearing clay (Theodore et al., 2003). The As (V) grains were determined to be of the light fraction. The authours were therefore able to determine the As (V) grains originated from siliceous rocks hosting the gold deposit (Theodore et al. (2003). Thus, Theodore et al. (2003) concludes that arsenic is the best pathfinder element for a Carlin-type system, in stream sediments or other media. Stream sediments show, on a regional scale, elevated arsenic concentrations; rock samples that cross-cut the deposit are elevated in arsenic compared to rock samples from unmineralized areas.

In the early 1980's to the mid 1990's, one till sample was collected every 4 square kilometres across Finland (Salminen, 1995). The ambitious project led to an anomaly, which led to collection of 4,640 samples over 16,000 km^2 (Salminen, 1995). Further follow-up sampling led two distinct anomalies, which were drilled, trench, and ultimately discovering gold-bearing arsenopyrite veins (Salminen, 1995). While the discovery was not economic, it is important to highlight that elevated arsenic concentrations pinpointed exactly where to drill and trench (Reimann et al., 2009).

2.5 Natural Sources of Arsenic

Arsenic is prevalent in the natural environment, with highest concentrations occurring near hydrothermal ore deposits because it is highly volatile (Reimann et al., 2009; Plant et al., 2014). In sulphide minerals, arsenic concentrations have been reported as high as 100,000 mg/kg and 76,000 mg/kg in iron oxide minerals. In most instances, however, arsenic concentrations are much lower (Plant et al., 2014). In igneous and metamorphic rocks, arsenic typically ranges from 1 to 10 mg/kg (Plant et al., 2014). Sedimentary rocks range from 20 to 200 mg/kg (Plant et al., 2014). In soils, arsenic concentrations are highest in organic-rich soils, average of 13 mg/kg, as a result of the presence of sulphide minerals (Plant et al., 2014). Soils can vary quite drastically in arsenic concentrations (Ross et al., 2007) because of several reasons, including arsenic use as a pesticide/herbicide, contamination from air emissions, and natural weathering of bedrock (Plant et al., 2014). The aquatic environment varies to a greater degree than observed in soils, ranging from 0.013 to 16 µg/L in rain water, <0.2 to 21,800 µg/L in river water, 0.06 to 9.2 mg/kg in uncontaminated lake water, 35 to 530 mg/kg in lake water influence by mining activities recorded in Canada (Plant et al., 2014). Seawater ranges from 0.5 to 3.7 mg/kg and groundwater ranges from below detection limit to 3,200 mg/kg in Bangladesh and 5,300 mg/kg in Argentina (Plant et al., 2014).

The arsenic cycle begins in the lithosphere, where much of the Earth's arsenic resides (Figure 2-3). Arsenic is released from the lithosphere through volcanic eruptions, weathering of rocks, geothermal release, and mining activities (Bowell et al., 2014). Arsenic enters the atmosphere primarily through volcanic activity, emissions, and forest fires. Arsenic is returned to the surface through precipitation. Anthropogenic emissions result in 25,000 tonnes per year, while precipitation results almost an equal amount, between 22,000 to 75,000 tonnes per year (Matschullat, 2000). Some terrestrial plants accumulate arsenic, but uptake is varied from species to species (Bowell et al., 2014). Arsenic is transferred to the hydrosphere from anthropogenic emissions and discharge, and from leaching of uncontaminated soils. Arsenic is returned to the lithosphere through subduction and sedimentation on the ocean floor. One short-coming with the diagram presented in Figure 2-3 is the absence of hydrothermal activity, such as Yellowstone National Park, which has been recorded as releasing arsenic to the atmosphere (Planer-Friedrich, 2004; Planer-Friedrich et al., 2006).

Many ore deposits are associated with arsenic, including volcanic massive sulphide (Hannington, 2014), sedimentary exhalative deposits (Goodfellow and Lydon, 2007), Mississippi valley-type deposits (Paradis et al., 2007), porphyry copper deposits (Cooke et al., 2014), epithermal gold deposits (Taylor, 2007), magmatic nickel (Eckstrand and Hulbert, 2007), among others. Here, the focus will be on greenstone belt quartz-carbonate (GSB) deposits. GSB deposits have also been referred to as orogenic lode gold, mesothermal gold, and shear zone related quartz-carbonate gold (Dubé and Gosselin, 2007).

Dubé and Gosselin (2007) describe this deposit-type as forming in greenstone belt terrane at a depth of five to ten kilometres, greenschist and amphibolite facies metamorphism, mafic to ultramafic host rocks, and significant faulting and shearing. Gold is often found in these terranes, such as the Archean Abitibi and Yellowknife greenstone belts and Paleozoic greenstone terrane in the Newfoundland Appalachian Mountains (Dubé and Gosselin, 2007). The mafic to ultramafic host rocks are an important component for this deposit because iron is required to facilitate precipitation of gold. Host rocks generally have been dominantly influenced by faulting and shearing. These faults and shears zones are associated with compression, or mountain-building events (Dubé and Gosselin, 2007). Veins, typically composed of quartz and/or carbonates (dolomite and calcite), fill in the faults and fractures. Gold is transported in quartz-carbonate rich hydrothermal fluids as a bisulphide complex (Groves et al., 2003; Dubé and

Gosselin, 2007). Since the fluids carrying gold are passing through faults and fractures, deposits are generally confined to this area. Thus, GSB deposits are structurally controlled (Dubé and Gosselin, 2007). Therefore, without the faults or fractures providing conduits for hydrothermal fluid, there would be no deposit. Mikcuki (1998) explained the deposition of gold by:

$$FeO + Au(HS)^{2-} \Leftrightarrow Au + FeS_2 + H_2O \qquad \textit{Reaction 2}$$

$$FeS + FeO + Au(HS)_2^- + As(OH)_3 + H_2S + 3H^+ + 2e^- \rightarrow Au^0 + FeS_2 + Fe(Au?)AsS + H_2S + 4H_2O \qquad \textit{Reaction 3}$$

Iron comes from the host rock and leaches out the sulphur that is transporting the gold, explaining why the deposits are commonly found with pyrite (Patey and Wilton, 1993; Dubé and Gosselin, 2007). In some deposits, such as the Giant and Con mine gold deposits, the gold is associated with arsenopyrite (Reaction 3; Ootes et al., 2011). As described by Armstrong, (1997), the gold can be incorporated into the structure of arsenopyrite, known as refractory. Refractory gold causes challenges in releasing the gold from the arsenopyrite, which results in the release of arsenic.

Although anthropogenic arsenic contamination has a profound impact on the environment (Section 2.6), natural sources of arsenic can have much more deadly impact. Bangladesh had a lack of fresh drinking water supply which was resulting in high mortality rates. To combat this issue, UNICEF and other organizations installed groundwater wells in the 1970's. Water quality tests of these wells did not include arsenic as one of the parameters analyzed. Years later, residents of Bangladesh began getting deformities and illnesses, and mortality rates drastically increased. It was not until 1990's that it was realized the groundwater wells were naturally high in arsenic, putting the Bangladesh population of 50 million at risk to arsenic poisoning (UNICEF, 2011). The aquifers supplying the groundwater wells are in reducing conditions, resulting in the mobilization of arsenic that is leached from the surrounding sedimentary rocks (Bowell et al., 2014). Twenty million people are still reported to be drinking water elevated in arsenic because there is no other drinking water source (UNICEF, 2011).

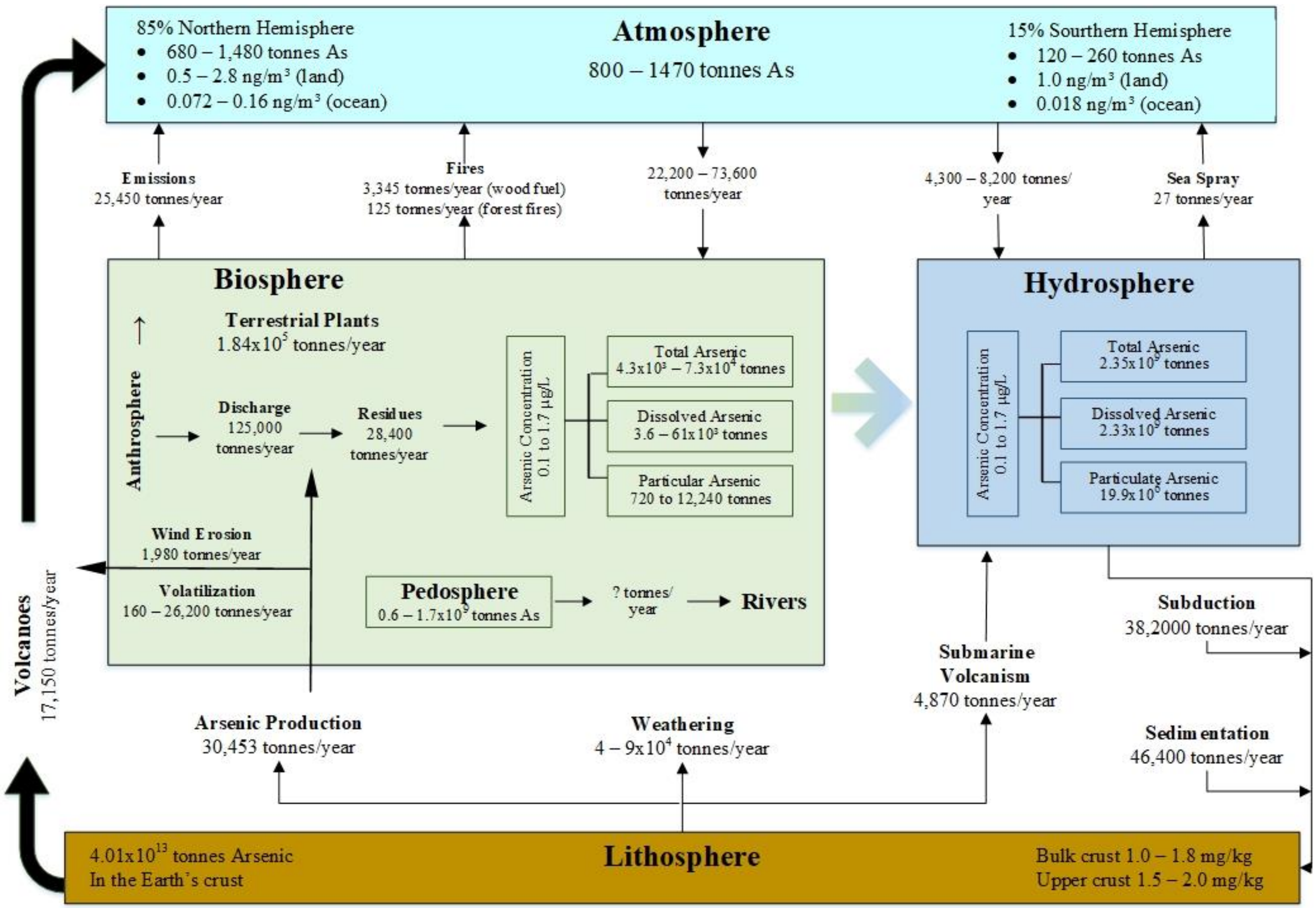

Figure 2-3: Global arsenic cycle (taken from Bowell et al., 2014, which modified from Matschullat (2000) and Zhu et al., 2014).

Attesting to natural processes affecting the arsenic soil concentration is a soil study done in Europe (Salminen et al., 2005). Figure 2-4 shows the arsenic concentrations in topsoil (0 to 20 cm) from samples collected for the continent-wide study. There is an obvious distinction of low arsenic in the northern countries (Norway, Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Denmark, and parts of Germany) and the southern countries (Portugal, Spain, France, England, Scotland, Ireland, Italy, Austria, Croatia, Slovakia, and Czech Republic). This boundary coincides with the extent of glaciation during the last ice age in central Europe; thus, the younger soils of the northern regions have less arsenic while the older, and more weathered soils of the south, have higher arsenic concentrations (Salminen et al., 2005).

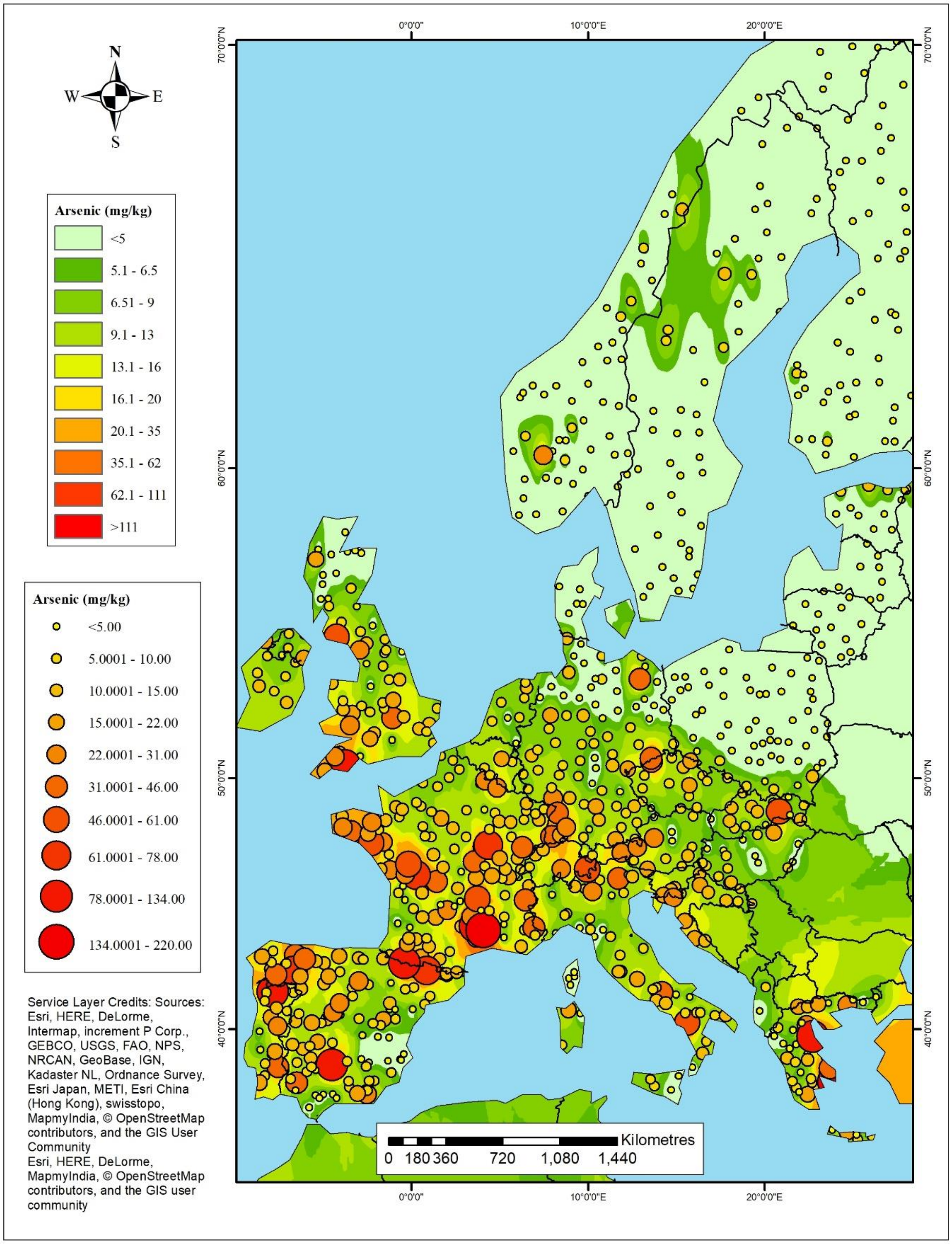

Figure 2-4: Arsenic in topsoil (0 to 20 cm) across Europe. Data from The Geochemical Atlas of Europe (Salminen et al., 2005); copyright © 2005 the Association of the Geological Surveys of The European Union (EuroGeoSurveys)/ the Geological Survey of Finland. Note, data is not available for Belarus, Ukraine, Russia, Moldova, Romania, Serbia, Bosnia and Herzegovina, Montenegro, Kosovo, Macedonia, Bulgaria, Turkey, Morocco, Algeria, and Tusnia.

2.6 Arsenic Contamination from Anthropogenic Sources

Anthropogenic sources of As include roasting of copper and gold ores, burning coal and oil, leaching of tailings, and application of pesticides and herbicides (Bowell et al., 2014). As described above, GSB deposits often have arsenic associated with the gold. Thus, arsenic can lead to environmental issues when extracting the gold. Fortunately, carbonate concentrations are often elevated, with the overall sulphide content low, limiting production acid rock drainage (Dubé and Gosselin, 2007; Desbarats et al., 2015). Arsenic has been noted to be an issue in neutral drainage from mine waste, forcing many mining operations to proactively remove arsenic before it enters the waste stream (Jamieson, 2014). Roasting is the main method to remove arsenic from the ore concentrate and prevent arsenic in waste streams. However, roasting arsenic-rich ore generates arsenic-bearing emissions. For example, roasting of gold ore at Giant Mine in the 1950's resulted in 7,500 tonnes per year of As_2O_3 emissions. Even by the 1990's with stricter regulations in place, 4 tonnes per year of As_2O_3 were still being emitted. The result was a persisting legacy of arsenic contamination from 60 years of mining.

Air dispersion modelling done in the early 1990's, centred around the roaster at Giant Mine, showed that despite emission controls in place, hourly and daily guidelines were regularly exceeded (Dillon, 1995). Further, the model showed that while sulphur dioxide emissions were spread evenly in all directions up to 5 km away, total arsenic emissions were highest to the north and south up to 3 km away, while in the east and west directions maximum concentrations were 2.5 km away. Thus, the aerial extent produced an elongated circular shape (Figure 2-5). Dillon (1995) suggested that the elongated shape was a result of inconsistent exit velocity from the roaster stack and dispersion mixing in the atmosphere. This built on previous work and provided further evidence that arsenic contamination occurred beyond the mine property boundaries.

Previous studies completed in the Yellowknife area on soils and vegetation showed arsenic concentrations highest in the near surface soils and closest to the Giant and Con min roasters (Hocking., 1978; Hutchinson et al., 1982). Additionally, arsenic concentrations decreased in the soil column and with increasing distance from the roasters. The elevated arsenic concentrations in the near surface soil suggest a source from the atmosphere (Hutchinson et al., 1982). Diversity of vegetation was minimal closest to roasters, suggesting only species tolerant to emission contamination could grow. Diversity of vegetation increased with increasing distance from the two roasters (Hocking et al., 1978; Hutchinson et al., 1982). Similar to Dillon (1995), arsenic contamination was observed farther north and south than east and west (Hocking et al., 1978; Hutchinson et al., 1982). In addition, Hutchinson et al. (1982) concluded that vegetation near the mine properties were taking up arsenic through their roots. The proximity of the highest arsenic concentrations to the roasters suggests contamination is from particulate fallout (Hocking et al., 1978). Coarser particulate deposit closest to the roasters while fine particulate travel farther distances (Wallace and Hobbs, 2006). Thus, while the bulk of contamination is close to the two point sources (Giant and Con mines), contamination can potentially be observed tens to hundreds of kilometres away. Since Giant Mine roasted ore for a longer period, arsenic from Giant has been the focus of many studies. However, Hocking et al. (1978) report the contribution of contamination from Con Mine is about one third that of Giant Mine, implying that Con provides a significant source of arsenic contamination.

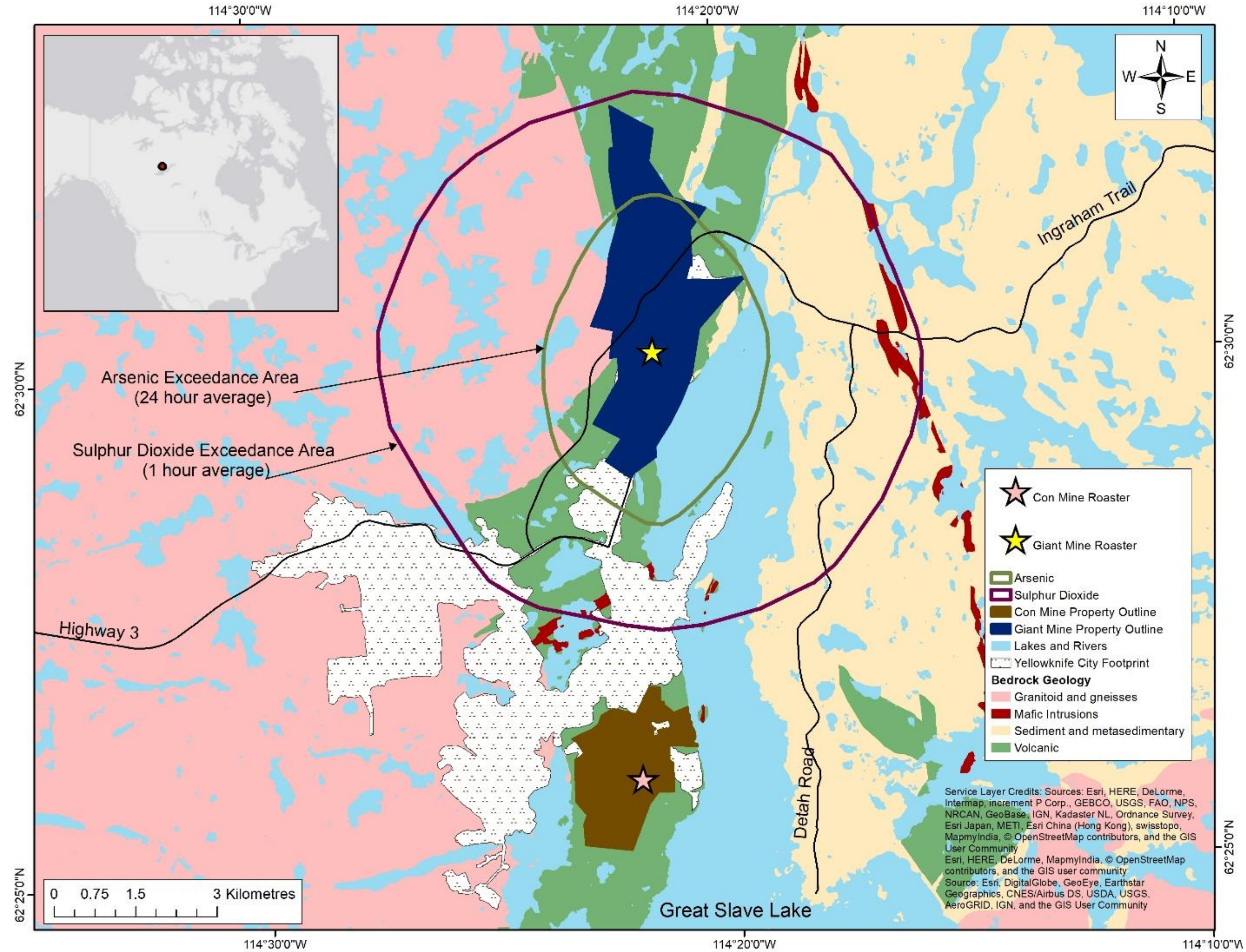

Figure 2-5: Predicted extreme maximum of total arsenic and sulphur dioxide emissions. For arsenic, the area extends 3 km to the north and south and 2.5 km to the east and west. For sulphur dioxide, the area of influence is circular with a 5 km radius. Modified after Dillon, 1995.

Geochemical mapping at local and regional scales have been shown to be an effective method at delineating arsenic contaminated areas from natural arsenic (Reimann et al., 2009). While this technique creates “hot-spots” of arsenic concentrations (Figure 2-4), arsenic distribution is a result of a multiple processes. To clearly establish arsenic contamination, or to use arsenic as an indicator, a high-density of samples are required (Reimann et al., 2009). For example, the Walchen Valley of Austria is home to former ore roasting of sulphide ores. Eight B-horizon soil samples collected for every square kilometre in an effort document the environmental impact of anthropogenic activity and determine the likelihood of another deposit. Although geochemical mapping could determine that soils near by were impacted by roasting, it could not be determined which areas at farther distances were impacted by roasting or naturally elevated in arsenic (Reimann et al., 2009). Additionally, a soil sample survey conducted in and surrounding Berlin showed elevated concentrations (average of 63.4 mg/kg) near a former steel mill (Reimann et al., 2014). The arsenic concentrations drastically decrease (~2 mg/kg) within one kilometre while areas farther away from the mill were slightly elevated (Reimann et al., 2014). Thus, while the former steel mill was one source of contamination, other processes affecting the arsenic soil concentration have an impact.

Chapter 3

Field and Analytical Methods

3.1 Field Methods

3.1.1 Field Sampling Locations

Soil sampling was conducted in two field seasons: July 17 to August 26, 2016, and August 14 to August 18, 2017. Over the course of the two field seasons, 311 soil samples were collected within a 30-km radius of the City of Yellowknife (Figure 3-1). Samples were collected in undisturbed locations from three terrain units within several target areas. Locations were determined undisturbed if there was no visible human impact. For example, samples were not collected near constructions sites, areas affected by industrial activity, or near residences. Target sites were chosen for three reasons: distance from former roasting operations, direction from roasters in relation to prevailing wind direction, and to achieve adequate coverage of the study area in relation to previous research sampling locations.

Two high-density sampling areas were completed during the 2016 sampling season along the Bypass Road to explore local scale variability (Figure 3-1). One area was near Fred Henne Territorial Park, approximately 4 km from the Giant Mine roaster, and the second was directly west of Giant Mine, within 2 km of the roaster.

Samples were collected from three terrain units: outcrop, forest canopy outcrop, and forest. Outcrop samples were collected mainly at higher elevations, in soil pockets atop of outcrops, and on outcrop slopes. Often, small shrubs and grasses were present but there was limited to no canopy cover (Figure 3-2). Forest-outcrop samples had moderate to significant canopy cover with outcrop present. These samples were mostly collected on the slopes of outcrops, approaching topographic lows (Figure 3-3). Forested samples were collected in dense forest with significant canopy cover and no outcrop present (Figure 3-4).

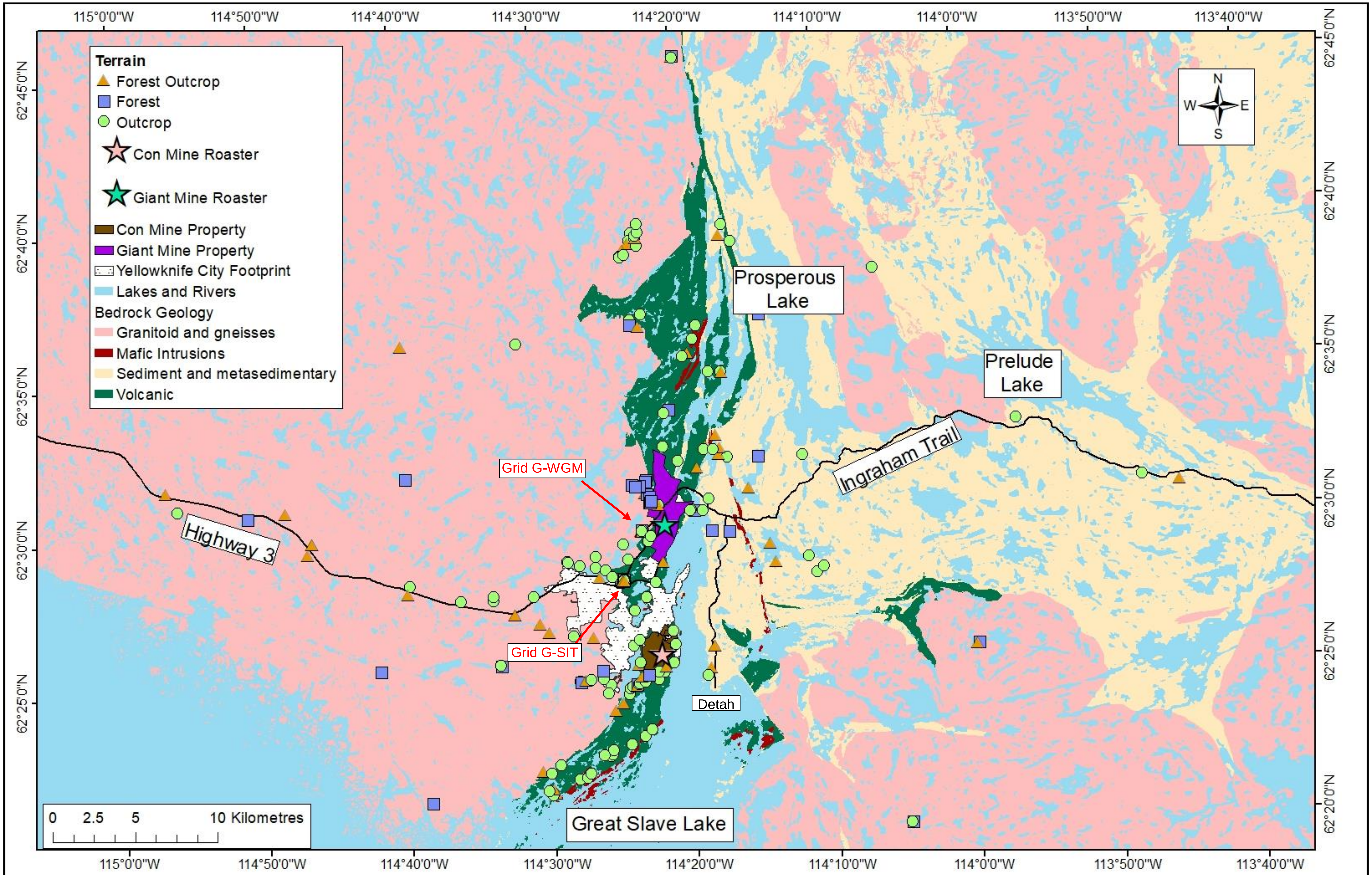

Figure 3-1: Location of soil samples collected in 2016 and 2017.

Figure 3-2: Example of outcrop sample; location is along the Bypass Road, sample ID YK-13.

Figure 3-3: Example of forest canopy outcrop soil; location is south of Gar Lake, sample ID YK-16.

Figure 3-4: Example of forest canopy sample; location is North of Giant Mine property, near Vee Lake, sample ID YK-70.

3.1.2 Field Methods

Soil samples were collected in aluminum core tubes, with an outside diameter of 5.1 cm and inside diameter of 4.9 cm. Cores, ranging in length from 5 to 30 cm, were driven into the ground using a 4.5 kg lead weight. A trowel was used to dig around the outside of the core once it was in the ground. This allowed for easy extraction and limited the loss of soil material from the bottom of the core. Parafilm was wrapped around the bottom of the core, followed by duct tape. The top of the core was cut with a pipe cutter to as close as the top of the soil surface as possible. The top of the core was then covered with parafilm and duct tape. The site name was written on the sample with an arrow indicating the top of the soil surface. Soil sampling equipment was cleaned with water and paper towel between each site. After the sample was collected, a field data sheet was filled out (Figure 3-5). Data recorded on the field data sheets is presented in Appendix A. A tracking sheet was used to keep track of samples collected and analysis completed (Appendix B).

Date:			/2016		TOC to (cm):		Length/Depth (cm):	
Sampler	Sample ID	Location & Elevation	Coords's	Type	TOS	SS	Core	Sample
JO RS			N W	OSC FCOSC FCSC FENC				
Soil Colour		Soil Texture						
QA/QC?	Yes No	WU?	Comments					
JO RS			N W	OSC FCOSC FCSC FENC				
Soil Colour		Soil Texture						
QA/QC?	Yes No	WU?	Comments					
JO RS			N W	OSC FCOSC FCSC FENC				
Soil Colour		Soil Texture						
QA/QC?	Yes No	WU?	Comments					
JO RS			N W	OSC FCOSC FCSC FENC				
Soil Colour		Soil Texture						
QA/QC?	Yes No	WU?	Comments					

OSC: Outcrop Soils	FCSC: Forest Canopy Soils	SS: Soil Surface
FENC: Wetland Soils	TOC: Top of Core	
FCOSC: Forest Canopy Outcrop Soils	TOS: Top of Sample	
G-SIT: Grid South Ingram Trail	LL: Long Lake	
G-WGM: Grid West of Giant Mine	YK: Yellowknife	
YR: Yellowknife River	CM: Con Mine	

Figure 3-5: Field data sheet used in the field. Each data sheet recorded up to 4 samples.

3.2 Quality Assurance and Quality Control Methods

Quality assurance and quality control (QAQC) methods were employed to ensure the accuracy, reproducibility of analytical results, and sample homogeneity. Four types of QAQC samples were used to complete this process: field duplicates, lab duplicates, split samples, and certified blanks. The original sample, defined as the parent sample and the QAQC sample was evaluated by calculating the relative percent difference (RPD) by the following calculation:

$$\text{RPD} = \frac{Absolute\ value\ (Parent - QAQC)}{Average\ (Parent, QAQC)} \times 100$$

Results below the analytical detection limit were not included for RPD calculations. Appendix C presents analytical results of arsenic for the parent and QAQC sample, and the calculated RPD. Appendix C also presents the results from Certified Standards and Blank samples.

Field Duplicates

Field duplicates (FD) were collected in the field at the same location as the parent sample, within one metre. Field duplicates provide insight to sample homogeneity and field sampling methods. The field duplicate results indicate a high degree of variability among the parent sample and the field duplicate sample, with 72% of the samples (n = 29) having an RPD greater than 20% for arsenic. The soil samples contain the potential to host several different arsenic host, such as arsenopyrite and arsenic trioxide. Arsenopyrite contains 46 wt% arsenic and arsenic trioxide contains 76 wt % arsenic. Thus, an uneven distribution of these host would result in varying total arsenic concentrations. Furthermore, the nugget effect may also result in varying results. The nugget effect occurs when there is an uneven distribution of small particles rich in arsenic (or any element of interest) creating sample heterogeneity.

Lab Duplicates

Laboratory duplicates (LD) were chosen at random from the samples submitted by ASU prior to analysis. After the sample was digested, two separate measurements were analyzed and reported separately. Reproducibility between laboratory duplicates was higher than field duplicates, with 22% of sample (n = 37) having an RPD for arsenic greater than 20%. Samples were neither ground nor mixed prior to analysis, providing a possible explanation for the generally low reproducibility.

Split Samples

Split samples (SS) were prepared by dividing a single sample evenly into multiple samples and submitting these with unique sample names to the laboratory. This provides an indication of variability within individual samples due to the natural properties of the soil varying at the scale of mm to cm. Reproducibility was higher than field duplicates but lower than lab duplicates, with 39% of samples (n = 31) having an RPD for arsenic greater than 20%.

Certified Standards and Blanks

The accuracy of the analytical results was tested by analyzing certified standards (n = 22): SS-1, SS-2, MESS-3 and MESS-4. SS standards are from SCP Science, Quebec; MESS standards are based on the National Research Council Canada (2016) certified values for *Marine Sediment Reference Material for Trace Metals and other Constituents*. ASU's expected result of 18 mg/kg of arsenic for MESS-3 and MESS-4 is based on an average of results obtained for partial digestion. All RPD values for reference standards for arsenic were below was 20%, most less than 10%. Blanks were analyzed as well to test for contamination within the analytical process. Blank samples (n = 20) were all below the analytical detection limit of 1 mg/kg.

3.3 Sample Preparation and Analytical Methods

3.3.1 Initial Sample Preparation and Soil Descriptions

Soil samples were placed in a freezer after sample collection and kept frozen until the cores were ready to cut. Once it was time for the cores to be cut, they were transferred to a refrigerator kept at 4°C to defrost. The aluminum tubes were cut lengthwise with an aluminum oxide abrasive cutting wheel on a table saw. The cores were then wrapped in plastic wrap to prevent sample loss. Samples were processed in the steps outlined in Appendix D, including the calculations for soil compression. Soil sample descriptions obtained during processing are presented in Appendix E. For a brief period, the table saw used to cut the cores at Queen's University was unavailable. The cores were taken to Matthew's Metals in Kingston, ON where they were cut with a hand grinder. Appendix E list the method of cutting for each sample.

3.3.2 Bulk Geochemistry

A minimum of 1 gram of soil from all 311 samples was submitted to Analytical Services Unit (ASU) at Queen's University for elemental analysis (Appendix B). The goal was to determine the arsenic concentrations in the PHL; therefore, the samples were neither sieved nor ground, reflecting the conditions the public may encounter.

Elemental concentrations were determined by inductively coupled plasma - optical emissions spectrometry (ICP-OES). Samples were digested using aqua regia solution containing hydrochloric acid and nitric acid, at a 3:1 volume ratio. Digestion time was 300 minutes at 90 °C. This method was chosen because it is the ISO standard for soil quality analysis and this method limits the loss of volatile elements, such as arsenic (ISO, 1995; Tighe et al., 2004). Gold and antimony with concentrations below 1.0 mg/kg were analyzed via inductively coupled plasma-mass spectrometry (ICP-MS). The same aqua regia digestion procedure was used as in the ICP-OES analysis. Gold was extracted using a hydrochloric acid/cysteine rinse and standard stabilization method. This method was developed by ASU based on stabilization methods provided in Wang and Brindle (2014) and Wang et al. (2014).

To assess potential contamination from the aluminum tubes and the lead weight used to drive the tubes into the ground, fragments of each metal were submitted to ASU. Fragments were cut with carbide scissors into approximately 1mm by 1mm squares and cleaned with ethanol. Appendix F presents the bulk geochemistry results of the aluminum tubing and lead weight, and calculations on the influence of contamination on the bulk geochemistry data. Results suggest aluminum, antimony, lead, and tin may have been compromised from the aluminum tubes and lead weight; thus, these elements were not used in any data analysis. Arsenic concentrations were not compromised.

3.3.3 Total Organic Carbon

A selection of 116 samples were analyzed for total organic carbon (TOC) using the LECO SC-444 method based on Nelson and Sommers (1982) at Guelph University (Appendix B). Samples were randomly selected using the Random Number Generator function in Minitab 17; from these samples, 12 were randomly selected for split samples. A minimum of 5 grams of sample from the PHL was submitted for each. Inorganic carbon can be determined by ashing the sample at 475^{o}C for three hours prior to LECO SC444 use. Organic carbon is calculated from the subtraction of the inorganic carbon result from the total carbon result. The LECO SC-444 method of carbon determination is based on the combustion and oxidation of carbon to form carbon dioxide (CO_2) by burning the sample at 1350°C in a stream of purified oxygen. The amount of evolved CO_2 is measured by infrared detection and used to calculate the percentages of carbon in the sample.

3.3.4 SEM-AM Samples

Forty-four samples analyzed by scanning electron microscope and automated mineralogy (SEM-AM) were selected based on their proximity to Giant and Con mine roasters, direction from the roasters, and their total arsenic content (Appendix B). Samples were made into polished pucks (Figure 3-6) as explained in Appendix G. The SEM used a voltage of 25kV, spot size 5.70 to 6.00 μm, 300x magnification, with a working distance approximately 12mm, and samples were standardized to copper.

Measurements used sparse phase liberation (SPL-Lt) by energy-dispersive X-ray spectroscopy (EDS) with the SEM's Quanta Field Emission Gun (FEG), and back-scatter electron (BSE) detector. Each scan took approximately 3 to 6 hours and covered the entire puck.

After the samples were scanned on the SEM, AM was then completed on each sample, using Mineral Liberation Analysis (MLA) software. Each mineral has a unique EDS spectrum. The software contains an user-generated library of minerals with their EDS spectra and thus can identify the minerals in the sample. However, knowledge of each sample is required to ensure identification by the software is accurate and to identify unknown minerals. Additional information can also aide in identification of minerals with AM. For example, molar ratios obtained from electron microprobe analysis (described below) can identify a mineral with higher accuracy than EDS spectra because spectra for certain elements can overlap. For each mineral that has been successfully identified, the spectrum is added to a library. The library built for these soil samples contains 53 phases, reflective of the wide-range in chemical composition and heterogeneity of soils in the Yellowknife area.

3.3.5 EMPA

Electron microprobe analysis (EMPA) was completed on 8 of the 44 samples that were analyzed by SEM-AM (Appendix B). The samples were selected based on their proximity to Con Mine because the goal was to compare the chemistry of iron oxides from the Con Mine roaster to the chemistry of iron oxides from the Giant Mine roaster. Analysis of all samples were completed at Queen's University using a JEOL JXA-8230 electron microprobe in wavelength-dispersive mode (WDS); voltage was 15 kV, beam current was 10 nA; a Pouchou and Pichoir XPP matrix correction was applied (Pouchou and Pichoir, 1988). Elements selected for analysis include aluminum, antimony, arsenic, calcium, copper, iron, lead, magnesium, manganese, potassium, silicon, sulphur, titanium, and zinc.

Figure 3-6: Pucks being prepared for SEM-AM analysis.

3.3.6 Synchrotron-based XANES Analysis

Twenty-two soil samples were selected for synchrotron-based analysis using bulk X-ray absorption near-edge structure (XANES) for characterization of the oxidation state in solid arsenic species (Appendix B). These samples were also analyzed for organic carbon. Pucks were made for each of these samples as well to be analyzed by SEM. However, some to the samples were organic rich and at the polishing stage, the material was lost to the point the puck could not be analyzed by the SEM. Analysis was completed at Sector 20-BM of Advanced Photon Source (APS) of Argonne National Laboratory in Lemont, Illinois (Figure 3-7). XANES analysis were completed within a cryostat chamber, temperature between 12-55 K. The low temperature avoided any beam-induced changes of arsenic speciation in the sample. Transmission measurements were done with a beam width of 7mm x 1mm; the transmission detector was perpendicular to the incoming beam. Samples were loaded at a 45° angle to the beam in an aluminum holder (Figure 3-8). Throughout the experiment a gold reference foil was used; a platinum foil was used during calibration. The arsenic K-edge was 11867 eV. Each scan ranged from 150 eV before the As K-edge and 300 eV past the As K-edge (11717 eV to 12167 eV). The As edge region ranged from 11847 eV to 11897 eV.

Samples were air-dried and ground to a fine powder using a mortar and pestle. The sample material was spread in a thin layer onto Kapton tape. The Kapton tape was then folded and cut to approximately 2mm x 5mm. XANES data collected were processed using linear combination fitting (LCF) in ATHENA (Demeter 0.9.24). Due to the heterogeneity of the samples, fits were not forced to 100%. Instead, after the fits were completed, components were then normalized 100%. Standards used for data processing were arsenopyrite [As (-1)], realgar [As(II)], orpiment [As(II½], arsenolite [As(III)], goethite [As (III)], mixture of maghemite and hematite [As (III)], mixture of maghemite and hematite [As (V)], scorodite [As (V)], tooeleite [As (V)], and yukonite [As (V)]. Detection limit for XANES analysis using LCF is 5% (Foster and Kim, 2014). Errors have been reported as high 30% for samples containing a mixture of As(III) and As(V) (Morin et al., 2003). However, several studies report errors of 10% is more common (Foster and Kim, 2014 and references therein).

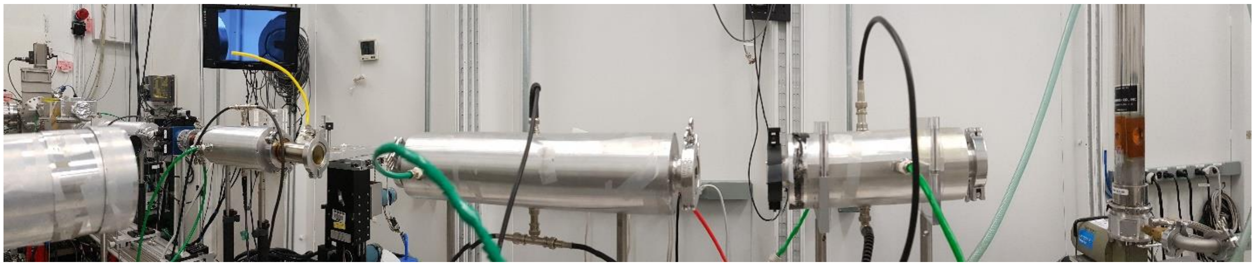

Figure 3-7: Sector 20 beamline at the APS synchrotron in Lemont, Illinois.

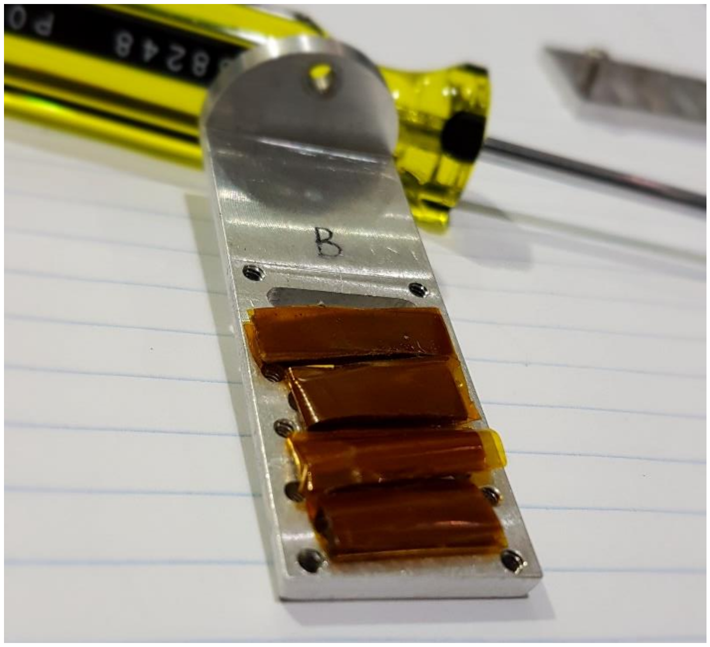

Figure 3-8: Aluminum holder for XANES analysis.

3.3.7 Statistical Analysis

All statistical analyses were performed in Minitab 18. The geochemical data was not normally distributed and thus non-parametric tests were used, unless otherwise stated. Regression analysis compared the relationship between arsenic concentration, distance and direction from the Giant Mine roaster, and elevation. A Kruskal-Wallis test and Dunn's post hoc analysis was performed to compare arsenic concentrations between terrain units, bedrock geology, wind direction, and soil horizons. Mann-Whitney test was used to compare arsenic content in iron oxides samples collected near Con Mine with those collected from Giant Mine tailings. Analysis of covariance was completed by using a generalized linear model to determine the effect all variables (terrain, bedrock, distance and direction from the roaster, soil horizon, and elevation) have on the distribution of arsenic in the Yellowknife area. For this test, the log of distance and arsenic was used. All tests were performed at a 95% confidence interval.

3.3.8 GIS Mapping and Interpolation

All maps were created in ArcMap version 10.5. Maps of Yellowknife used Geographic Coordinate System WGS 1984; projection used WGS 1984 UTM Zone 11N Transverse Mercator. The central median was -117.0. The false Easting 500000 and the false Northing 0.0. The map of Europe presented in Chapter 2 used Geographic Coordinate System WGS 1984; projection used WGS 1984 Web Mercator Auxiliary Sphere; the false Easting was 0 and the false Northing was 0. Geochemical interpolation used the inverse distance weighted (IDW) method with the default power value of 2. The IDW method uses the following formula:

$$\hat{Z}(s_o) = \sum_{i=1}^{N} \lambda_i Z(s_i)$$

Where $\hat{Z}(s_o)$ is the value of interest at location s_o;N is the number of known values surrounding the point of interest; λ_i are the weights assigned to each measured point that will be used in the calculation; and $Z(s_i)$ is the observed value at the location (s_i). This method employs the assumption that points closer together are more similar than those that are far apart, which is based on Tobler's First Law of Geography (Tobler, 1970; Esri, 2017). Thus, measured values close to an unknown point will be interpreted to be more similar than measured values farther away. Lima et al. (2008) did a comparative study and showed MIDW (multifractal inverse weighted distance) distinguish geochemical anomalies, as opposed to other interpolation methods, such as kriging, which smooth out the data and anomalies are less evident. Distinguishing anomalies from background is crucial when evaluating the extent of contamination from a point source. Lima et al. (2008) used the MIDW rather than IDW because the data encompassed the majority of Europe; thus, the interpretation method was required to interpret data at multiple scales (local: 0.5 to 500 km^2; regional: 500 to 500,000 km^2; continental: 0.5 to 50 million km^2 (Reimann et al., 2009)). This project focused on a much smaller area than the study by Lima et al. (2008) and thus the IDW method was deemed appropriate.

Chapter 4

Results and Discussion

4.1 Results

4.1.1 Soil Classification

Soil core depth ranged from 4.9 to 30.4 cm (median = 13.5 cm) indicating soil in the Yellowknife region is shallow. Organic material was prevalent on the surface, consisting of leaf litter (twigs, leaves, pine cones, pine needles, etc.), mosses, and other woody materials with varying degrees of decomposition. Although the organic soil horizon does not typically include non-decomposed organic material (SCWG, 1998), one of the objectives of this study was determine the arsenic concentration in the top 5 cm of soil material. Therefore, the term "O-horizon" will be used to here to refer the surface portion of decomposed and non-decomposed organic material. The soil below the O-horizon, referred to hear as the A-horizon, was generally brown to dark brown in colour and often the thickest horizon in the soil samples. Typically, this horizon contained organic material, silt to clay sized grains with some pebbles and little leaching determined by the brown to dark brown colour. The A-horizon develops in situ from accumulation of overlying organic matter, or eluviation of materials in solution or suspension, or a combination of the two processes (SCWG, 1998). In 36 soil samples, the O-horizon was absent, leaving the A-horizon exposed at the surface. Soil samples contained a B-horizon in 54% of samples (n = 171), typically consisting of silt and clay sized grains, and to a lesser extent sand to pebble sized grains, with organic content primarily of thin, wispy roots. The change from A-horizon to B-horizon was often marked by a colour change, brown/dark brown changing to a light brown and in a few instances, orange colour, suggesting oxidation. The B-horizon, referred to as the "mineral horizon" (SCWG, 1998), forms from the accumulation of material washing down from the overlying horizons, or formed in situ from weather processes (Brady and Weil, 2004). The C-horizon, sitting below the B-horizon, was only present in 15 samples. The C-horizon was composed of sandy material referred and no organics, except for roots extending down into the C-horizon from the overlying B-horizon. Till is material transported by glaciation, which can be up to 100's of kilometres away (Evans, 2017).

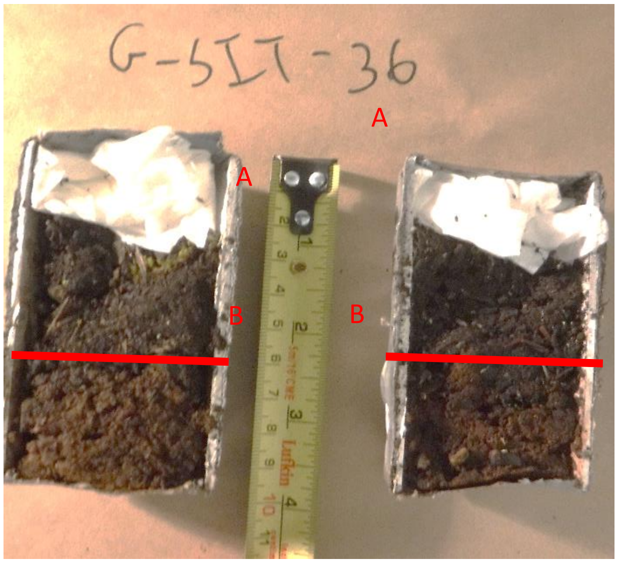

Figure 4-1: Soil sample G-SIT-36 with A and B horizons.

Figure 4-2: Soil sample G-SIT-37 with O and A horizons.

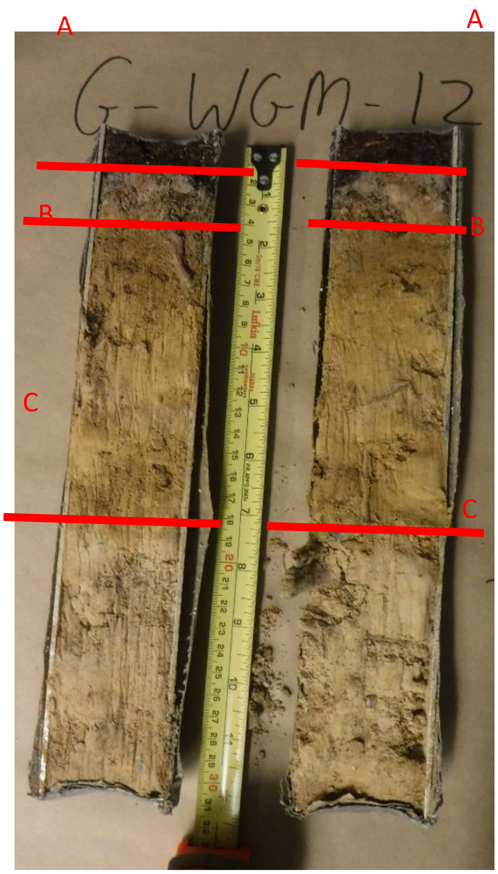

Figure 4-3: Soil sample G-SIT-38 with O, A and B horizons.

Figure 4-4: Soil sample G-WGM-12 with O, A, B, and C horizons.

Figures 4-1 to 4-4 show examples of the different soil horizons observed in this study. Based on the descriptions above and provided in Appendix E, the soils collected in this study can be classified in the Brunisolic order (SCWG, 1998). There are four groups and eighteen subgroups within the Brunisolic order. Distinction of these groups requires pH of the soil, which was not recorded during this study (SCWG, 1998). Therefore, the soil samples have not been classified beyond the Brunisolic order.

4.1.2 Bulk Geochemistry

Results in this section were discussed in combination with results by Maitland (2018) in Jamieson et al. (2017). The results presented here do not include data by Maitland (2018).

Arsenic concentration (based on aqua regia digestion) in the PHL ranges from 1.0 to 4,700 mg/kg, with an average of 388 mg/kg and a median of 160 mg/kg (n = 311). Results are presented in Appendix H and depicted in Figures 4-5 and 4-6. Arsenic is above the local Residential Guideline of 160 mg/kg (GNWT, 2003) in 49% of samples collected (n = 152). Arsenic is above the local Industrial Guideline of 340 mg/kg (GNWT, 2003) in 33% of samples (n = 102). Arsenic was above CCME residential and industrial guidelines of 12 mg/kg, for 93% of samples collected (CCME, 2015). Thirteen other elements were also compared to CCME soil quality guidelines (Table 4-1). Copper was above residential guideline and industrial guideline for 17% and 7% of samples, respectively. Barium, cobalt, nickel, selenium, thallium, uranium, vanadium, and zinc were also above residential guidelines in at least one sample; cobalt, copper, nickel, selenium, thallium, vanadium, and zinc were also above industrial guidelines in at least one sample. Aluminum, antimony, lead, and tin were not compared to their respective guidelines because of suspected contamination from the lead weight and aluminum tubes used in collecting samples (Appendix F). However, it is likely that antimony is elevated in the PHL. Results by Maitland (2018) show antimony is above the CCME (2015) residential guideline of 20 mg/kg in 31% of samples (n = 155) and above the industrial guideline of 40 mg/kg in 21% of samples (n = 155). Thallium, a highly toxic element (Kazantzis, 2000), was above residential and industrial guideline of 1 mg/kg in 16 samples. The high mobility of thallium is used as an indicator mineral in gold exploration (Warren and Horsky, 1986). Assuming it is natural, no correlation of bedrock type and thallium was observed in this study, but this may be an area worthy of future work.

Arsenic did not show a correlation with any other element analyzed. However, arsenic and antimony were expected to be correlated (Bromstad, 2011) but since antimony values were compromised (Appendix F), comparisons could not be made. Arsenic and gold were also expected to correlate (Bromstad, 2011). However, 34% (n = 38) of gold results were below detection limit and therefore correlations could not be completed.

Table 4-1: Elements compared to CCME soil quality guidelines (CCME, 2015).

Element	Residential Guideline		Industrial	
	(mg/kg dry weight)	# of samples above guideline	(mg/kg dry weight)	# of samples above guideline
Arsenic	12	290	12	290
Barium	500	1	2000	0
Beryllium	4	0	8	0
Cadmium	10	0	22	0
Cobalt	50	2	300	1
Copper	63	52	91	22
Molybdenum	10	0	40	0
Nickel	45	10	89	1
Selenium	1	22	2.9	2
Silver	20	0	40	0
Thallium	1	16	1	16
Uranium	23	6	300	0
Vanadium	130	1	130	1
Zinc	200	14	360	2

Soil samples were collected in three terrain units: outcrop, forest, and forest outcrop samples (Figure 4-7). A Kruskal-Wallis test and Dunn's post hoc analysis was completed to compare the median arsenic concentrations among terrain units. Forest samples (median = 43 mg/kg) had significantly less arsenic than forest outcrop (median = 170 mg/kg) and outcrop (median = 180 mg/kg) samples (p <0.001).

There was no statistical significance observed between median arsenic concentrations in forest outcrop and outcrop samples (*p* >0.05). Loading of arsenic (mg/cm^3) was calculated for terrain units to compare arsenic concentrations in terrain units (Appendix I). This was done to assess the affect of bulk density on the reported arsenic concentrations. There was no difference in trends observed between arsenic concentrations and arsenic loading. Therefore, the comparison of arsenic concentrations in terrain units is valid.

Arsenic shows a decrease in concentration with an increase in distance from the Giant Mine roaster ($R^2_{(adjusted)}$ = 0.476; p <0.001; Figure 4-8). This was expected as previous studies completed in the Yellowknife area also show arsenic decreasing with increasing distance from Giant Mine, as discussed in Section 2.6 (Hocking et al., 1978; Hutchison et al., 1982).

Arsenic concentrations were compared to the direction from the Giant Mine roaster (Figure 4-9). Directions between 315° to 0° and 0° to 45° were grouped as North; 45° to 135° were grouped as East; 135° to 225° were grouped as South; and 225° to 315° were grouped as West. Median concentrations of were highest in the west direction (n = 94; median = 570 mg/kg) compared to the south direction (n = 126; median = 160 mg/kg), north direction (n = 70; median = 61 mg/kg), and east direction (n = 21; median = 53 mg/kg) (p <0.001; Figure 4-4). The south direction was significantly higher than the east and north directions (p = 0.004, p = 0.001, respectively). Given the predominant wind direction is from east to west (Environment Canada, 2017), it is not unexpected that the highest arsenic concentrations are to the west of Giant Mine.

Arsenic concentrations were compared to the local bedrock geology. Arsenic concentrations in soils located on granitoid and gneissic bedrock were significantly higher (n = 152; median 215 mg/kg) than metasediment and sedimentary (n = 31; median = 47) (p < 0.001). Soil arsenic concentrations with underlying volcanic bedrock (n = 123; median = 180 mg/kg) also contain significantly more arsenic than metasediment and sedimentary (p <0.001). Metasedimentary and sedimentary bedrock is found to the east of Yellowknife while volcanic rock trends north south through Yellowknife, encompassing Giant Mine and Con Mine; granitoid and gneisses extend to the west of Yellowknife. Thus, the difference in soil arsenic concentrations among bedrock units may be a function of direction and distance from Giant and Con mines, rather than the bedrock itself.

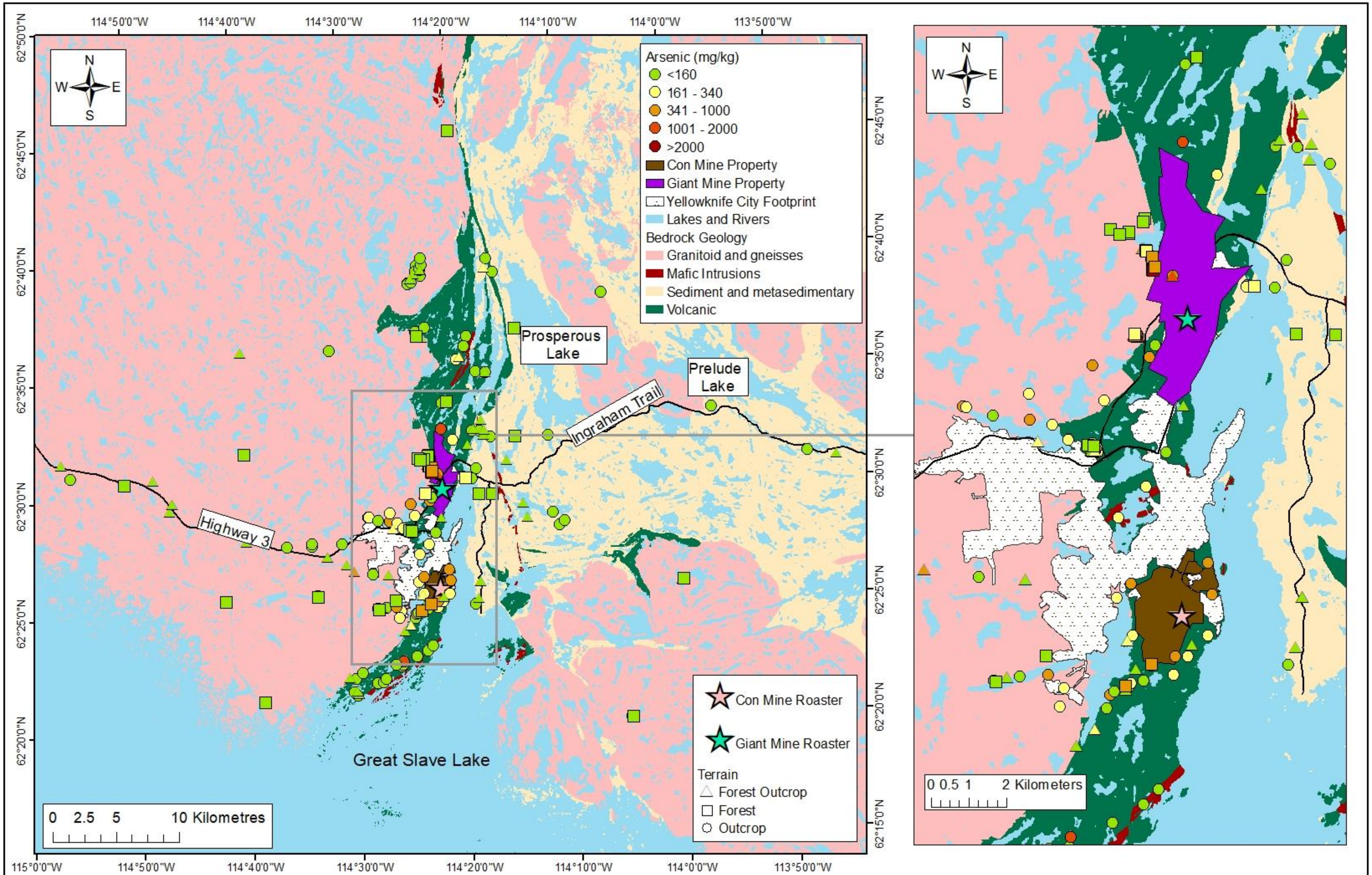

Figure 4-5: Arsenic concentrations in the PHL. Colours of dots based on terrain units; size of dots based on arsenic concentration.

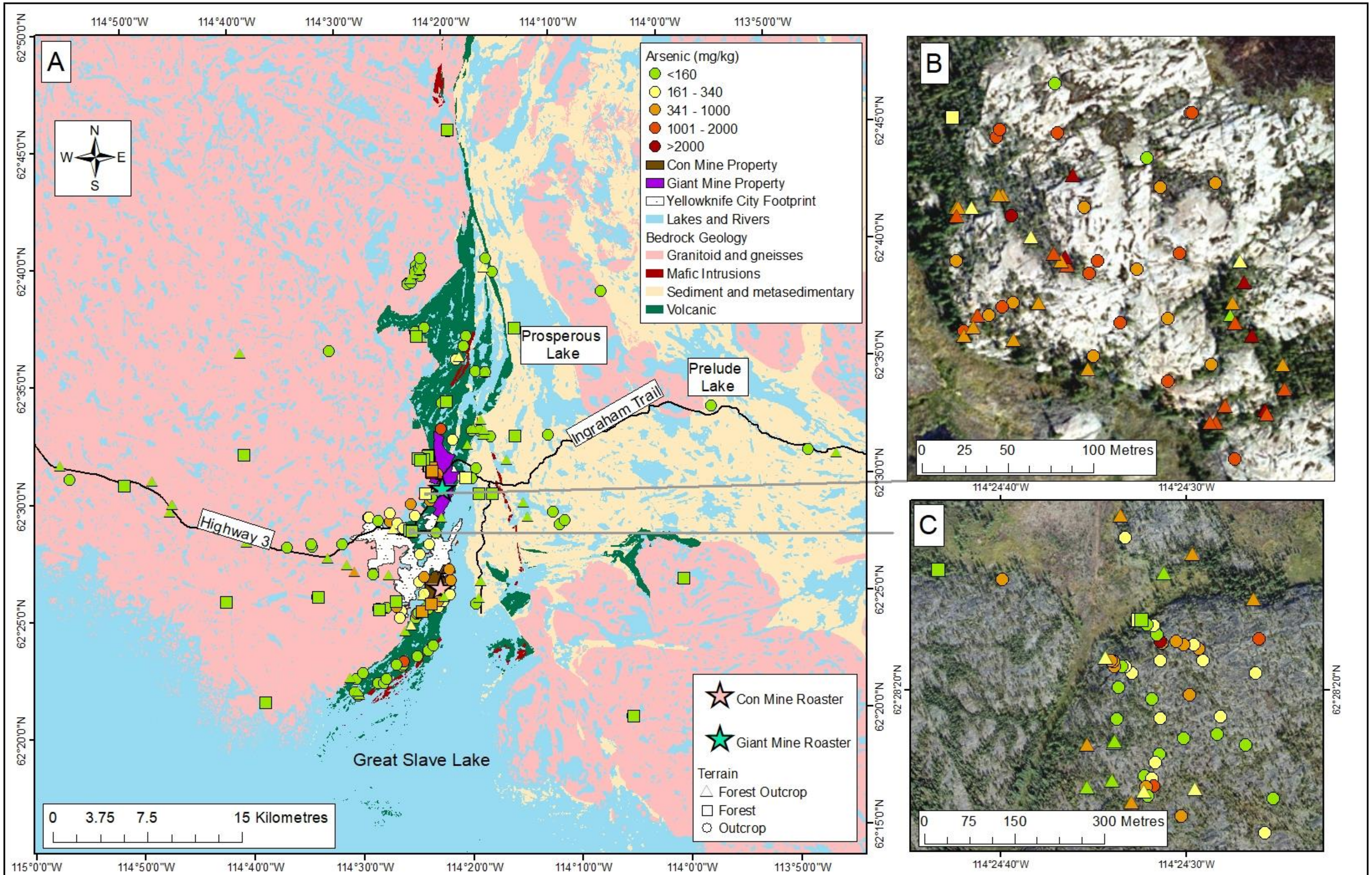

Figure 4-6: Arsenic results in the PHL around Yellowknife (A), at the grid west of Giant Mine (G-WGM) (B), and at the grid south of the Ingraham Trail (G-SIT-) (C). Colours of dots based on terrain units; size of dots based on arsenic concentration.

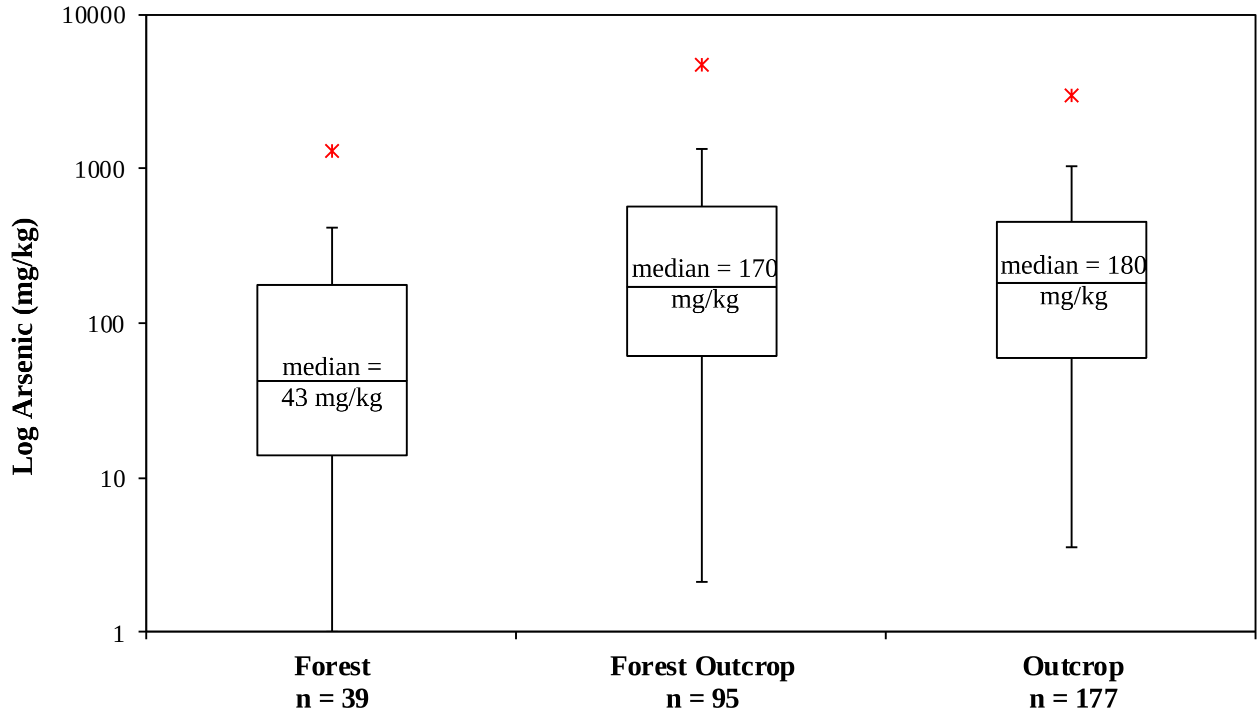

Figure 4-7: Boxplot showing arsenic concentration in the PHL based on terrain unit. This boxplot was created by using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1. However, for the Forest terrain unit, the lower whisker was a negative value and therefore the minimum value defines the lower whisker.

Two high-density sampling areas were completed near Fred Henne Territorial Park and directly west of Giant Mine to explore local scale variability (Figure 4-6). The Grid south on the Ingraham Trail (G-SIT) ranged in arsenic concentrations in the PHL from 32 to 3,000 mg/kg (n = 59). A Kruskal-Wallis test with Dunn's post hoc comparison did not find a significant difference in arsenic concentrations between forest (n = 3; median = 130 mg/kg), forest outcrop (n = 14; median = 230 mg/kg), and outcrop (n = 42; median = 245 mg/kg) terrain units ($p > 0.05$). The absence of a statistically significant difference is likely a result of a small sample size. The Grid West of Giant Mine (G-WGM) ranged in arsenic concentrations from 99 to 4,700 mg/kg. Only one forest sample (arsenic = 250 mg/kg) was collected in this grid, reflecting the rocky terrain of the area. Forest outcrop (n = 31) and outcrop (n = 27) had identical median values (1,000 mg/kg).

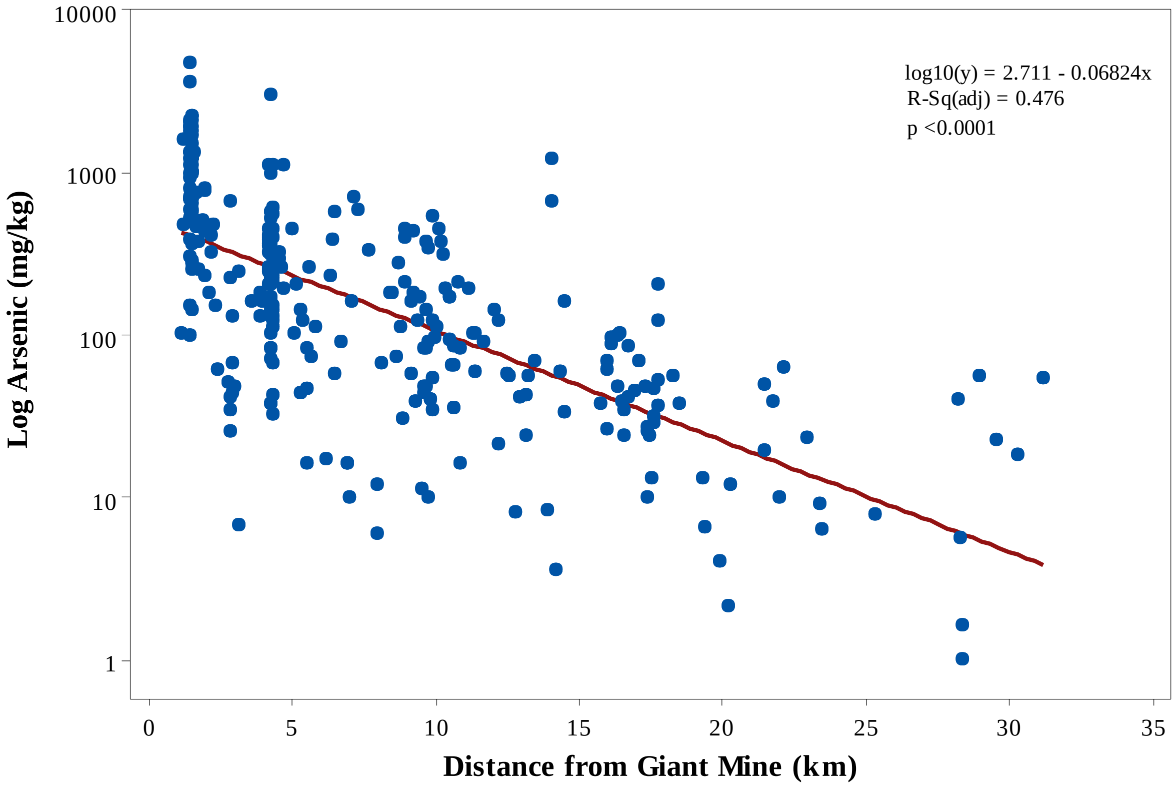

Figure 4-8: Arsenic concentrations decreasing with increasing distance from Giant Mine.

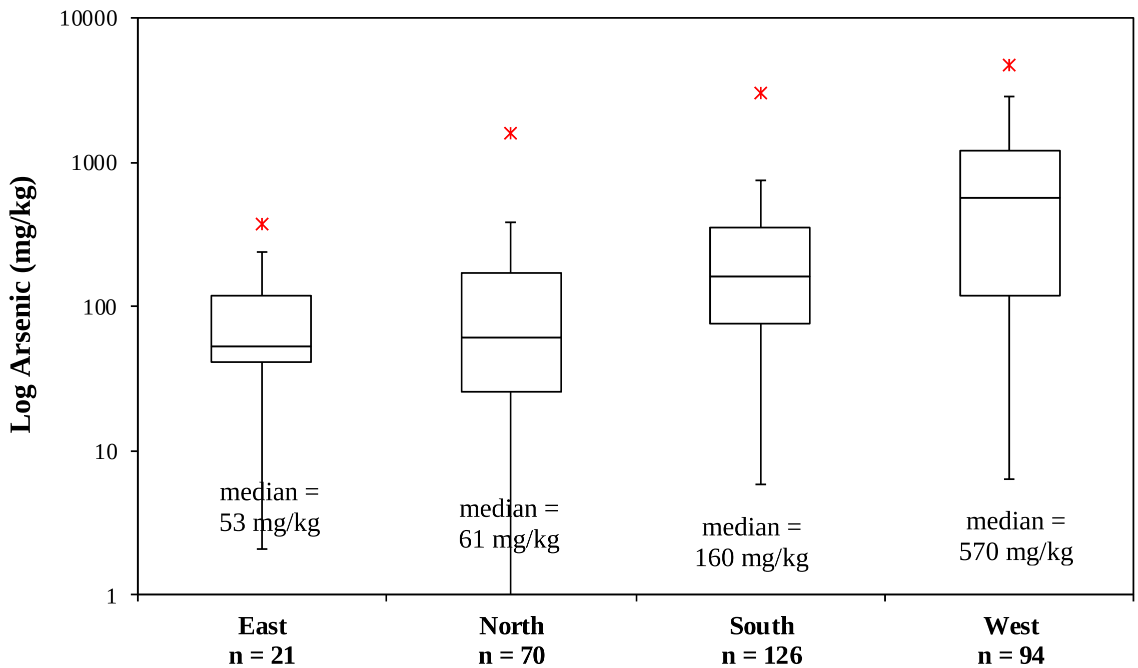

Figure 4-9: Boxplot of arsenic concentrations group by direction from Giant Mine. East includes samples collected between 45° to 135°; north between 315° to 0° and 0° to 45°; south between 135° to 225°; and west between 225° to 315°. Red stars show the maximum outlier. Note that the prevailing wind direction is from east to west in the Yellowknife area (Environment Canada, 2017). This boxplot was created by

using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1. However, for the North direction, the lower whisker was a negative value and therefore the minimum value defines the lower whisker.

In each high-density sampling area, samples were collected on what appeared to be areas that drained water from areas of high elevation to areas of low elevation (i.e. drainage paths). Three drainage paths were sampled on each grid area with a minimum of seven samples on each drainage path. Figures 4-10 and 4-11 show the drainage paths for each grid. Each drainage path shows variable arsenic concentrations, but no clear relationship emerges with drainage.

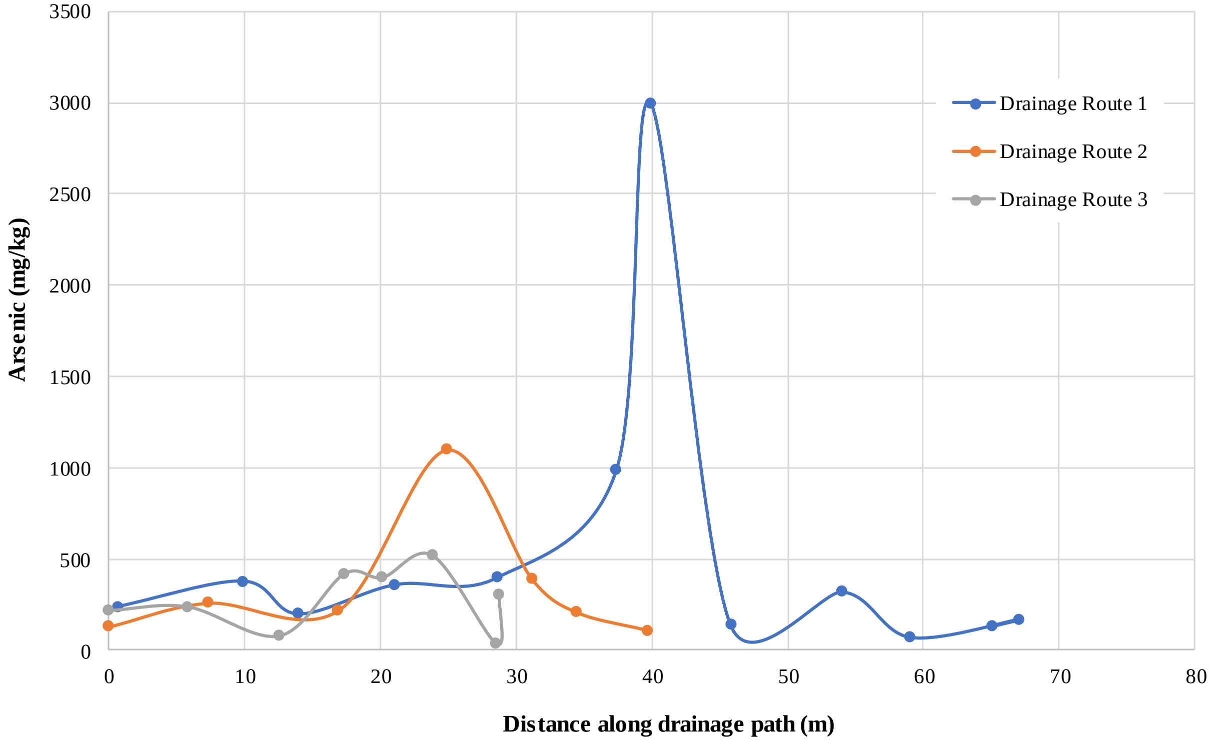

Figure 4-10: Arsenic concentration on drainage paths at the high-density sampling area near Fred Henne Territorial Park (samples G-SIT-21 to G-SIT-46 Dup).

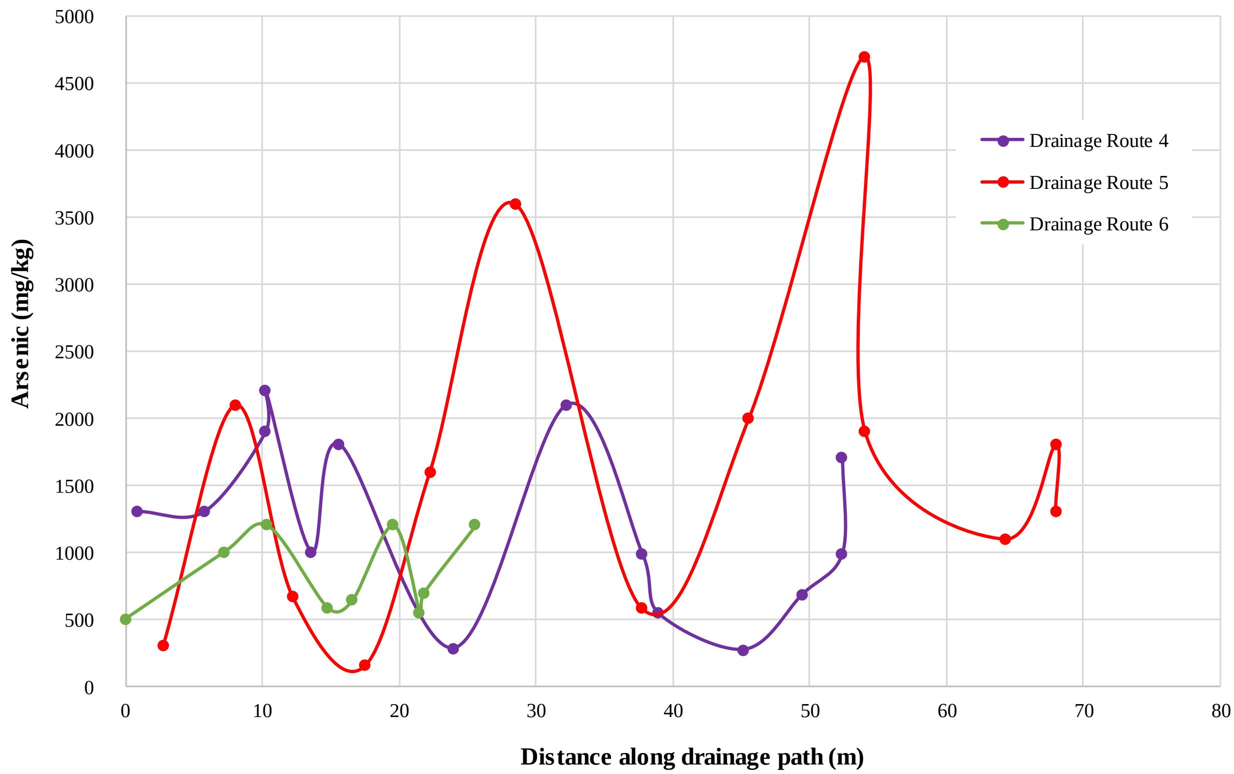

Figure 4-11: Arsenic concentration on drainage paths at the high-density sampling area west of Giant Mine (samples G-WGM-01 to G-WGM-32).

Elevation values were extracted from a digital elevation model (DEM) for each sample point (obtained from Natural Resources Canada, 2018). Elevation was recorded in the field with a Garmin etrex30x GPS. However, it was noted in the field that as the field crew were scaling down an outcrop, the GPS increased in elevation. Thus, the values were considered suspect. Elevation values from the DEM were compared to arsenic concentrations for all the drainage paths combined. The relationship shows arsenic increasing with decreasing elevation ($R^2_{(adjusted)} = 0.312$; $p < 0.001$) (Figure 4-12). Figure 4-12 shows little topographic difference (207 to 210 metres) within the grids; thus, to determine if areas of lower elevation are significantly different from areas of higher elevation, categories were created and compared with a Kruskal-Wallis test and post hoc comparisons. The two points at 209 m elevation were group with 210 m elevation. Arsenic concentrations at 210 m elevation were significantly less (n = 27; median = 240 mg/kg) than 208 m elevation (n = 13; median = 1,600 mg/kg) and 207 m elevation (n = 23; median = 1,000 mg/kg). Thus, while for the entire drainage path there does not appear to be a pattern with elevation and arsenic, arsenic does appear to be accumulating in small soil pockets. These small soil pockets are disconnected, offering a potential explanation why arsenic does not show a pattern on the entire drainage path, consistent with results presented by Bromstad et al. (2017). Arsenic was compared with elevation for the entire data set; no significant relationship was observed ($R^2_{(adjusted)}$ = 0.0088; p = 0.054).

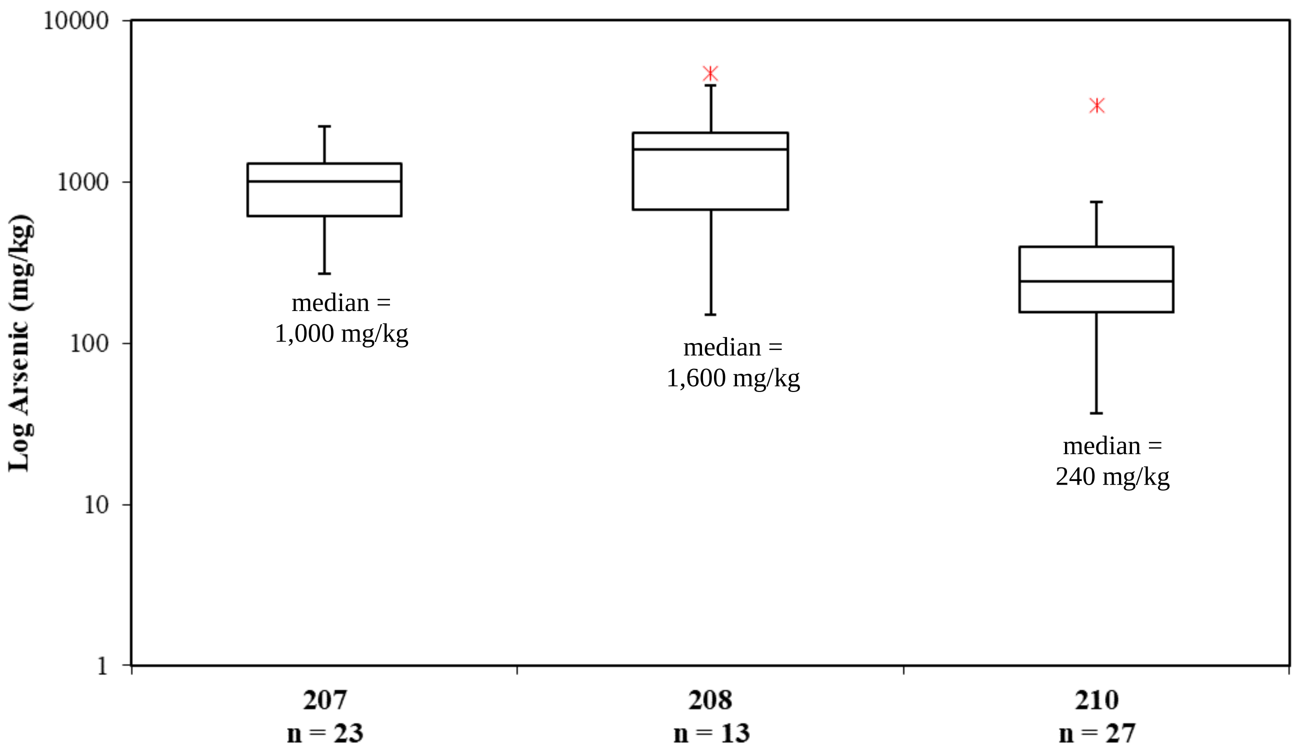

Figure 4-12: Boxplot showing arsenic concentrations versus elevation along all six drainage paths. Arsenic concentrations at elevation 210 m were significantly less than arsenic concentrations at 208 and 207 m elevation (p <0.001). This boxplot was created by using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1.

4.1.3 Total Carbon

Total carbon (TC) results are presented in Appendix H. Total carbon results range from 1.41 to 49.2 % dry weight (median = 29.05 % dry weight; n = 114). Organic carbon is higher than inorganic carbon in all samples. Total carbon, organic carbon, and inorganic carbon did not show correlations with arsenic in the PHL (Figures 4-13 to 4-15). Given the O-horizon contains primarily organic matter, and during the sample description process noted the PHL consisted of O and A horizon, the question arose if the A-horizon had an effect on the arsenic and TC relationship. The thickness of each horizon was measured during the sample processing procedure. The depth of the PHL, with compression taken into account, was also measured. The portion of each horizon submitted for analysis was then calculated. A regression plot of TC vs. arsenic, grouped based on soil horizons, shows organic content is variable in all soil horizons, as is arsenic content (Figure 4-16). Arsenic in samples with 100% O-horizon (n = 99; median = 90), 100% A horizon (n = 36; median = 250), and a mixture of O and A-horizon (n = 176; median = 200) were compared using a Kruskal-Wallis test with Dunn's post hoc comparisons. The results indicate that arsenic concentrations in the O-horizon were significantly less than the mixture of O and A horizon (p <0.001), and the A-horizon (p = <0.001). Thus, it appears arsenic concentrations in the PHL are being influenced of the thickness of the O-horizon.

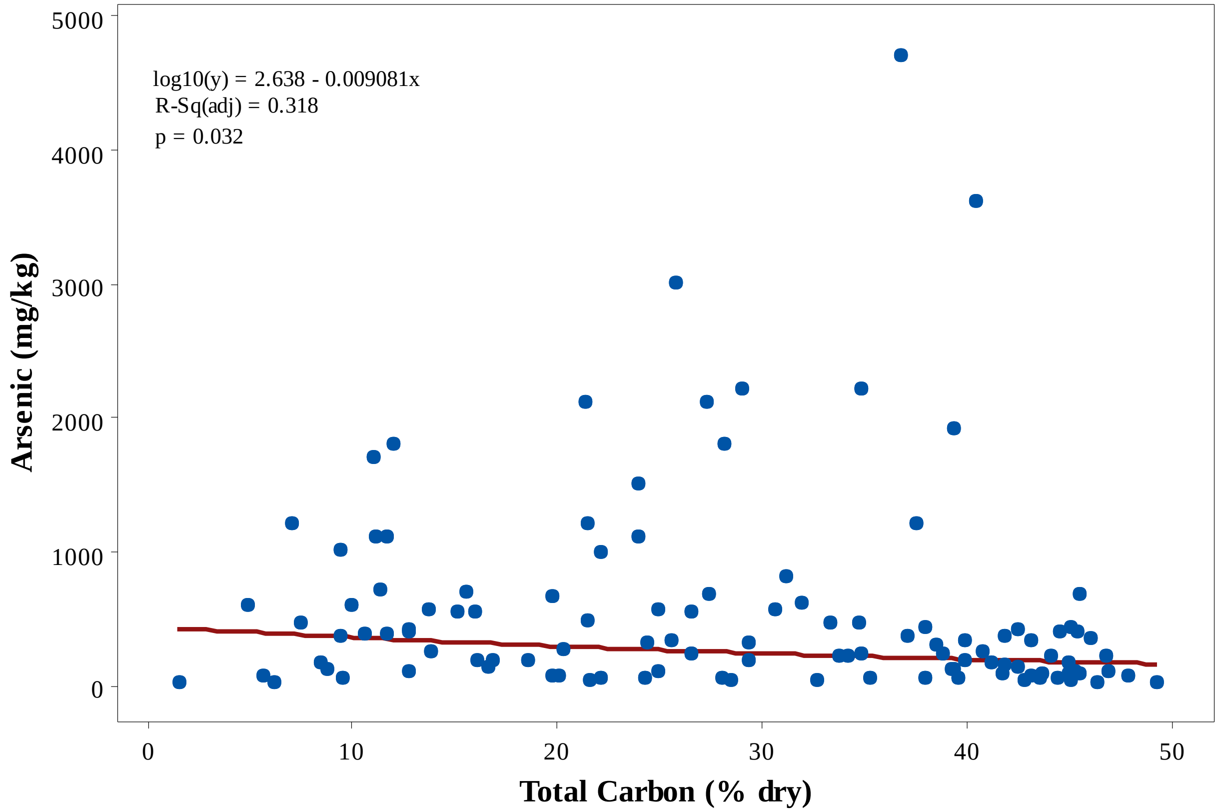

Figure 4-13: Total carbon versus arsenic in the PHL.

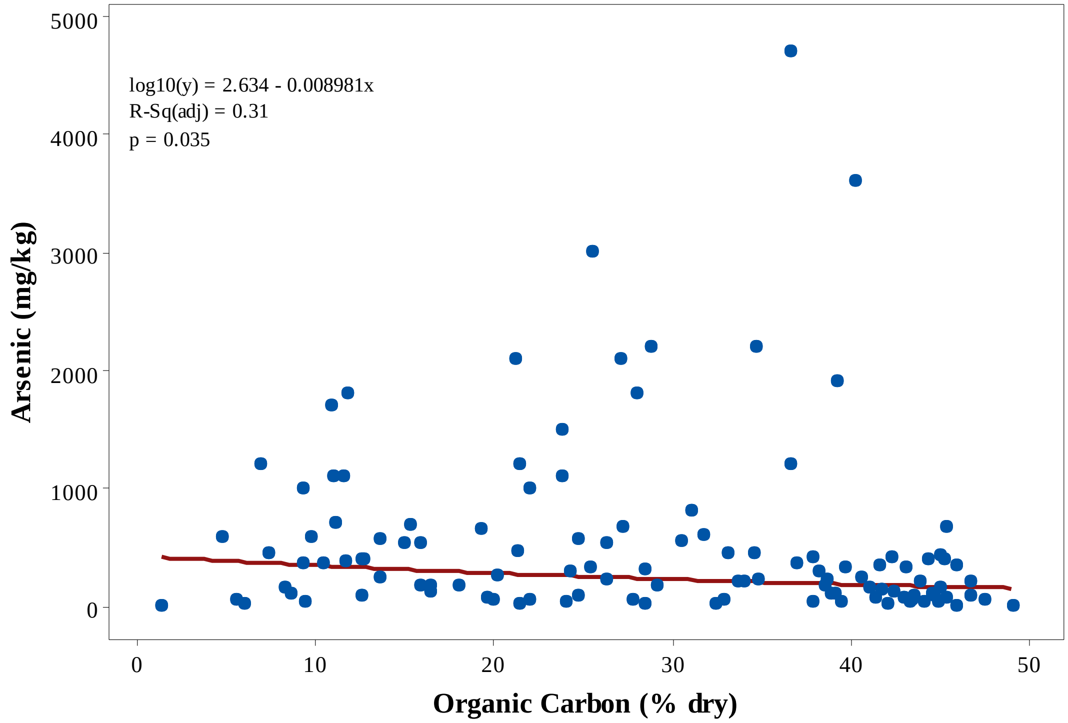

Figure 4-14: Organic carbon versus arsenic in the PHL.

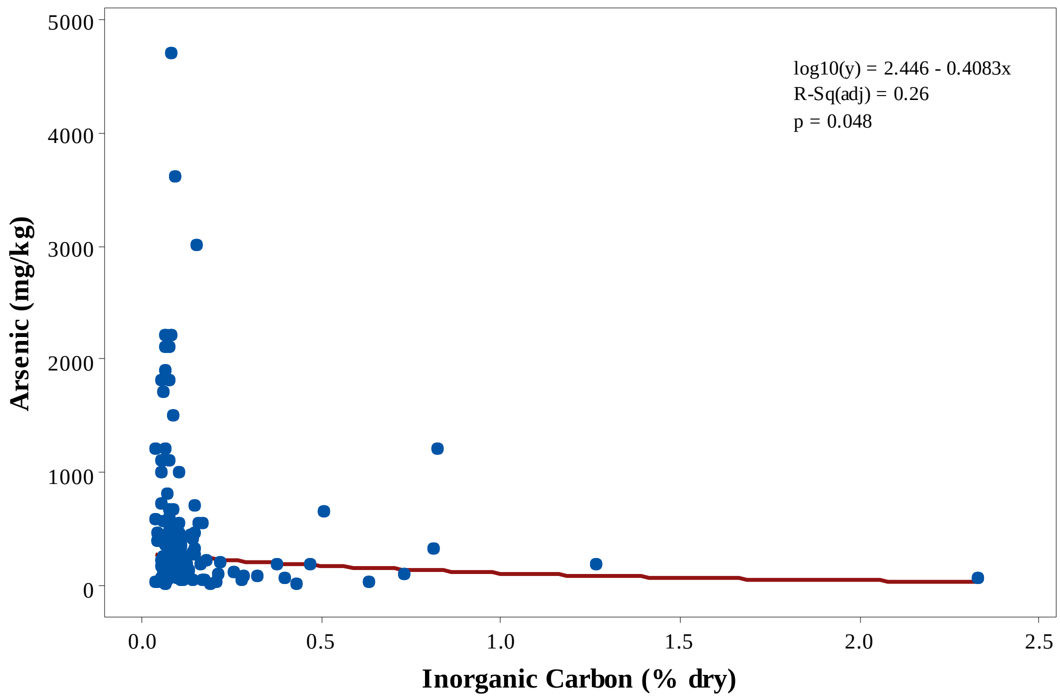

Figure 4-15: Inorganic carbon versus arsenic in the PHL.

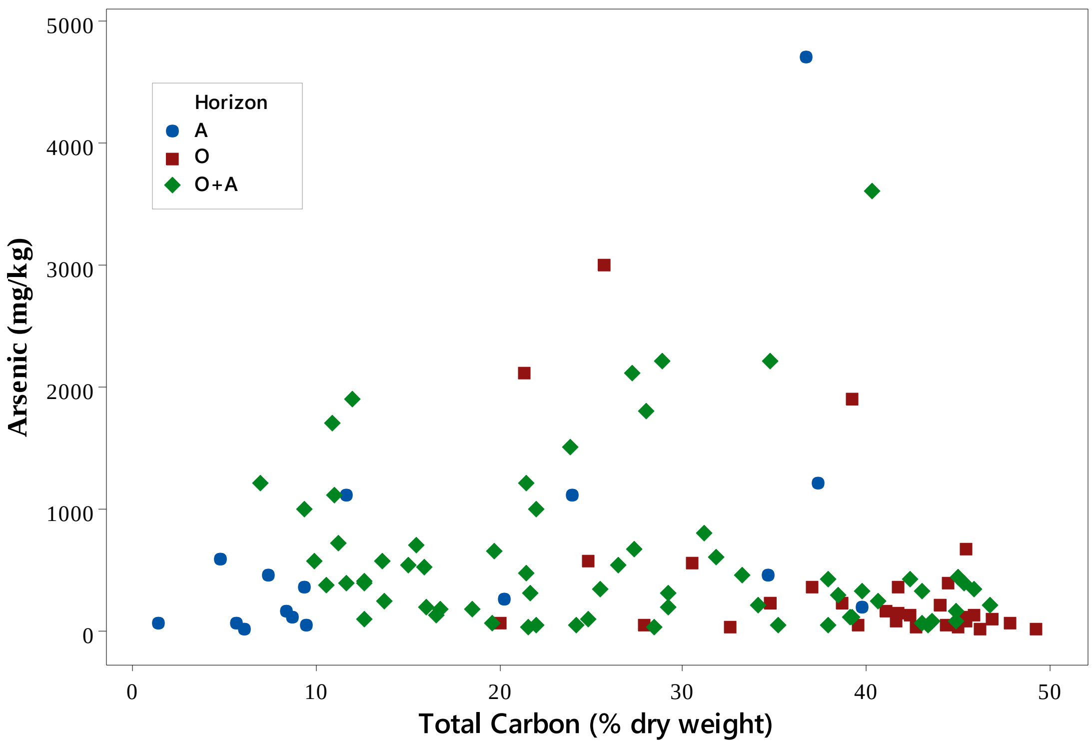

Figure 4-16: Total carbon versus arsenic coloured by soil horizon.

4.1.4 Mineralogy of arsenic hosts

Arsenic hosts identified with SEM-AM in soils include arsenic trioxide, iron oxides with arsenic, iron oxides with a mixture of elements, manganese oxides with a mixture of elements, organics with iron oxides and a mixture of other elements, and rarely arsenopyrite, arsenic-bearing pyrite, enargite, iron-calcium arsenate, and scorodite (Table 4-2; Appendix J). Based on the number of particles, iron oxides are the most abundant arsenic host, with the following exceptions and their dominant arsenic phase: CM-08, manganese oxides with arsenic; G-SIT-20, arsenic trioxide; G-WGM-14, arsenic trioxide; G-WGM-17, arsenic trioxide; TX-20 and TX-20-Dup, manganese oxides with arsenic; and YK-39, organics with arsenic, calcium, and iron oxides. The texture and spectra of iron oxides can be used to distinguish roaster-generated oxides from naturally forming soil iron oxides (Bromstad et al., 2015). Natural iron oxides have an inhomogeneous texture consisting of an amalgamation of grains (Figure 4-17) and their spectra is mixed, containing variable amounts of iron, calcium, manganese, magnesium, aluminum, and arsenic, among other elements. Roaster-generated iron oxides have a spectrum with only iron and arsenic.

Antimony is present in roaster-generated iron oxides as well (Riveros et al., 2000; Walker et al., 2015; Bromstad et al., 2017; and this study, see below) but in low concentrations and often do not show on the spectrum of roaster-generated iron oxides. Two classes of roaster-generated iron oxides have been identified based on texture. Roaster-generated iron oxides in samples collected closer to Con Mine have spongy texture and lack concentric zoning (Figure 4-18) whereas roaster iron oxides from samples collected near Giant Mine primarily are concentric and porous (Figure 4-19), similar to those presented in Walker et al. (2015). User-defined AM can distinguish between natural iron oxides (mixed spectra) and roaster-generated iron oxides (spectra with only iron and arsenic) and thus the portions can be determined. Based on particle count, roaster-generated iron oxides are more abundant than naturally-formed iron oxides with a mixed spectrum in all samples, with one exception: YK-24, an outcrop sample collected north of the Giant Mine property.

Seven samples collected around Con Mine were analyzed by EMPA (CM-08, CM-18, CM-22, CM-23, CM-24, CM-25, and Grace-05) (Appendix K). Arsenic ranged in concentration from 0.00 to 7.18 wt% (median = 0.29 wt%). Iron ranged in concentration from 68.67 to 93.67 wt% (median = 87.46 wt%). Antimony concentrations ranged from 0.00 to 2.82 wt% (median = 0.03 wt%). Three iron oxide grains were analyzed from a sample near Giant Mine (G-WGM-23). Median arsenic, iron, and antimony concentrations were 2.92, 68.93, and 0.05 wt%, respectively.

Arsenic trioxide was identified in 35 of the 44 samples analyzed. Bromstad et al. (2017) showed the presence of As_2O_3 on the Giant Mine property. It was therefore not surprising that As_2O_3 was found in soils surrounding the Giant and Con mine properties. Additionally, As_2O_3 was identified 30 km away from Giant Mine to the east, opposite to the predominant wind direction. The texture of As_2O_3 grains from samples near Giant Mine were similar to arsenic trioxide grains near Con Mine. Grains showed smooth to irregular edges with mottled texture (Figure 4-20). As_2O_3 grains were typically liberated, rather than part of a cluster of grains. Seven arsenic trioxide grains were analyzed with EMPA in four samples collected near Con Mine (CM-08, CM-18, CM-22, and CM-23). Arsenic concentrations ranged from 87.66 to 100 wt%. Minor amounts of iron (0.02 to 0.19 wt%), antimony (0.08 to 1.76 wt%), and magnesium (0.11 to 0.26 wt%) were present. One grain in CM-24 originally thought to be arsenic trioxide was identified as scorodite (arsenic = 46.96 wt%; iron = 32.24 wt%).

Table 4-2: Particle count of arsenic hosts identified by SEM-AM. Iron oxides with As and arsenic trioxide are from stack emissions; iron oxides mixed with arsenic are interpreted to be naturally forming iron oxides.

Sample ID	Arsenic Trioxide (As_2O_3)	FeOx + As	FeO + As, mixed spectra	MnOx + As, mixed spectra	Organics + FeOx, As	Arsenopyrite (FeAsS)	As-Bearing Pyrite	Enargite (Cu_3AsS_4)	Fe-Ca Arsenate	Scorodite ($FeAsO_4 \cdot 2H_2O$)
CM-08	38	132	15	362	5	0	0	1	1	0
CM-18	11	76	9	28	14	0	0	1	0	0
CM-22	18	385	164	220	15	0	0	0	1	0
CM-23	26	342	32	2	19	0	0	2	9	0
CM-24	16	1308	143	14	1126	0	1	0	1	3
CM-25	2	827	495	244	3	0	0	1	0	0
Grace-01	6	31	2	0	3	0	0	0	0	0
Grace-05	0	142	10	2	14	0	0	1	1	0
G-SIT-03	86	167	3	0	1	0	0	0	0	0
G-SIT-20	234	34	2	0	0	0	0	0	7	0
G-SIT-20-Dup	8	11	4	1	0	0	0	0	0	0
G-SIT-27	12	2608	1059	9	3	0	0	0	0	0
G-SIT-47	5	128	24	9	0	1	0	0	0	0
G-SIT-53	11	20	2	11	0	0	0	0	0	0
G-WGM-14	823	598	54	267	58	3	0	0	69	0
G-WGM-17	993	826	44	1	39	1	0	0	37	0
G-WGM-21	15	54	8	7	8	0	0	0	0	0
G-WGM-21-Dup	135	195	12	0	1	0	0	0	5	0
G-WGM-23	547	594	77	3	16	0	0	1	41	0
G-WGM-44	131	432	19	96	5	0	0	0	3	0
IL-01	6	134	5	58	3	1	0	1	3	0
IL-11	0	180	10	7	5	1	0	3	1	0
LL-01	6	35	10	2	5	0	0	0	0	0
LL-04	1	487	115	22	2	0	0	0	0	0
LL-06	178	359	10	2	1	0	0	0	10	0
TX-02	4	485	341	68	0	2	0	0	2	0
TX-20	3	285	16	426	1	0	0	0	0	0
TX-20-Dup	4	155	5	189	1	1	0	1	0	0
YK-01	0	41	5	8	6	0	0	0	1	0
YK-05	88	115	4	52	0	0	0	0	7	0
YK-20	52	107	5	0	3	0	0	0	4	0
YK-20-Dup	93	183	14	5	1	0	0	0	1	0
YK-24	3	237	474	514	0	0	0	0	1	0
YK-36	1	36	6	1	1	0	1	1	0	0
YK-39	0	15	0	0	16	0	0	0	0	0

Sample ID	Arsenic Trioxide (As_2O_3)	FeOx + As	FeO + As, mixed spectra	MnOx + As, mixed spectra	Organics + FeOx, As	Arsenopyrite (FeAsS)	As-Bearing Pyrite	Enargite (Cu_3AsS_4)	Fe-Ca Arsenate	Scorodite ($FeAsO_4 \cdot 2H_2O$)
YK-54	0	30	2	0	5	0	0	0	0	0
YK-59	4	134	4	7	0	0	0	0	0	0
YK-61	0	39	1	1	4	0	0	2	1	0
YK-62	0	28	3	0	3	0	0	0	0	0
YK-63	0	27	6	27	1	0	1	0	0	0
YK-66	3	59	6	1	0	0	0	0	1	0
YK-68	0	16	0	0	1	2	1	0	1	0
YK-69	4	82	6	1	2	0	0	1	1	0
YK-78	3	26	1	2	3	0	0	0	1	0

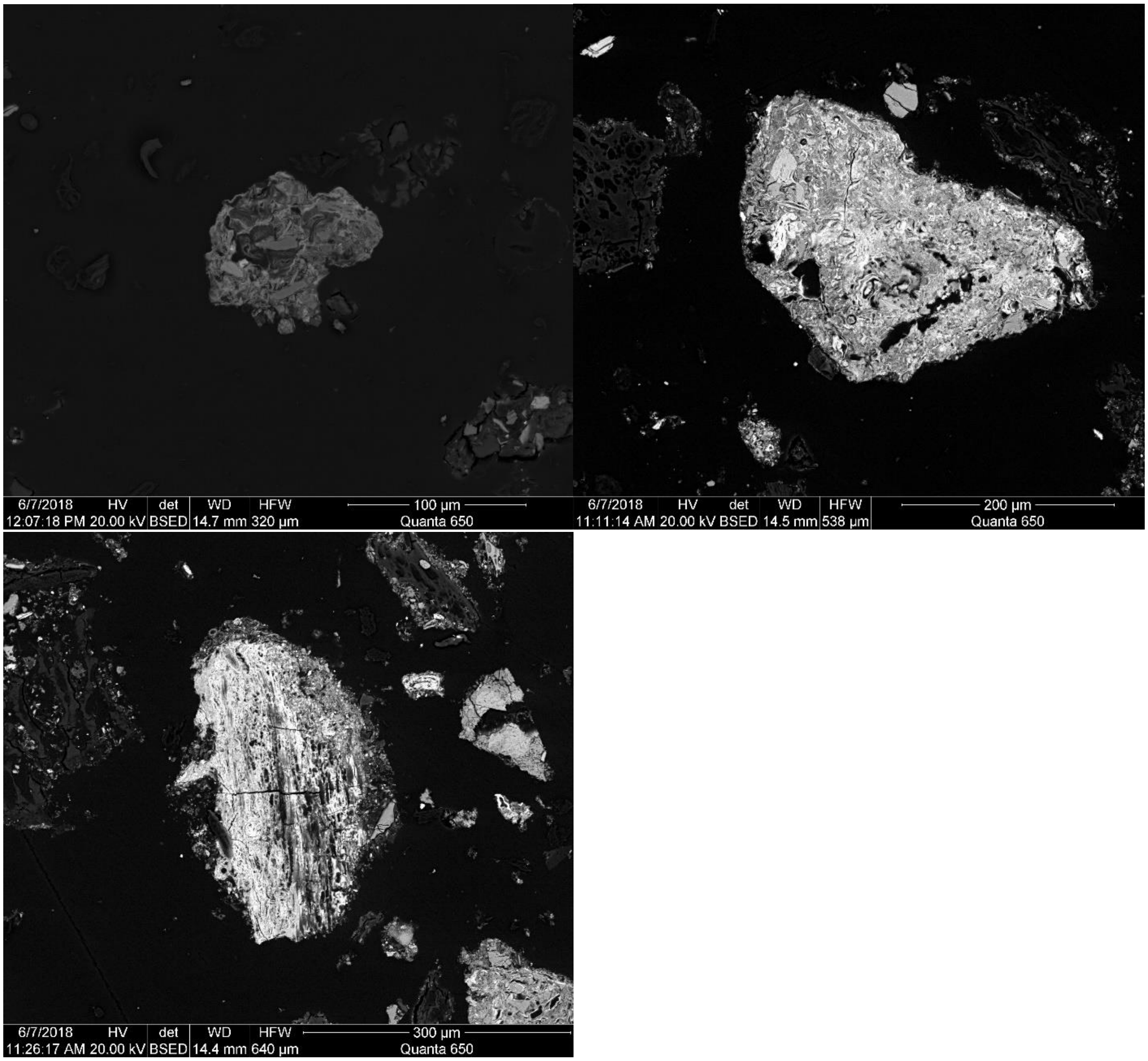

Figure 4-17: SEM backscatter images of a naturally forming iron oxides; the top left grain is from CM-22; the other two grains are from sample G-SIT-27.

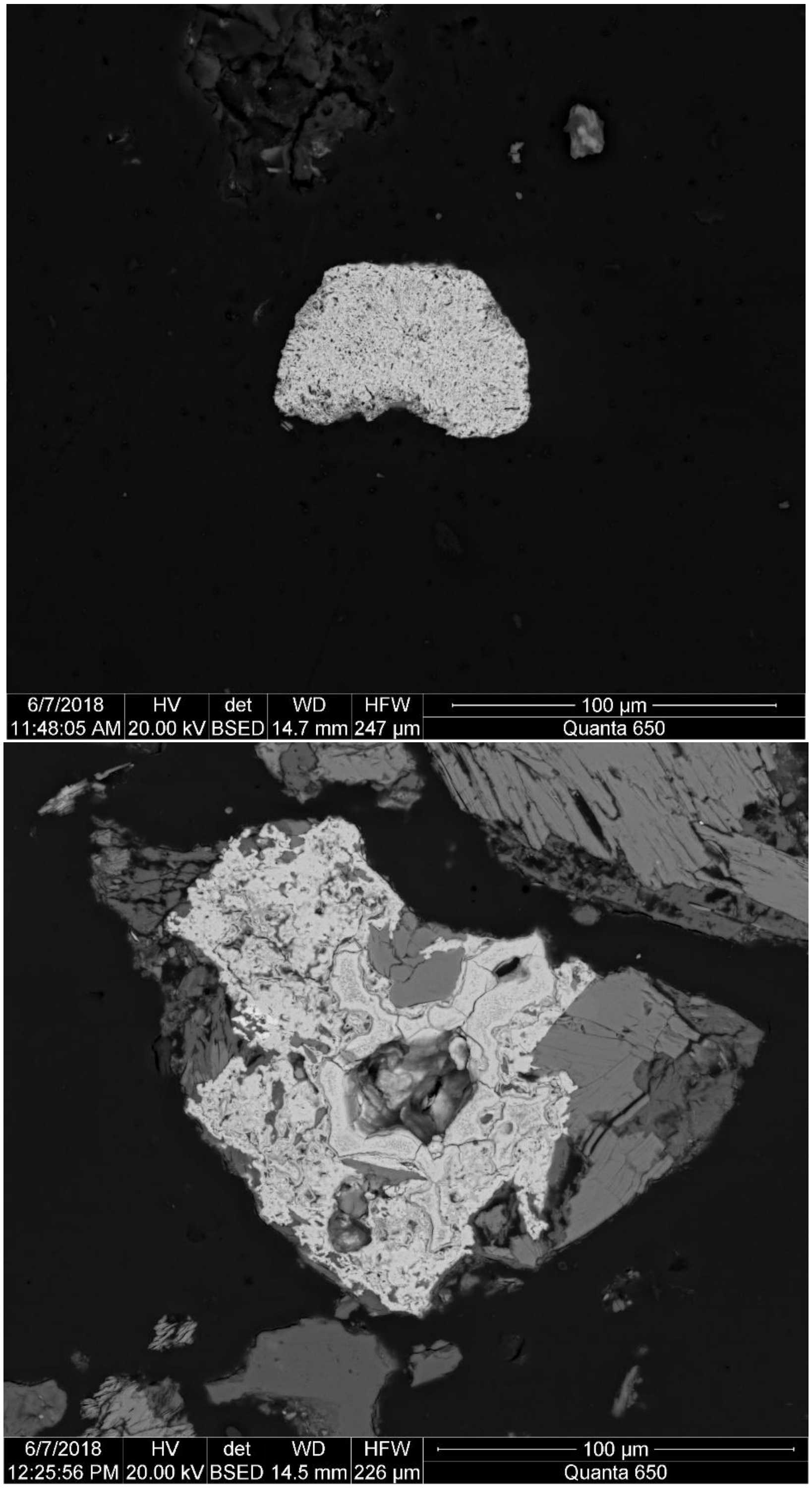

Figure 4-18: SEM backscatter images of a roaster-generated iron oxides from samples collected near Con Mine (CM-22 and CM-24, respectively).

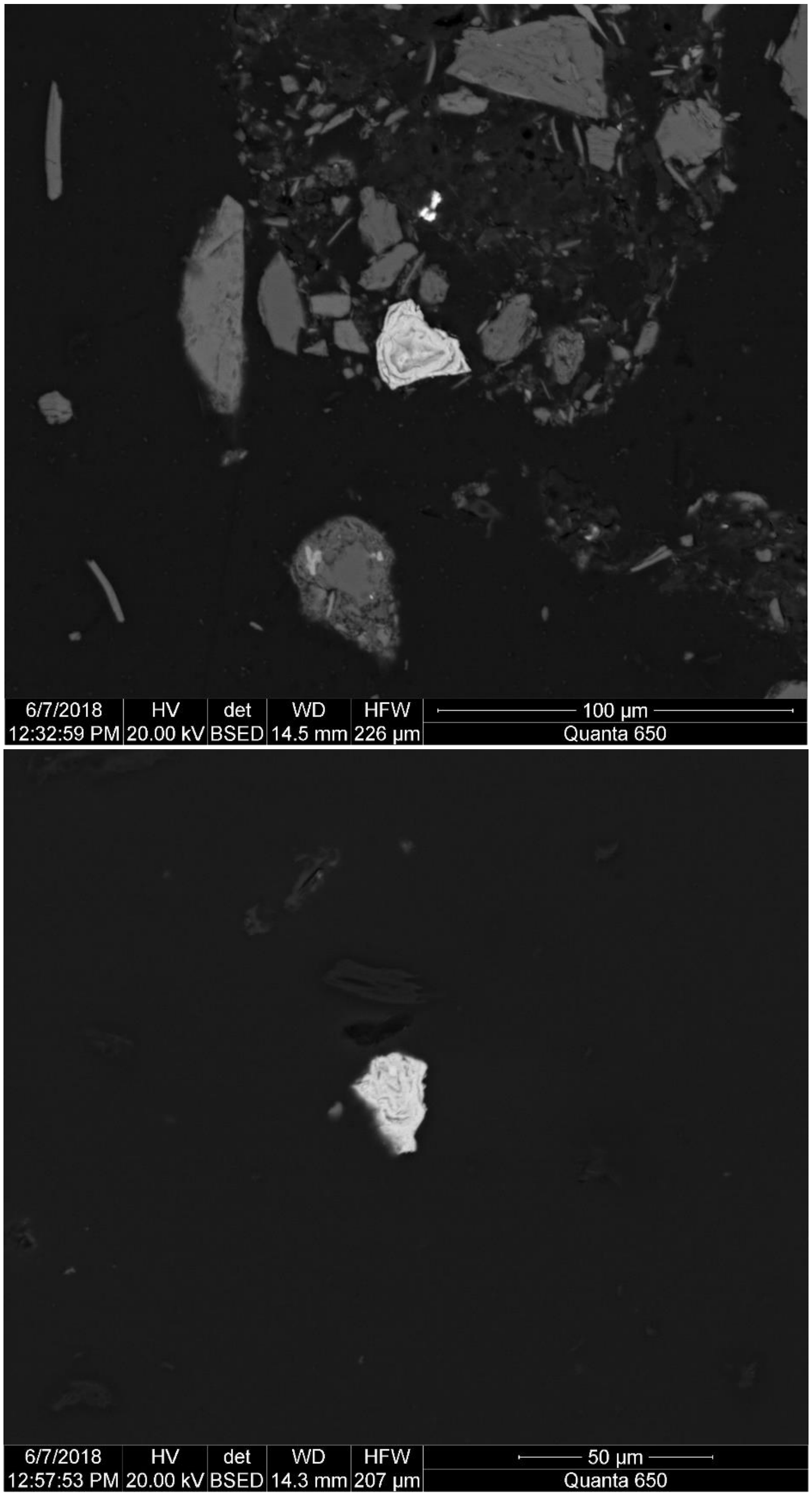

Figure 4-19: SEM backscatter images of a roaster-generated iron oxides from samples collected near Giant Mine (G-WGM-44 and G-WGM-14, respectively).

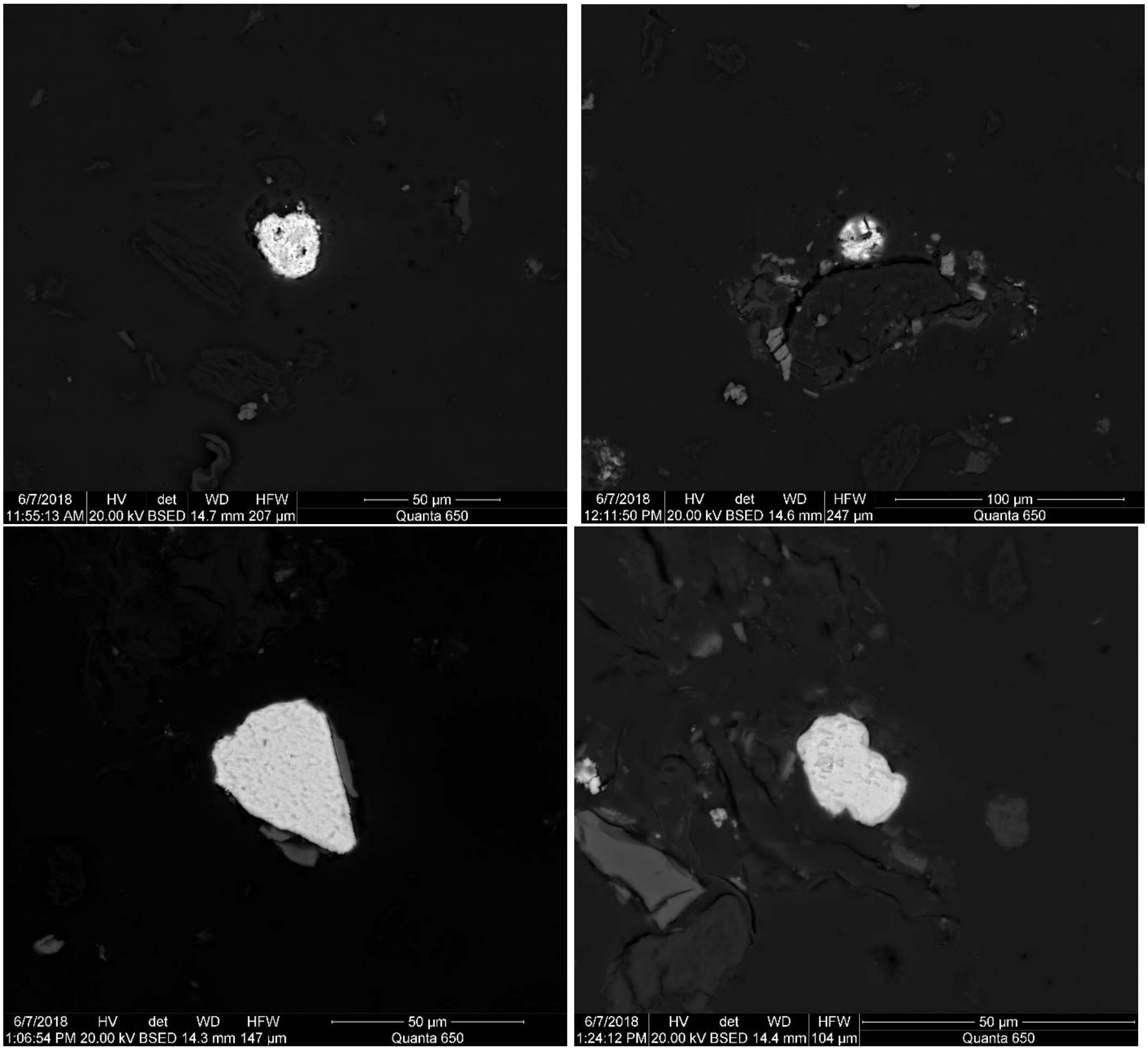

Figure 4-20: SEM backscatter images of arsenic trioxide grains from collected near Con Mine (top) and Giant Mine (bottom).

4.1.5 Arsenic oxidation state

The oxidation state of arsenic was evaluated in 22 samples (Table 4-3; Appendix L). The bulk XANES data indicate the dominate arsenic oxidation states were As (V) and As (III). As (-I) was present in lesser amounts, except in G-SIT-14 and G-SIT-20. LCF analysis of the bulk XANES data indicate As (-I) ranges from <5% to 27%, As (III) ranges from <5% to 98%, and As (V) ranges from <5% to 100%. Standards used in LCF analysis that had the best fit were arsenopyrite, maghemite-hematite with sorbed

As (III), arsenolite, goethite with sorbed As (III), maghemite-hematite with sorbed As (V), scorodite, tooeleite ($Fe_8(AsO_4, SO_4)_6(OH)_6 \cdot 5H_2O$) and yukonite ($Ca_3Fe(AsO_4)_2(OH)_3 \cdot 5H2O$). Other standards, like orpiment and realgar, did not improve LCF analysis suggesting these arsenic-sulphides (oxidation states of 2.5 and 2, respectively), were not present. Orpiment and realgar are not expected to persist in oxic environments like surface soils. Their absence is therefore not unexpected. The detection limit for LCF of XANES data is 5% (Foster and Kim, 2014).

Table 4-3: Oxidation state of arsenic in the soil PHL. Data analyzed by bulk XANES analysis. Data processed by LCF and normalizing the data after the fitting.

Sample	As(-I)	As(III)	As(V)
G-SIT-02	<5%	66%	34%
G-SIT-03	<5%	53%	47%
G-SIT-04	20%	77%	<5%
G-SIT-06a	<5%	<5%	96%
G-SIT-06b	<5%	13%	87%
G-SIT-10	<5%	14%	86%
G-SIT-14	23%	62%	15%
G-SIT-20	27%	13%	57%
G-SIT-20Dup	<5%	19%	81%
G-SIT-26	<5%	<5%	100%
G-SIT-27	<5%	<5%	100%
G-SIT-36	<5%	<5%	96%
G-SIT-37	<5%	32%	68%
G-SIT-43	<5%	19%	81%
G-SIT-45	<5%	92%	8%
G-SIT-47	<5%	22%	73%
G-SIT-53	<5%	52%	48%
LL-01	<5%	98%	<5%
LL-02	<5%	<5%	100%
LL-04	<5%	17%	83%
LL-06	<5%	<5%	91%
LL-07	<5%	66%	34%

4.2 Discussion

4.2.1 Controls on the Distribution of Arsenic in the PHL

Several factors are affecting the arsenic concentrations in PHL around the Yellowknife area. Analysis of Covariance (ANCOVA) was completed by running a General Linear Model (GLM) to analyze which factors have a significant effect. Arsenic concentrations and distance from Giant were not normally distributed and therefore these data were logarithmically transformed. Iterative modeling indicates that terrain units, soil horizon (O and A horizon), distance from Giant Mine, and direction from Giant Mine have a significant effect on arsenic concentration ($R^2_{(adjusted)} = 0.6461$; $p < 0.05$) in the PHL while elevation does not have a significant effect ($p = 0.80$) (Table 4-4). Several important points can be inferred from these results.

The most important factors on arsenic distribution in the PHL is distance from Giant Mine, soil horizon, and terrain unit. Distance was expected to be a main controlling factor because as many studies have shown, an increase in distance from the contamination point source results in a decrease in contaminant concentration (Reimann et al., 2009). Several studies from the Yellowknife area have also observed this trend of decreasing arsenic concentrations with increasing distance from the Giant Mine roaster (Hocking et al., 1978; Hutchinson et al., 1982; Kerr, 2006).

Table 4-4: Results of Analysis of Covariance by General Linear Model explaining arsenic distribution in the PHL. Distance from Giant Mine, terrain unit, and soil horizon are the most important factors in explaining arsenic distribution.

Source	Degrees of Freedom	F-Value	*p*-Value
Log of distance from Giant Mine	1	308.41	<0.001
Terrain unit	2	11.46	<0.001
Soil Horizon	2	9.47	<0.001
Direction from Giant Mine	3	2.74	0.038
Bedrock geology	3	2.64	0.055
Elevation	1	0.06	0.855

The significant impact of terrain units on arsenic concentrations is likely due to a combination of factors influenced by local conditions. The geographical location of terrain units appears to be influenced by elevation. Elevation for outcrop samples (n = 177; median = 207 masl) and forested outcrop samples (n = 95; median = 207 masl) was significantly higher than the elevation of forested samples (n = 39; median = 192 masl) (Table 4.5). This appears to have resulted in differences in total sample depth. The total sample depth for outcrop (n = 177; median = 12.6) and forest outcrop (n = 95; median = 13.7) samples was significantly shallower than forest samples (n = 39; median = 16.6). At higher elevations where outcrop samples were collected, and slopes of hill sides where often forest outcrop samples were collected, soil accumulation appears to be slow attesting to the shallower outcrop and forest outcrop samples. Forest samples likely have a thicker total depth due to the accumulation of decaying organic matter and erosion from surrounding areas.

The connection of shallow outcrop samples, topography, and arsenic concentrations was also noted by Bromstad et al. (2017). They suggested that arsenic-bearing airborne emissions deposited on outcrops at high elevations were washed down by precipitation and accumulated in topographic lows on the outcrops. The topographic lows consisted of shallow soil pockets, primarily O and A horizons (Bromstad et al., 2017; this study). The areas accumulating arsenic, the authours stated, were disconnected by exposed bedrock, restricting migration of arsenic from one shallow outcrop soil to another. Thus, once arsenic from airborne emissions accumulates in the soil, the arsenic appears to stay in place. Evidence shown in Figure 4-12 further supports this theory by showing topographic lows (elevation of 207 and 208 masl) has significantly higher arsenic than slightly elevated outcrops (elevation 210 masl). The limited mobility resulted in higher arsenic concentrations in outcrop and forest outcrop samples compared to forest samples.

Forest samples have substantial canopy cover, protecting the underlying soil from airborne emissions. Kerr (2006) noted that despite soils in forested areas of the Yellowknife region being lower in arsenic concentrations, leaf litter and bark were elevated in arsenic (626 mg/kg and 2,100 to 4,800 mg/kg, respectively). Kerr (2006) suggested the source of arsenic was from airborne emissions. Thus, the limited mobility of arsenic appears to be the case for forested areas as well: arsenic deposited on vegetation likely remains on the vegetation resulting in lower arsenic concentrations in forest soils.

Table 4-5: Terrain unit characteristics.

Parameter (units)	**Statistic**	**Forest**	**Forested Outcrop**	**Outcrop**
Arsenic (mg/kg)	median	43	170	180
	count	39	95	177
Elevation (masl)	median	192	207	207
	count	39	95	177
Total sample depth (cm)	median	16.6	13.7	12.6
	count	39	95	177

As suggested by Bromstad et al. (2017), the soil horizon depth also plays a significant role on arsenic concentrations in the PHL (Section 4.1.3). The reason the O-horizon has significantly less arsenic than the A-horizon can be linked to the roasting history. By the end of 1963, 86% of emissions were released from Giant Mine roasting (Wyre, 2008) and 85% of emissions were released by Con Mine roasting (Hocking et al., 1978). Since this time, it is likely the O-horizon has accumulated organic matter, such as pine needles, mosses, and leaf litter, at various levels of decomposition. Thus, the thickness of the O-horizon has likely increased since 1963. O-horizons take several years to tens of years to develop, depending on several factors including environmental parameters (temperature, aeration, soil pH, particle size, and soil moisture) and food source for soil organisms (Brady and Weil, 2004). Thus, despite soil samples from this study collected in regional proximity to each other, development of O-horizons since 1963 differ from sample to sample. Samples with a PHL consisting of only the O-horizon likely have the conditions to develop an O-horizon at a faster rate than soil samples with a PHL consisting of O+A and A-horizons. The development of a thicker O-horizon in soils since 1963 would effectively dilute the arsenic concentration, resulting in the lower arsenic concentrations in the PHL. The distinction of 1963 is important because two parallel electrostatic precipitators were installed at Giant Mine that were very efficient at reducing arsenic-bearing emissions (Wrye, 2008). After 1963, approximately 3,000 tonnes of arsenic emissions were released from Giant Mine (Wyre, 2008) and 368 tonnes from Con Mine (Hocking et al., 1978). Despite the O-horizon consisting of significantly less arsenic than A-horizon, the O-horizon is still high in arsenic (range = 1.0 to 3,000 mg/kg; median = 90.0 mg/kg). Thus, as the O-horizon was developing, a significant amount of arsenic emissions was still being released, resulting in elevated arsenic concentrations in the O-horizon.

Lower arsenic concentrations in the PHL because of a thicker O-horizon does not imply arsenic below the PHL is not elevated. Bromstad et al. (2015) presented arsenic concentrations in soil samples collected on the Giant Mine property that were above 1,000 mg/kg at 10 cm depth.

Arsenic concentrations can vary widely within a short distance, even within the same terrain unit (Figure 4-6). In the discussion above, soil horizon was a major contributor to the distribution of arsenic in the PHL across the entire dataset. This relationship appears to hold true on a smaller scale. For example, samples G-SIT-36, G-SIT-37, and G-SIT-38 (Figures 4-1, 4-2, 4-3, respectively) were collected within 10 metres of each other (Figure 4-21). The PHL for G-SIT-36 consisted entirely of A-horizon (Table 4-6). Consequently, G-SIT-36 had significantly higher arsenic concentrations in the PHL, compared to G-SIT-37 and G-SIT-38. Given that these samples are close to the Giant Mine roaster (less than 5 km), and given these samples were collected within 10 metres of each other, they likely received the same input of airborne emissions. Thus, it appears the O-horizon that developed where samples G-SIT-38 and G-SIT-37 were collected has diluted the arsenic concentration in the PHL

Table 4-6: Differences in soil horizons corresponding with differences in arsenic concentration in the PHL for samples depicted in Figure 4-21.

Sample	**Soil horizon in PHL**	**Arsenic (mg/kg)**
G-SIT-36	A	1100
G-SIT-37	O + A	390
G-SIT-38	O	210

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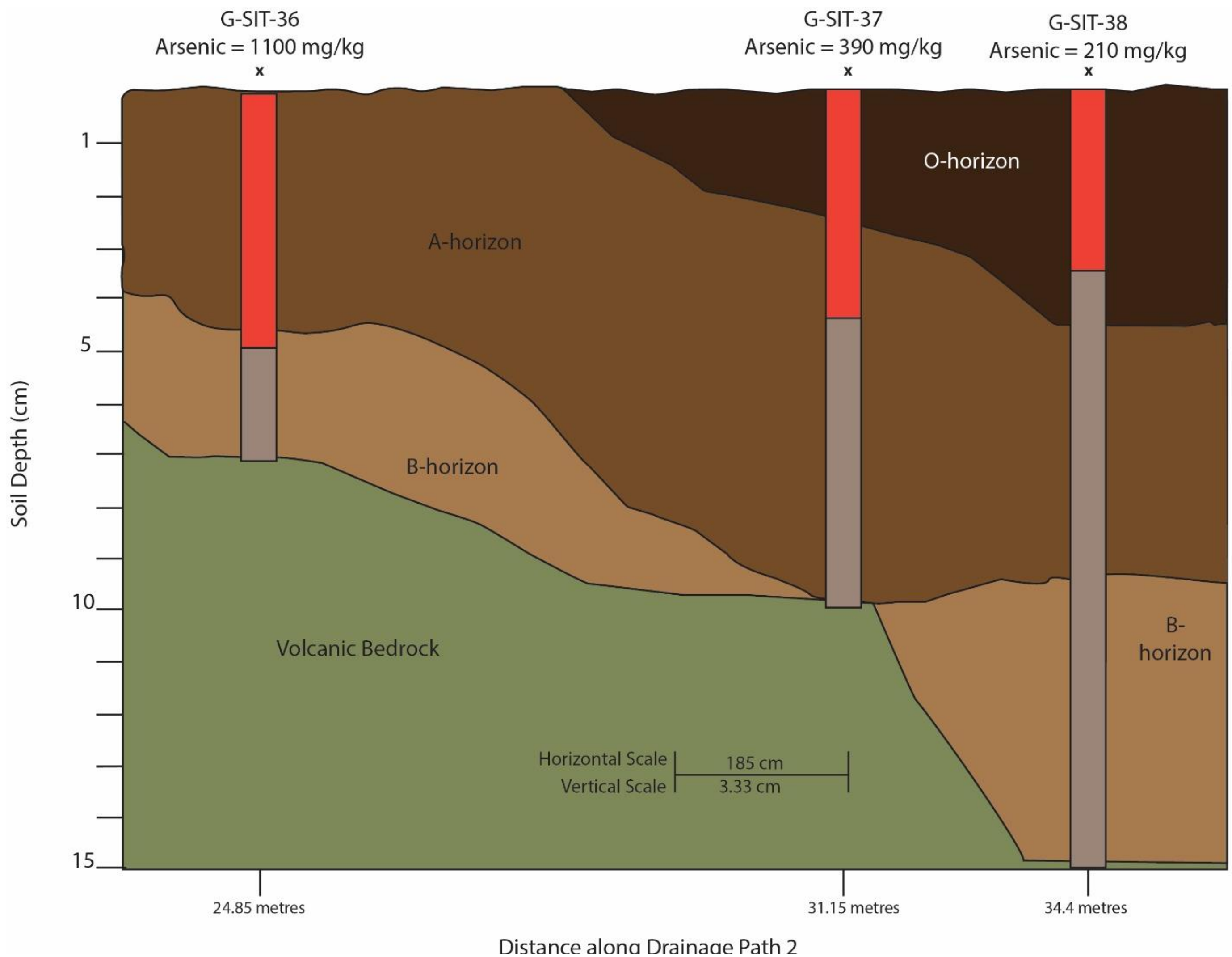

Figure 4-21: Cross-section drawing of soil samples G-SIT-36, G-SIT-37, and G-SIT-38. The red portion of the core sample represents the PHL for each sample; the remaining gray portion shows the total depth of the sample. Boundaries between each soil horizon and bedrock are interpreted based on the horizon depths in each of the samples. Vertical exaggeration is 55x. The PHL is at different depths for each sample because of compression during sample collection. Refer to Appendix D for details on how compression was calculated.

The GLM shows that wind direction has a less, but significant, effect on arsenic compared to terrain, distance, and soil horizon (Table 4-4). The dominant wind direction for the Yellowknife is from east to west. However, during the summer, winds come from the north at a higher velocity (Environment Canada, 2017). Thus, although the West and South wind directions showed a significant effect on the arsenic distribution (Section 4.1.1), when compared with other factors the direction the sample was collected is less significant. Furthermore, arsenic trioxide was found at YK-36, which is approximately 30 km east of Giant Mine. Despite this sample being in the opposite direction of the predominant wind direction, the presence of arsenic trioxide suggests factors other than wind are responsible for the dispersal of emissions. One possible explanation could be the exit velocity of emissions from the Giant Mine roaster. Results presented by Dillon (1995) show the exit velocity of roaster emissions from Giant Mine was variable. A higher exit velocity could allow particles to research higher altitudes, resulting in particles being transported farther from the source.

4.2.2 Evidence for distinguishing contamination from Giant Mine versus Con Mine

Previous studies have shown that Con Mine has contributed arsenic to the environment in the Yellowknife area (Hocking et al., 1978; Hutchison et al., 1982; Jamieson et al., 2017). Arsenic concentrations in the PHL with increasing distance from Giant Mine was presented in Jamieson et al. (2017). Our results show samples collected within 3 km of Con Mine fall above the trend line for the data set, suggesting the samples were likely influenced by an additional source. This additional source is suggested to be Con Mine roasting operations. This conclusion is supported by Hocking et al. (1978) which found arsenic concentrations increased near the Con Mine roaster and decreased farther away from Con Mine. Therefore, if the soils around the Con Mine property have been influenced by roasting at Con Mine, it is possible to identify differences in contamination compared to Giant Mine.

Con Mine processed pre-1970 tailings (i.e. tailings generated during the years of roasting) through an autoclave process to turn arsenic trioxide and roaster-generated iron oxides into a stable iron arsenate (MCML, 2007). No mineralogical study has been found on the tailings after they were processed in the autoclave. However, it is likely scorodite was the main product of this process (SRK, 2002; MCML, 2007) which produced no stack emissions. Scorodite was identified by EMPA (Section 4.1.4) in CM-24. Given the proximity of CM-24 (1.57 km) to Con Mine, the presence of scorodite in the sample is likely a result of windblown dust. Previous studies have not documented scorodite in tailings, soils, or dust on or around the Giant Mine Property (Walker et al. 2005; Walker et al., 2015; Bromstad et al., 2017; Bailey, 2017). Haffert and Craw (2008) presented data showing the dissolution of arsenic trioxide producing scorodite at a pH below 5.0. Given the pH of tailings at Giant Mine are near neutral (Walker, 2006) and the fact that Giant Mine did not use an autoclave in processing of tailings during mining or remediation (SRK, 2002), it is not surprising scorodite has not been observed at Giant Mine. Since scorodite is likely a result of wind blown dust, identification of scorodite in soil samples is not a reliable tool to distinguish Giant and Con mine contamination from stack emissions.

A more robust method to determine the difference between Giant and Con mine contamination is to examine the roasting history (Table 4-7; see Chapter 1 for a detailed description). For the duration of Con Mine roasting, an Edwards-type hearth roaster was employed, which produces hematite (α-Fe_2O_3) as the main iron oxide (MCML, 2007; Walker et al., 2015). The first few years of roasting at Giant Mine consisted of an Edwards-type hearth roaster, which was upgraded in 1952 to a Dorroc roaster (More and Pawson, 1978; Moir et al., 2006). In 1958, a fluosolids roaster was installed at Giant Mine and used until the mine closed in 1999 (More and Pawson, 1978; Moir et al., 2006; Walker et al., 2015). As a result, the bulk of roaster-generated iron oxide emissions released at Giant Mine were produced by the fluosolids roaster (Moir et al., 2006; Walker et al., 2015). The fluosolids roaster produces maghemite (γ-Fe_2O_3) as the main iron oxide (Walker et al., 2015). As described in Section 4.1.4, textures of roaster-derived iron oxides in soil samples collected around Con Mine generally consisted of spongy texture and lacked zoning whereas textures of roaster-generated iron oxides from Giant Mine were primarily concentric and porous. Similarly, Bailey (2017) described iron oxides from Giant Mine tailings as having concentric texture and Walker et al. (2015) noted iron oxides from Giant Mine tailings were mainly concentric while calcine collected at Con Mine consisted primarily of iron oxides with a spongy texture. Therefore, it is likely the roaster-generated iron oxides in soils from around Con Mine are hematite, and those from around Giant Mine are maghemite.

Walker et al. (2015) described two ways in which iron oxides forming in the roaster incorporate arsenic: arsenic, along with oxygen, chemisorbs to the surface of the iron oxides, and maghemite consisting of defect sites allowing arsenic to form a trigonal bridging complex. Hematite has a smaller surface area compared to maghemite, resulting in less availability for arsenic to chemisorb. Walker et al. (2015) reported all hematite grains analyzed in their study had <2% arsenic content, whereas maghemite grains ranged from <0.5 to 7%. Bailey (2017) reported the median arsenic concentrations in the iron oxides from the Giant Mine tailings as 2.55 wt% as As_2O_3 (n = 22). In comparison, the median arsenic concentrations in iron oxides from soils collected around Con Mine report a median of 0.29 wt% as As_2O_3. Therefore, the arsenic content in iron oxides from the soil samples collected near Con Mine are significantly less than the arsenic content in the iron oxides reported from Giant Mine tailings ($p < 0.001$).

Based on Hocking et al. (1978), Hutchison et al. (1982), and Jamieson et al. (2017), the soil samples around Con Mine are likely influenced by Con Mine roasting. Furthermore, based on Walker et al. (2015), these soils affected by Con Mine roasting likely contain hematite as the main iron oxide. As mentioned above, hematite has less surface area and does not have defects, compared to maghemite. Thus, the difference in arsenic content observed in iron oxides from Giant and Con mine is a result of their respective roasting operations. Therefore, identification of iron oxides, the arsenic content of the iron oxides, and texture of iron oxides are defining features that can be used to distinguish Giant Mine contamination from Con Mine contamination.

Table 4-7: Summary of the characteristics of roasting at Giant and Con mines. See Chapter 1 for a more in-depth discussion.

Characteristic	Con Mine	Giant Mine
Roaster type	Edwards type (1948 – 1970)[1,2]	Edwards (1949-1952)[3,4] Dorroc (1952-1958)[3,4] Fluosolids (1958 -1999) [2,3,4]
Calcine origin[5]	Edwards[2]	Fluosolids[2]
Dominant Fe oxide	Hematite[2]	Maghemite[2,6]
Arsenic content	Hematite contains <2% [2]	Maghemite <0.5 to 7% [2]
Texture	Greater spongy, less concentric[2]	Greater concentric[2,6]
Roasting temperature	First stage – 500[1] Second stage – 550[1]	First stage – 500[2] Second stage – 500[2]

[1]MCML (2007)
[2]Walker et al. (2015)
[3]Moir et al. (2006)
[4]More and Pawson (1978)
[5]Walker et al. (2015) used calcine from Edwards-type hearth roaster from Con Mine and fluosolids from Giant Mine. It should be noted that the other methods used at Giant Mine also created calcine (Walker et al., 2005).
[6]Bailey (2017)

4.2.3 Anthropogenic Arsenic or Geogenic Arsenic

There has long been a theory that arsenic is naturally high in Yellowknife (GNWT, 2003), as evident by local residential and industrial arsenic guidelines (GNWT, 2003) which are more than 13 times the CCME (2015) soil guideline for arsenic. Figure 4-5 shows arsenic drastically decreasing with distance. However, this is hard to interpret solely based on a map that simply plots concentration at specific locations. In many geochemical studies interpolation maps are created to view the distribution of a particular element or parameter. For example, as discussed in Chapter 2.6, Salminen et al. (2005) used an interpolation map of arsenic in the top 20 cm for samples collected across Europe, showing elevated arsenic concentrations coincide with the extent of glaciation and highlighted areas of industrial activity. Figure 4-22 is an interpolation map based on arsenic concentrations collected in the PHL collected by Wrye (2008), Bromstad (2011), Maitland (2018) and this study. The interpolation used the inverse distance weighted (IDW) method (Section 3.3.8). It is important to note that interpreted arsenic concentration on the map may not be the true value. This map is meant to show general trends, rather than predicting the concentration of arsenic in an exact location. One limitation to this interpolation method is that local variability is lost. For example, the grid near Fred Henne Territorial Park ranged from 32 to

3,000 mg/kg; however, the grid is within the 341 to 1,000 mg/kg category. Despite this limitation, important trends can be observed.

Arsenic is highest near the mine sites, as expected based on data presented in Figure 4-5. Elevated arsenic concentrations extend in a more linear, north-south trend, rather than horizontal as one might expect given the dominant wind direction. This is similar to the observed pattern reported by Dillon (1995) and discussed in Section 2.6. This linear trend may be a result of the stronger north-south winds in the summer (Pinard et al., 2008; Environment Canada, 2017). It is likely also affected by the fact that Con Mine is essential due south of Giant Mine. Thus, the two point sources of contamination are themselves in a linear trend. At the outer edge of the Yellowknife City footprint, the interpolation suggests arsenic concentrations drop below 100 mg/kg, and at approximately 15 km to the west from the Giant Mine roaster, and approximately 8 km to the east, arsenic is interpolated to drop below 50 mg/kg. This map shows that arsenic concentration in the PHL is below the perceived background value of 150 mg/kg (GNWT, 2003) beyond the city limits. However, the map shows that arsenic tends to be higher than the CCME (2015) soil guideline of 12 mg/kg, suggesting that arsenic might in fact be naturally elevated. Hocking et al. (1978) suggested a “natural” background arsenic value of less than 25 m/kg. Based on the interpretation provided by Figure 4-22, 25 mg/kg appears to be more appropriate than current background value of 150 mg/kg (GNWT, 2003).

To further compare natural and roasting-derived arsenic sources in soils, the arsenic concentration in each phase was calculated (Table 4-8). Roaster-derived iron oxides and naturally forming iron oxides have been distinguished, as explained in Section 4.1.4. Therefore, the sum of anthropogenic arsenic (arsenic trioxide and roaster-derived iron oxide with arsenic) was divided by aqua regia arsenic results. The percent of anthropogenic arsenic in the soil PHL ranges from 5 to 100%, with a median of 83% (n = 44). Furthermore, 57% (n = 44) of samples analyzed are equal to or greater than 80% anthropogenic arsenic. Based on this method, anthropogenic arsenic accounts for the majority of arsenic in the PHL. This information, in combination Figure 4-22, suggests background arsenic in the Yellowknife area is significantly lower than 150 mg/kg. Further work is required to determine a more representative background arsenic value and an update to current arsenic guidelines.

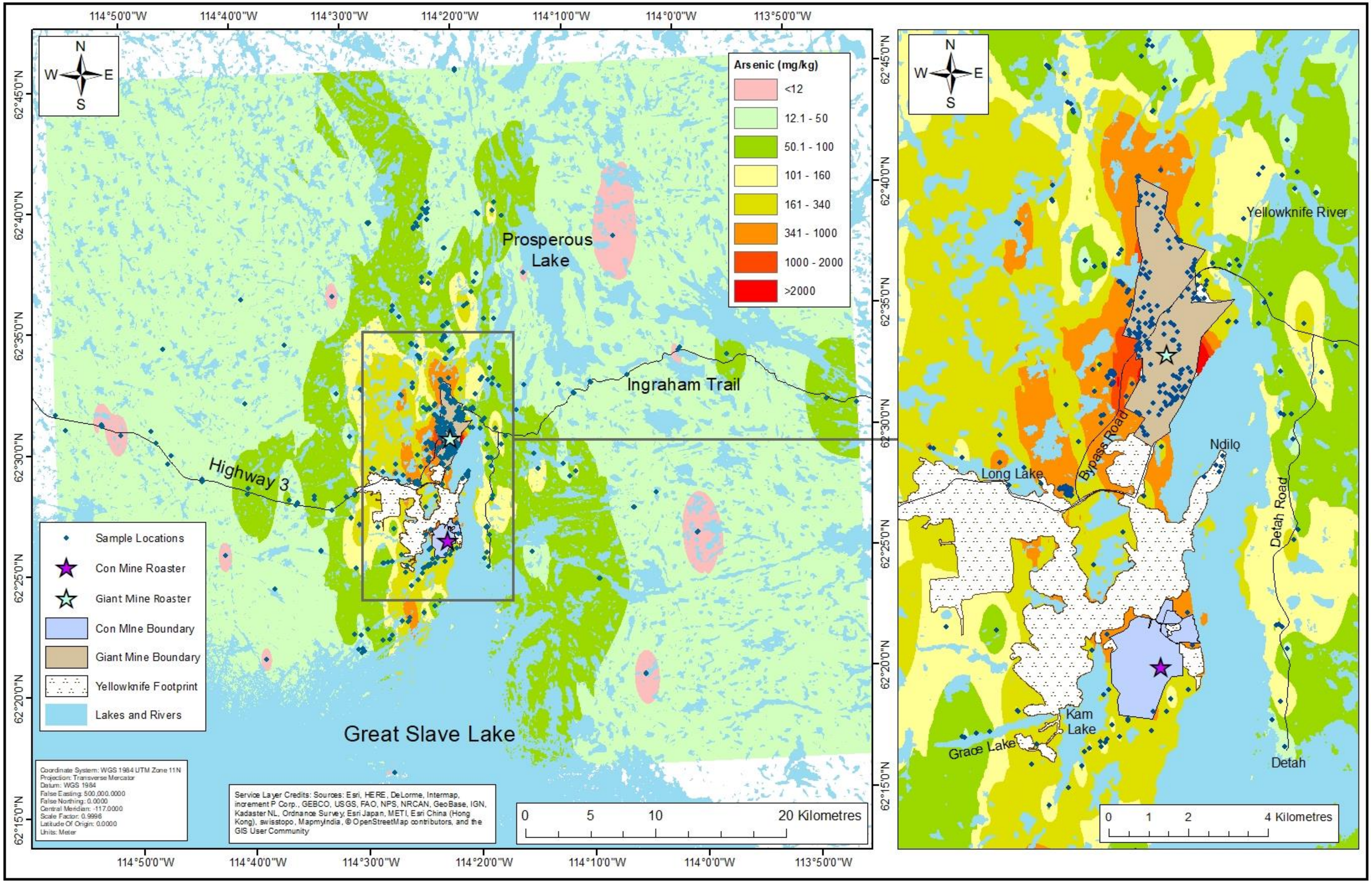

Figure 4-22: Interpolation map of arsenic in the PHL using the IDW method in ArcGIS.

Table 4-8: Arsenic in each As-bearing host phase (mg/kg). The column on the right indicates the total amount of arsenic in the samples that is from anthropogenic (ore roasting) processes. Details of how the results were calculated are presented in Appendix J.

	Anthropogenic Arsenic		Natural Arsenic									Summary	
Sample ID	**Arsenic Trioxide**	**Roaster FeOx with As**	**Arsenopyrite**	**As-Bearing Pyrite**	**Enargite**	**Fe-Ca Arsenate**	**Natural FeOx with As**	**MnOx with As**	**Organics and FeOx with As**	**Realgar**	**Scorodite**	**Arsenic (aqua regia)**	**Anthropogenic Arsenic**
CM-08	218.27	36.20	0.00	0.00	0.40	4.02	12.76	253.39	0.53	14.42	0.00	540.00	47%
CM-18	188.14	48.75	0.00	0.00	0.96	0.00	16.70	13.48	1.97	0.00	0.00	270.00	88%
CM-22	319.23	133.58	0.00	0.00	0.00	2.63	74.53	58.62	1.41	0.00	0.00	590.00	77%
CM-23	42.89	69.60	0.00	0.00	2.17	201.83	11.81	0.12	1.58	0.00	0.00	330.00	34%
CM-24	151.53	372.43	0.00	0.08	0.00	2.46	51.25	3.32	111.99	0.00	16.94	710.00	74%
CM-25	1.45	181.28	0.00	0.00	0.11	0.00	354.49	32.55	0.12	0.00	0.00	570.00	32%
Grace-01	63.61	16.79	0.00	0.00	0.00	0.00	0.22	0.00	0.37	0.00	0.00	81.00	99%
Grace-05	0.00	368.82	0.00	0.00	23.67	2.00	37.21	1.22	7.08	0.00	0.00	440.00	84%
G-SIT-03	344.94	44.17	0.00	0.00	0.00	0.00	0.65	0.00	0.24	0.00	0.00	390.00	100%
G-SIT-20	380.15	6.19	0.00	0.00	0.00	2.26	0.11	0.00	0.00	1.29	0.00	390.00	99%
G-SIT-20-Dup	141.67	10.44	0.00	0.00	0.00	0.00	4.35	1.21	0.00	2.33	0.00	160.00	95%
G-SIT-27	31.70	1408.51	0.00	0.00	0.00	0.00	1557.67	1.71	0.41	0.00	0.00	3000.00	48%
G-SIT-47	299.15	475.27	6.24	0.00	0.00	0.00	304.11	15.24	0.00	0.00	0.00	1100.00	70%
G-SIT-53	316.93	89.11	0.00	0.00	0.00	0.00	5.04	38.92	0.00	0.00	0.00	450.00	90%
G-WGM-14	1924.42	45.48	1.29	0.00	0.00	31.13	4.57	89.42	3.69	0.00	0.00	2100.00	94%
G-WGM-17	1542.95	35.30	0.11	0.00	0.00	14.16	5.95	0.05	1.48	0.00	0.00	1600.00	99%
G-WGM-21	2463.89	1547.24	0.00	0.00	0.00	0.00	410.26	112.93	165.69	0.00	0.00	4700.00	85%
G-WGM-21-Dup	1807.56	83.71	0.00	0.00	0.00	5.69	2.96	0.00	0.08	0.00	0.00	1900.00	100%
G-WGM-23	1579.49	166.35	0.00	0.00	0.10	14.87	36.16	0.47	2.57	0.00	0.00	1800.00	97%
G-WGM-44	1540.86	192.79	0.00	0.00	0.00	10.74	10.09	144.41	1.12	0.00	0.00	1900.00	91%
IL-01	8.51	34.22	20.26	0.00	3.12	4.95	1.36	47.48	0.11	0.00	0.00	120.00	36%
IL-11	0.00	9.22	0.26	0.00	2.08	0.02	0.73	0.39	0.29	0.00	0.00	13.00	71%
LL-01	199.36	123.77	0.00	0.00	0.00	0.00	43.99	2.69	10.20	0.00	0.00	380.00	85%
LL-04	1.21	260.56	0.00	0.00	0.00	0.00	167.20	20.81	0.22	0.00	0.00	450.00	58%
LL-06	246.38	40.81	0.00	0.00	0.00	1.40	1.16	0.18	0.07	0.00	0.00	290.00	99%
TX-02	0.78	39.66	0.86	0.00	0.00	0.13	157.10	1.46	0.00	0.00	0.00	200.00	20%
TX-20	15.59	379.00	0.00	0.00	0.00	0.00	11.79	243.42	0.20	0.00	0.00	650.00	61%
TX-20-Dup	191.48	491.46	4.67	0.00	4.94	0.00	12.26	495.05	0.14	0.00	0.00	1200.00	57%

Sample ID	Anthropogenic Arsenic		Natural Arsenic									Summary	
	Arsenic Trioxide	Roaster FeOx with As	Arsenopyrite	As-Bearing Pyrite	Enargite	Fe-Ca Arsenate	Natural FeOx with As	MnOx with As	Organics and FeOx with As	Realgar	Scorodite	Arsenic (aqua regia)	Anthropogenic Arsenic
YK-01	0.00	10.21	0.00	0.00	0.00	0.62	4.72	2.15	0.30	0.00	0.00	18.00	57%
YK-05	309.98	36.84	0.00	0.00	0.00	5.12	1.61	16.46	0.00	0.00	0.00	370.00	94%
YK-20	672.16	69.39	0.00	0.00	0.00	12.64	2.66	0.00	3.15	0.00	0.00	760.00	98%
YK-20-Dup	385.95	35.88	0.00	0.00	0.00	0.22	4.87	3.03	0.04	0.00	0.00	430.00	98%
YK-24	0.55	8.89	0.00	0.00	0.00	0.00	123.17	47.38	0.00	0.00	0.00	180.00	5%
YK-36	7.34	30.69	0.00	0.25	2.07	0.00	12.16	0.38	0.11	0.00	0.00	53.00	72%
YK-39	0.00	46.37	0.00	0.00	0.00	0.00	0.00	0.00	16.63	0.00	0.00	63.00	74%
YK-54	0.00	8.63	0.00	0.00	0.00	0.00	0.72	0.00	0.66	0.00	0.00	10.00	86%
YK-59	4.39	8.11	0.00	0.00	0.00	0.00	0.28	0.22	0.00	0.00	0.00	13.00	96%
YK-61	0.00	1.31	0.00	0.00	0.11	0.07	0.02	0.01	0.08	0.00	0.00	1.60	82%
YK-62	0.00	4.66	0.00	0.00	0.00	0.00	0.64	0.00	0.31	0.00	0.00	5.60	83%
YK-63	0.00	17.91	0.00	1.80	0.00	0.00	1.73	18.52	0.05	0.00	0.00	40.00	45%
YK-66	3.63	5.90	0.00	0.00	0.00	0.13	2.15	0.18	0.00	0.00	0.00	12.00	79%
YK-68	0.00	1.69	4.30	0.05	0.00	0.13	0.00	0.00	0.03	0.00	0.00	6.20	27%
YK-69	2.26	5.13	0.00	0.00	0.10	0.41	0.92	0.01	0.07	0.00	0.00	8.90	83%
YK-78	4.15	6.29	0.00	0.00	0.00	0.07	0.05	0.24	0.20	0.00	0.00	11.00	95%

Chapter 5

Conclusions and Future Work

5.1 Conclusions

The results from this study show arsenic concentrations in the PHL within 30 km of the City of Yellowknife range from 1.0 to 4,700 mg/kg (Figures 4-5 and 4-6; Appendix H). Arsenic concentrations are highest near the Giant and Con mine roasters and decrease drastically beyond 10 km to the west from these two point sources (Figure 4-22). To the east of Giant and Con mines, arsenic concentrations are generally below 100 mg/kg beyond 2 km. Elevated arsenic near the roasters and less arsenic farther away was also observed in Hocking et al. (1978), Hutchison et al. (1982), and Jamieson et al. (2017). Additional factors identified in this study having a significant effect on the distribution of arsenic concentrations in the PHL are terrain units (outcrop, forest outcrop, and forest), and soil horizons within the PHL (O and A horizons) (Table 4-6 and Figure 4-21).

Outcrop and forest outcrop soil samples contain significantly higher arsenic concentrations compared to forest samples (Table 4-5 and Figure 4-7). Shallow soil pockets develop on outcrops in the Yellowknife area. Arsenic-bearing emissions deposited on the surrounding exposed bedrock was washed down into these shallow soil pockets. Once the arsenic emissions are in these soil pockets, their mobility is restricted (Bromstad et al., 2017) resulting in high arsenic concentrations in the soil pockets. Shallow soil pockets also developed on shallow slopes of outcrops, or on top of outcrops where significant canopy cover developed, resulting in the elevated arsenic concentrations in forest outcrop soil samples. The limited mobility of arsenic resulting in high arsenic concentrations in outcrop and forest outcrop samples, also resulted in lower arsenic concentrations in the forested areas. The canopy cover from forested areas effectively blocked the underlying soil from the airborne arsenic emissions based on data provided by Kerr (2006). Bark, leaves, and pine needles in forest areas contained elevated arsenic suggesting the emissions were falling on the vegetation but not reaching the soil because of the limited mobility of arsenic emissions (Kerr, 2006; Bromstad et al., 2017).

The differences in the rate of O-horizon development has resulted in varying arsenic concentrations in the PHL that can be observed on the local scale (within 10 metres, Figure 4-21) and on the regional scale. Soil samples with a PHL consisting of only O-horizon have significantly lower arsenic than soil samples with a PHL containing only A-horizon (Table 4-6, Figure 4-21). This observation relates to the roasting history of Yellowknife. Since the bulk of emissions were released in 1963 (Hocking et al., 1978; Wrye, 2008), the O-horizon has been developing at varying rates, depending on several factors, including temperature, soil pH, soil moisture, aeration, and food for soil organisms (Brady and Weil, 2004). The samples that developed a thicker O-horizon effectively diluted the arsenic concentrations in the PHL. After 1963, emissions were still being released, resulting in elevated arsenic concentration in the O-horizon, but still significantly less than the A-horizon.

This study has shown that the arsenic hosts in the PHL are predominately roaster-derived iron oxides with arsenic, arsenic trioxide, and natural iron oxides containing arsenic (Table 4-8). Anthropogenic arsenic accounts for 80% arsenic or more in 57% (n = 44) samples analyzed. This calculation is based on the method of distinguishing roaster-derived iron oxides from natural iron oxides as described in Section 4.1.4 and the method of calculating arsenic distribution described in Appendix J. These suggest that the current background of 150 mg/kg (GNWT, 2003) for arsenic is significantly higher than the true background value, and that a much lower background value would be more accurate. Hocking et al. (1978) suggested the arsenic background value is at maximum 25 mg/kg, which these data appears to support. However, further work is still required to determine the true background value of arsenic, as discussed below. The residential and industrial remediation guidelines developed for the Yellowknife area were based on the background value of 150 mg/kg and limited public exposure to arsenic contaminated soils (GNWT, 2003). These data show the arsenic concentrations are elevated in the PHL and in easily assessable areas, such as the Bypass Road and Fred Henne Territorial Park. Therefore, these data refute both arguments made in GNWT (2003) for a background arsenic value of 150 mg/kg.

Not only should the background value be revisited, but the remediation guidelines need to be revisited as well. The residents of Yellowknife should not have to tolerate elevated arsenic soil concentrations resulting from roasting operations.

Despite the proximity of Giant and Con mines, operational history of the two mines has been very different, dictated by the nature of the ore (Section 1.2.3, 1.2.4, and 4.2.2). The results of this study show Con Mine roaster-generated iron oxides are typically hematite and have a median arsenic concentration of 0.29 wt% as As_2O_3. Furthermore, roasted-generated iron oxides from Giant Mine are primarily maghemite and contain up to 7 wt% arsenic (Walker et al., 2015). Walker et al. (2015) described the reason maghemite contains more arsenic than hematite is because maghemite grains have a higher surface area than hematite grains, allowing more arsenic to chemisorb to its surface. Additionally, maghemite has defects sites allowing for arsenic to form a trigonal binding complex (Walker et al., 2015). Therefore, Giant Mine contamination can be distinguished from Con Mine contamination in soils based on the presence of roaster-derived maghemite and hematite grains and their respective arsenic content. In Jamieson et al. (2017) we presented results indicating samples within 3 km of Con Mine were influenced by Con Mine roasting. The above results confirm this conclusion. Samples CM-08, CM-18, CM-22, CM-23, CM-24, and CM-25 were collected within 2.5 km of Con Mine, identified by Jamieson et al. (2017) as being influenced by Con Mine roasting, and contain predominately hematite iron oxides with a median arsenic concentration of 0.29 wt% as As_2O_3.

5.2 Future Work

Recommendations for future work on the arsenic concentrations in Yellowknife soils, determining background arsenic values for Yellowknife, and distinguishing Giant Mine contamination from Con Mine contamination are as follows:

- Since arsenic trioxide was identified in a sample 30 km from Giant Mine, additional sampling is required to find the maximum extent of contamination. Additional sampling at farther distances from the roasters will also aide in determining the natural background arsenic value. Samples should be collected from all three terrain units and distributed evenly. If possible, samples from all three terrains units should be collected in close proximity to each other. Bulk geochemistry and detailed mineralogy should be completed on these samples to confirm if arsenic is anthropogenic or geogenic.

- Contamination of the aluminum tubes and lead weight provided a significant hurdle in data analysis, primarily because arsenic could not be compared to with antimony, a relationship shown in previous studies from Giant Mine (Riveros et al., 2000; Bromstad, 2011; Fawcett and Jamieson, 2011; Bromstad et al., 2017). Rather than using the aluminum tube and relying on an additional source to drive the tube into the ground, a soil corer should be used to avoid contamination issues (ITM Instruments Inc., 2018). Since the soil corer is half the diameter of the aluminum tubes, multiple samples will likely be required to get sufficient material. However, several benefits will be achieved from using a soil corer: samples will be collected in highly efficient manner; compaction will not have to be calculated; the soil profile can be viewed in the field and thus each horizon can be measured in the field rather than in the lab; soil samples collected can be put into plastic bags (either Ziploc or Whirl pak brands), which will allow material from multiple samples to be easily homogenized; and samples will be much easier to transport, compared to aluminum core samples.
- Analysis of iron oxide grains by micro X-ray diffraction and micro-XANES in soil samples collected around Con Mine to confirm if the iron oxides are in fact hematite. If the iron oxides are confirmed as hematite, EMPA analysis should be completed on the hematite grains to determine the arsenic concentration.
- Data presented in this study suggest a thicker O-horizon effectively dilutes the soil arsenic concentrations in the PHL. It is expected that samples from this study consisting of only an O-horizon in the PHL will show higher arsenic concentrations in the A-horizon. If confirmed, detailed mineralogical analysis, at 1 to 2 cm intervals, should be conducted on these samples. Analysis at this high of resolution will determine the vertical extent of anthropogenic

contamination and if in fact the arsenic trioxide contamination is not mobile. Confirming the mobility of arsenic trioxide will aide in identifying remediation solutions.

- One such possible remediation solution of soil contaminated with arsenic trioxide is to cover the contaminated area with organic material. This study has shown that a thicker O-horizon dilutes the arsenic concentration in the PHL. Therefore, a study into whether it would be feasible to cover areas elevated in arsenic with organic material as a remediation technique would prove beneficial to the City of Yellowknife. Often, remediation of contaminated soil requires the soil to be excavated, like those on the Con Mine property (MCML, 2007). However, to do this for the entire area that has been contaminated (anthropogenic arsenic found 30 km from the Giant Mine roaster in this study) would not be practical. The addition of organic material may be more practical but investigations into unexpected consequences is warranted and is a key area of future research. An assessment would also have to be done to determine the areas that pose the greatest risk to the public, such as the Bypass Road and Fred Henne Territorial Park. Data presented in this study will help with that assessment.

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Appendix A

Soil Sample Locations and Descriptions

Sample ID	Location	QA/QC	Date	Elevation (m) Recorded with GPS	Coordinates Decimal Degrees		Type	Soil Colour	Soil Texture	In Field Measurements					Public Health Layer	Sample Comments
										Top of Core to (cm):			Core Length (cm)	Sample Depth (cm)		
										Top of Sample		Ground Surface				
					Latitude	Longitude				In Ground	AC					
G-SIT-01	Bypass Road	P	20-Jul-16	210	62.47306	-114.41206	Forest Canopy	Dark Brown	Clayey	18.8	0	0	12.3	12.3	1.98	Organic rich, lots of peat, in forested area just off outcrop.
G-SIT-02	Bypass Road	P	20-Jul-16	204	62.47299	-114.41109	Outcrop	Brown	Clayey	11.7	1	10.3	7.7	6.7	4.14	Soil pocket in outcrop, moss growing in it, some organics.
G-SIT-03	Bypass Road	P	20-Jul-16	203	62.47344	-114.40932	Forest Canopy Outcrop	Light Brown	Silty clayey	9.2	2	1.4	12	10	2.81	Large outcrop soil pocket, near edge, lots of trees.
G-SIT-04	Bypass Road	P	20-Jul-16	201	62.47328	-114.40924	Outcrop	Light Brown	Silty	2	0	0	11.7	9.7	4.15	Small outcrop soil pocket, small trees (after first few cm soil turns light gray).
G-SIT-05	Bypass Road	P	20-Jul-16	200	62.47317	-114.40824	Forest Canopy Outcrop	Brown	Silty	19.7	2.9	19.2	12.1	9.2	4.74	Moderate outcrop soil pocket, many trees.
G-SIT-06	Bypass Road	P	20-Jul-16	201	62.47286	-114.40732	Forest Canopy Outcrop	Brown	Clayey	2.4	2.4	6.2	8.1	5.7	15.00	On edge of steep outcrop face (bottom), many trees, slightly damp.
G-SIT-07	Bypass Road	P	20-Jul-16	203	62.47304	-114.40866	Forest Canopy Outcrop	Dark Brown/Black	Clayey	21.4	2.2	19	10.8	8.6	3.91	Organic rich soil, soil pocket at very edge of outcrop, trees and moss.
G-SIT-08	Bypass Road	P	20-Jul-16	209	62.47243	-114.40871	Outcrop	Black	Clayey, 3 cm of moss	21.7	1.4	21.3	10	8.6	4.78	Damp, moderate soil pocket on outcrop, few trees.
G-SIT-09	Bypass Road	P	20-Jul-16	209	62.47219	-114.40828	Outcrop	Brown	Clayey, 3 cm of moss	10.7	1	10.6	10.7	9.7	4.95	Small soil pocket, moss and dead tree.
G-SIT-10	Bypass Road	P	20-Jul-16	208	62.47189	-114.40837	Outcrop	Dark Brown	Clayey, 6 cm of moss	17.1	1.8	13.9	16.3	14.8	4.11	Small outcrop soil pocket with moss and a tree, damp.
G-SIT-10-Dup	Bypass Road	FD	20-Jul-16	208	62.47189	-114.40837	Outcrop	Dark Brown	Clayey, 6 cm of moss	18.2	1.5	12.4	16.5	15	3.61	Small outcrop soil pocket with moss and a tree, damp.
G-SIT-11	Bypass Road	P	20-Jul-16	209	62.47184	-114.40744	Outcrop	Brown to Dark Brown	Clayey	16.6	2	13	17.5	15.5	4.06	Soil pocket on outcrop with no vegetation (peat filled), damp, thick organics.
G-SIT-12	Bypass Road	P	20-Jul-16	207	62.47147	-114.40702	Outcrop	Black and Brown	Clayey	2.7	2.7	0	14.7	12.7	4.12	Organic rich, moist, outcrop pocket with 1 very healthy baby tree.
G-SIT-13	Bypass Road	P	20-Jul-16	207	62.47123	-114.40714	Outcrop	Black	Clayey, 4 cm of moss	3.5	3.5	0	19.7	16.2	4.11	Damp, soil outcrop pocket with tree and moss.
G-SIT-14	Bypass Road	P	20-Jul-16	206	62.47135	-114.4084	Outcrop	Brown to Dark Brown	Clayey, 1-2 cm of moss	4.6	2	0	10.4	8.4	3.23	
G-SIT-15	Bypass Road	P	20-Jul-16	203	62.47145	-114.40916	Forest Canopy Outcrop	Light Brown	Silty	21.3	2	17.4	12.7	10.7	3.66	Soil pocket with many trees, only needles on trees are near tops.
G-SIT-16	Bypass Road	P	20-Jul-16	205	62.47163	-114.40896	Outcrop	Brown to Light Brown	Silty clay	20.9	2.3	18.7	10.4	8.1	3.93	Soil pocket on outcrop, higher elevation and more exposed than G-SIT-15 (close by), A&B horizon present.
G-SIT-17	Bypass Road	P	20-Jul-16	202	62.47155	-114.40982	Forest Canopy Outcrop	Brown to Light Brown	Clayey silt, 2-3 cm of moss and organics	5.2	5.2	0	18.9	13.7	3.62	Moist at bottom.
G-SIT-18	Bypass Road	P	20-Jul-16	206	62.47202	-114.40937	Outcrop	Brown	Clay	3.1	3.1	2.7	18.7	15.6	4.88	Water at bottom of the hole, moss and low shrub growing in it.
G-SIT-19	Bypass Road	P	20-Jul-16	208	62.47224	-114.40935	Outcrop	Brown	Clayey with some pebbles	0	0	0	13	13	5.00	Layers include: moss-->weathered-->organics-->soil.
G-SIT-20	Bypass Road	P	20-Jul-16	210	62.47216	-114.40884	Outcrop	Dark Brown	Clayey	19.3	1.5	9.5	13.9	12.4	2.79	Very wet soil pocket with trees, bush and moss.
G-SIT-20-Dup	Bypass Road	FD	20-Jul-16	210	62.47216	-114.40884	Outcrop	Dark Brown	Clayey	12	2.5	6	21.1	18.6	3.78	Very wet soil pocket with trees, bush and moss.
G-SIT-21	Bypass Road	P	21-Jul-16	204	62.47243	-114.40807	Outcrop	Black	Clayey, approx. 2 cm of moss	2	2	0	10.4	8.4	4.04	DR-1-1, 60 cm from DR-1-START, small soil pocket in crevice with moss and a tree.
G-SIT-22	Bypass Road	P	21-Jul-16	203	62.47251	-114.40814	Outcrop	Black	Clayey, organic rich	4.8	4.8	3.9	10.5	5.7	4.32	DR-1-2, 9 m 87 cm from DR-1-START, sample at an angle, small soil pocket in crevice with moss.
G-SIT-23	Bypass Road	P	21-Jul-16	203	62.47254	-114.40821	Outcrop	Dark Brown	Clayey, organic rich	4.8	4.8	5.6	16.4	11.6	5.37	DR-1-3, 13 m 95 cm from DR-1-START, outcrop soil pocket by a large tree.

Sample ID	Location	QA/QC	Date	Elevation (m) Recorded with GPS	Coordinates Decimal Degrees		Type	Soil Colour	Soil Texture	In Field Measurements					Public Health Layer	Sample Comments
										Top of Core to (cm):			Core Length (cm)	Sample Depth (cm)		
										Top of Sample		Ground Surface				
					Latitude	Longitude				In Ground	AC					
G-SIT-24	Bypass Road	P	21-Jul-16	203	62.47254	-114.40836	Outcrop	Dark Brown	Clayey, approx. 1.5 cm of moss on top	6.1	6.1	5.8	11.8	5.7	4.75	DR-1-4, 21 m 08 cm from DR-1-START, small soil pocket in crevice, moss growing.
G-SIT-25	Bypass Road	P	21-Jul-16	204	62.47256	-114.40848	Outcrop	Dark Brown	Clayey, approx. 2 cm of moss on top	19.7	2.7	17.4	13.1	10.4	4.09	DR-1-5, 28 m 65 cm from DR-1-START, small outcrop soil pocket in crevice with moss. GPS error; went down in slope but elevation on GPS went up.
G-SIT-26	Bypass Road	P	21-Jul-16	204	62.47255	-114.40869	Outcrop	Dark Brown	Clayey, approx. 1 cm of moss on top	6.8	0.5	4.3	12	11.5	4.11	DR-1-6, 37 m 40 cm from DR-1-START, outcrop soil pocket with moss.
G-SIT-27	Bypass Road	P	21-Jul-16	205	62.47256	-114.40872	Outcrop	Brown	Clayey	2.9	2.9	0	11	8.1	3.68	DR-1-7, 39 m 90 cm from DR-1-START, outcrop soil pocket with ground cover. GPS error; went down in slope but elevation on GPS went up.
G-SIT-28	Bypass Road	P	21-Jul-16	204	62.47261	-114.40877	Outcrop	Dark Brown	Clayey, organic rich, approx. 1.5 cm of moss on top	20.4	2	19.9	12.2	10.2	4.77	DR-1-8, 45 m 80 cm from DR-1-START, outcrop soil pocket with moss and by a tree.
G-SIT-29	Bypass Road	P	21-Jul-16	200	62.47267	-114.40882	Outcrop	Brown	Clayey, approx. 1 cm of moss on top	8.8	8.8	8.2	18.3	9.5	4.70	DR-1-9, 54 m 00 cm from DR-1-START, small soil pocket in crevice with trees *may have lost some sample at bottom.
G-SIT-30	Bypass Road	P	21-Jul-16	199	62.47268	-114.40892	Outcrop	Brown	Clayey, very organic rich	23.7	3	0	11	8	1.26	DR-1-10, 59 m 05 cm from DR-1-START, soil pocket in crevice with trees, likely all organics.
G-SIT-31	Bypass Road	P	21-Jul-16	197	62.47271	-114.40905	Forest Canopy	Dark Brown	Clayey, organic rich	17.8	2.6	0	16	13.9	2.19	DR-1-12, 67 m 06 cm from DR-1-START, soil at bottom of outcrop, lots of trees and grasses, lots of roots at bottom.
G-SIT-31-Dup	Bypass Road	FD	21-Jul-16	196	62.47271	-114.40901	Forest Canopy	Dark Brown	Clayey, organic rich	19.6	2.4	3	13.6	11.2	2.01	DR-1-11, 65 m 07 cm from DR-1-START, soil at bottom of outcrop, lots of trees and grasses, lots of roots at bottom.
G-SIT-32	Bypass Road	P	21-Jul-16	207	62.47178	-114.40873	Outcrop	Dark Brown	Clayey, organic rich, approx. 2 cm of moss on top	7.8	1.8	11	13	11.2	5.00	DR-2-1, 0 m 00 cm from DR-2-START, soil outcrop in crevice with moss.
G-SIT-33	Bypass Road	P	21-Jul-16	206	62.47172	-114.40879	Outcrop	Dark Brown	Clayey, 2 cm of moss on top	9.9	1.8	5.9	7.8	6.8	3.15	DR-2-2, 7 m 30 cm from DR-2-START, small soil pocket in crevice with moss and bush.
G-SIT-34	Bypass Road	P	21-Jul-16	204	62.47166	-114.40881	Outcrop	Dark Brown	Clayey, organic rich	2.1	2.1	0	14.4	12.3	4.27	DR-2-3, 14 m 20 cm from DR-2-START, soil pocket with moss and trees, damp.
G-SIT-35	Bypass Road	P	21-Jul-16	203	62.47161	-114.40884	Outcrop	Black	Clayey, organic rich, approx. 1.5 cm of moss on top	17.7	1.5	19.6	13.7	12.2	5.92	DR-2-4, 16 m 90 cm from DR-2-START, soil pocket with moss and tree, very close to G-SIT-16.
G-SIT-36	Bypass Road	P	21-Jul-16	203	62.47156	-114.40882	Outcrop	Dark Brown	Clayey	22.6	2.5	25.4	8.9	8.3	5.00	DR-2-5, 24 m 85 cm from DR-2-START, small soil pocket with moss and a tree, damp.
G-SIT-37	Bypass Road	P	21-Jul-16	203	62.47155	-114.40893	Outcrop	Dark Brown to Black	Clayey, organic rich	0.5	0.5	0	9	10.4	4.72	DR-2-6, 31 m 15 cm from DR-2-START, small soil pocket with tree and moss.
G-SIT-38	Bypass Road	P	21-Jul-16	203	62.47152	-114.40897	Outcrop	Dark Brown	Clayey, organic rich	5.4	5.4	0.5	16.7	15.0	3.49	DR-2-7, 34 m 40 cm from DR-2-START, soil pocket with lots of trees, pine needles.
G-SIT-39	Bypass Road	P	21-Jul-16	204	62.47149	-114.40891	Forest Canopy Outcrop	Brown	Clayey, approx. 3 cm moss to approx. 2 cm organics to soil	6.6	6.6	0.5	21.8	15.2	3.57	DR-2-8, 39 m 70 cm from DR-2-START, large soil pocket with many trees, bushes, grass and moss.
G-SIT-40	Bypass Road	P	21-Jul-16	206	62.47234	-114.40914	Outcrop	Brown	Clayey	19.7	2	15.9	13.5	11.5	3.76	DR-3-1, 0 m 00 cm from DR-3-START, small soil pocket with tree and moss.
G-SIT-41	Bypass Road	P	21-Jul-16	204	62.47239	-114.40924	Outcrop	Dark Brown	Clayey, organic rich	5.7	5.7	2.8	17.2	11.5	3.99	DR-3-2, 5 m 75 cm from DR-3-START, soil pocket with trees and moss.
G-SIT-42	Bypass Road	P	21-Jul-16	201	62.47239	-114.4093	Outcrop	Brown	Clayey	19	0.5	10.2	12.1	11.6	2.84	DR-3-3, 12 m 53 cm from DR-3-START, soil pocket with trees.
G-SIT-43	Bypass Road	P	21-Jul-16	202	62.47239	-114.40941	Outcrop	Brown - Dark Brown	Clayey, little organics, approx. 2 cm moss layer	3.6	3.6	1.5	18.5	14.9	4.38	DR-3-4, 17 m 30 cm from DR-3-START, soil pocket with tree and moss.

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					Latitude	Longitude				Top of Core to (cm):			Core Length (cm)	Sample Depth (cm)		
										Top of Sample		Ground Surface				
										In Ground	AC					
G-SIT-44	Bypass Road	P	21-Jul-16	201	62.47242	-114.40942	Outcrop	Brown - Dark Brown	Clayey	22.9	2	24.4	9.7	7.7	6.21	DR-3-5, 20 m 10 cm from DR-3-START, small soil pocket with moss and 1 bush.
G-SIT-45	Bypass Road	P	21-Jul-16	200	62.47243	-114.40946	Outcrop	Brown	Clayey, approx. 2 cm moss layer on top	22.8	1	19.6	9.7	8.7	3.66	DR-3-6, 23 m 80 cm from DR-3-START, small soil pocket with moss and tree.
G-SIT-46	Bypass Road	P	21-Jul-16	199	62.47245	-114.40955	Forest Canopy Outcrop	Brown	Clayey	13	0.5	10.6	8.3	7.8	3.82	DR-3-7, 28 m 50 cm from DR-3-START, soil pocket with many trees, moss and ground cover.
G-SIT-46-Dup	Bypass Road	FD	21-Jul-16	198	62.47245	-114.40954	Forest Canopy Outcrop	Brown	Clayey	13	1.7	15	8	6.3	7.33	DR-3-8, 28 m 70 cm from DR-3-START, soil pocket with many trees, moss and ground cover.
G-SIT-47	Bypass Road	P	13-Aug-16	205	62.47258	-114.40723	Outcrop	Brown	Clayey with some sand, very wet	0	0	0	20.5	20.5	5.00	Small soil pocket with pine tree, sloped outcrop into it, pine needles and moss.
G-SIT-48	Bypass Road	P	13-Aug-16	211	62.47234	-114.40728	Outcrop	Dark Brown to Black	Silty clay with lots of organics and cobbles, wet	9.3	0.5	2.8	11.3	10.8	3.12	Small soil pocket with steep sides, pine tree in middle, moss and pine needles.
G-SIT-49	Bypass Road	P	13-Aug-16	210	62.47204	-114.40781	Outcrop	Brown	Clay, some organics, wet	25.3	0.8	25.5	11.6	10.8	5.09	Exposed, small soil pocket with short willow bush, peat and very wet.
G-SIT-50	Bypass Road	P	13-Aug-16	209	62.47192	-114.40786	Outcrop	Dark Brown	Clay, very organic rich	8.5	1	0	18.6	17.6	3.37	Moderate soil pocket with thick peat, birch and willow and short shrub, some grass, exposed and steep sided.
G-SIT-51	Bypass Road	P	13-Aug-16	207	62.47203	-114.40871	Outcrop	Dark Brown	Sandy clay with organics on top	18.6	1	10	13.2	12.2	2.93	Moderate soil pocket with lots of peat and several pine tree and shrubs, moss and pine needles, minor leaf litter.
G-SIT-52	Bypass Road	P	13-Aug-16	205	62.47186	-114.40942	Forest Canopy Outcrop	Light Brown (Grayish)	Clayey with a bit of sand	15.8	0	5.7	15.9	15.9	3.06	Moderate soil pocket forested with pine and bushes, groundcover, moss, twigs, and pine needles.
G-SIT-52-Dup	Bypass Road	FD	13-Aug-16	206	62.47187	-114.40941	Forest Canopy Outcrop	Light Brown (Grayish)	Clayey with a bit of sand	12.4	0.5	5.1	20	19.5	3.64	Moderate soil pocket forested with pine and bushes, groundcover, moss, twigs, and pine needles.
G-SIT-53	Bypass Road	P	13-Aug-16	205	62.47185	-114.40982	Forest Canopy Outcrop	Orangey Reddish Brown	Clayey with a bit of sand and some organics	16.3	0.7	7	14.7	14	3.00	Moderate forested soil pocket with pine, birch trees, branches, groundcover and pine needles.
G-SIT-54	Bypass Road	P	13-Aug-16	203	62.4716	-114.40945	Forest Canopy Outcrop	Orangey Brown to Reddish Brown	Clayey	6.3	0.8	3.5	9.8	9	3.81	Large forested soil pocket, sample near edge, moss and many pine needles, roots visible within hole, twigs and pinecones.
G-SIT-55	Bypass Road	P	13-Aug-16	203	62.47154	-114.4082	Forest Canopy Outcrop	Brown	Clay with some organics	21.7	0.4	17	9.8	9.4	3.33	Edge of forested pocket but more open, pine and birch and willow, groundcover, leaflitter and pine needles, twigs.
G-WGM-01	Bypass Road	P	10-Aug-16	201	62.4986	-114.38478	Outcrop	Brown	Mixture of silt, sand and clay plus organics	4.7	0.5	4.4	11.5	11	4.87	DR-4-1, 93 cm from DR-4-START, small soil pocket with lots of pine needles, sample at base of pine tree, minor moss.
G-WGM-02	Bypass Road	P	10-Aug-16	204	62.49857	-114.38482	Outcrop	Light Brown	Sandy with little bit of clays	12.3	1	12.6	8.8	7.8	5.20	DR-4-2, 5 m 77 cm from DR-4-START, small soil pocket with moss and some pine needles, pine tree above it.
G-WGM-03	Bypass Road	P	10-Aug-16	204	62.49859	-114.38494	Forest Canopy Outcrop	Light Brown	Sandy with some clay, pebble to cobble sized clasts	9.2	0.7	5	12	11.3	3.65	DR-4-3, 10 m 25 cm from DR-4-START, moderate soil pocket with increase in vegetation, several pine trees, pine needles and some moss.
G-WGM-03-Dup	Bypass Road	FD	10-Aug-16	204	62.49861	-114.38495	Forest Canopy Outcrop	Light Brown	Sandy with some clay, pebble to cobble sized clasts	9.8	0	6	9	9	3.52	DR-4-4, 10 m 25 cm from DR-4-START, moderate soil pocket with increase in vegetation, several pine trees, pine needles and some moss.
G-WGM-04	Bypass Road	P	10-Aug-16	202	62.4986	-114.38497	Forest Canopy Outcrop	Light Brown, Orangey	More clay than G-WGM-03 but still sandy with pebble and gravel clasts	7	0.5	5	9	8.5	4.05	DR-4-5, 13 m 57 cm from DR-4-START, moderate soil pocket with many pine trees, pine needles, moss and some groundcover.

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										Top of Sample		Ground Surface				
					Latitude	Longitude				In Ground	AC					
G-WGM-05	Bypass Road	P	10-Aug-16	202	62.49862	-114.38501	Forest Canopy Outcrop	Orangey with a reddish tinge	Clay with boulders	12.7	0.5	11.9	9	8.5	4.57	DR-4-6, 15 m 66 cm from DR-4-START, moderate soil pocket with pine trees, aspen and moss + pine needles.
G-WGM-06	Bypass Road	P	10-Aug-16	201	62.49866	-114.38513	Forest Canopy Outcrop	Brown, Orangey Red	Organics on top, some pebbles, clay and some sand	6.2	1	7.3	12.7	11.7	5.52	DR-4-7, 24 m 00 cm from DR-4-START, moderate soil pocket with pine trees, moss and slight groundcover.
G-WGM-07	Bypass Road	P	10-Aug-16	200	62.49871	-114.38523	Outcrop	Light Brown	Clayey, little bit of sand, gravel sized pieces	0	0	0	16.5	16.5	5.00	DR-4-8, 32 m 25 cm from DR-4-START, moderate soil pocket with pine trees, moss and pine needles.
G-WGM-08	Bypass Road	P	10-Aug-16	202	62.49876	-114.38528	Forest Canopy Outcrop	Light Brown	Clayey, some sand	1.5	1.5	2	18.5	17	5.15	DR-4-9, 37 m 75 cm from DR-4-START, large soil pocket with pine trees, moss and groundcover, pine needles present.
G-WGM-09	Bypass Road	P	10-Aug-16	201	62.49876	-114.3853	Forest Canopy Outcrop	Light Brown	Clayey, some sand	5.3	1	3.1	15.3	14.3	4.33	DR-4-10, 38 m 94 cm from DR-4-START, large soil pocket with pine trees, moss and pine needles.
G-WGM-10	Bypass Road	P	10-Aug-16	201	62.49873	-114.38544	Forest Canopy Outcrop	Light Brown	Clayey sand	3	3	0	12.5	9.5	3.80	DR-4-11, 45 m 25 cm from DR-4-START, moderate soil pocket with pine trees, moss and some pine needles.
G-WGM-11	Bypass Road	P	10-Aug-16	201	62.49873	-114.38552	Forest Canopy Outcrop	Light Brown	Clayey with a bit of sand	2	2	0	30.4	28.4	4.67	DR-4-12, 49 m 45 cm from DR-4-START, moderately forested, moss and pine needles and groundcover.
G-WGM-12	Bypass Road	P	10-Aug-16	201	62.49873	-114.38551	Forest Canopy Outcrop	Light Brown and Orangey	Clayey with some sand, minor organics	3.5	3.5	0	30.8	27.3	4.43	DR-4-13, 52 m 40 cm from DR-4-START, large soil pocket, very forested, moss and pine needles with minor groundcover.
G-WGM-12-Dup	Bypass Road	FD	10-Aug-16	201	62.49871	-114.38552	Forest Canopy Outcrop	Light Brown and Orangey	Clayey with some sand, minor organics	3	3	0	30.8	27.8	4.51	DR-4-14, 52 m 40 cm from DR-4-START, large soil pocket, very forested, moss and pine needles with minor groundcover.
G-WGM-13	Bypass Road	P	11-Aug-16	201	62.4986	-114.38403	Forest Canopy Outcrop	Light Brown	Sandy, damp	6.2	1.2	2.2	14.2	13	3.82	DR-5-1, 2 m 77 cm from DR-5-START, moderate soil pocket with pine trees moss and pine needles.
G-WGM-14	Bypass Road	P	11-Aug-16	201	62.49855	-114.38401	Forest Canopy Outcrop	Brown	Clayey sand with some gravel, damp	21.4	1	18.6	11.2	10.2	3.92	DR-5-2, 8 m 04 cm from DR-5-START, moderate soil pocket with many pine trees, some birch and willow trees, moss, pine needles and minor leaf litter.
G-WGM-15	Bypass Road	P	11-Aug-16	200	62.4985	-114.38407	Forest Canopy Outcrop	Brown to Light Brown	Clayey with some sand, damp	16.9	1	11.6	10.6	9.6	3.22	DR-5-3, 12 m 25 cm from DR-5-START, moderate soil pocket with trees (pine and birch), pine needles, leaf litter and moss.
G-WGM-16	Bypass Road	P	11-Aug-16	199	62.49847	-114.38408	Forest Canopy Outcrop	Light Brown	Sand, minor clay, damp	7.7	0	4.8	22.7	22.7	4.43	DR-5-4, 17 m 49 cm from DR-5-START, moderate soil pocket with pine and birch trees, a bush, mostly leaf litter and some pine needles.
G-WGM-17	Bypass Road	P	11-Aug-16	201	62.49845	-114.38406	Forest Canopy Outcrop	Light Brown	Sandy, bit of clay and gravel with organics present (top), clayey sand (bottom)	18.4	1	6	13.8	12.8	2.54	DR-5-5, 22 m 28 cm from DR-5-START, moderate soil pocket with pine trees and some birch, moss, pine needles and leaf litter present.
G-WGM-18	Bypass Road	P	11-Aug-16	200	62.49842	-114.38397	Forest Canopy Outcrop	Brown to Light Brown	Sandy clay, layered gravel sized pieces	10.9	0	7.5	20.5	20.5	4.29	DR-5-6, 28 m 53 cm from DR-5-START, narrower soil pocket with pine trees, moss and pine needles.
G-WGM-19	Bypass Road	P	11-Aug-16	200	62.49835	-114.38381	Forest Canopy Outcrop	Very Light Brown	Very clayey	10.3	0	8.5	21.7	21.7	4.62	DR-5-7, 37 m 80 cm from DR-5-START, large soil pocket with pine trees, grasses, bushes, moss and some leaf litter, drainage path starts to split.
G-WGM-20	Bypass Road	P	11-Aug-16	201	62.49829	-114.3838	Forest Canopy Outcrop	Gray Brown to Light Brown	Sandy and clay (top), clay	9.9	0	4.4	22	22	4.00	DR-5-8, 45 m 60 cm from DR-5-START, large soil pocket with pine trees and willow, lots of moss.

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G-WGM-21	Bypass Road	P	11-Aug-16	199	62.49824	-114.3839	Forest Canopy Outcrop	Orangey Brown (Top), Brown Lower	Clayey, wet muck, peat layer, damp	13.6	0	8.9	18.3	18.3	3.98	DR-5-9, 54 m 10 cm from DR-5-START, moderate soil pocket with pine and willow trees, lots of moss, some leaf litter.
G-WGM-21-Dup	Bypass Road	FD	11-Aug-16	199	62.49823	-114.38389	Forest Canopy Outcrop	Orangey Brown (Top), Brown Lower	Clayey, wet muck, peat layer, damp	11.4	0	6.3	20.3	20.3	4.00	DR-5-10, 54 m 10 cm from DR-5-START, moderate soil pocket with pine and willow trees, lots of moss, some leaf litter.
G-WGM-22	Bypass Road	P	11-Aug-16	200	62.49825	-114.38411	Forest Canopy Outcrop	Brown with Red tint (Top), more Gray (Bottom)	Sandy clay, damp	5.9	0	0	24.8	24.8	4.04	DR-5-11, 64 m 30 cm from DR-5-START, narrower, moderate soil pocket with trees and low brush, pine needles and moss.
G-WGM-23	Bypass Road	P	11-Aug-16	200	62.49821	-114.38416	Forest Canopy Outcrop	Brown	Finer sand	17.4	0.5	13.9	14.3	13.8	3.99	DR-5-12, 68 m 01 cm from DR-5-START, slightly wider, moderate soil pocket with pine and birch trees, leaf litter, pine needles and moss.
G-WGM-24	Bypass Road	P	11-Aug-16	200	62.49821	-114.38419	Forest Canopy Outcrop	Light Brown	Silty clay	6.3	0	4.8	24	24	4.71	DR-5-13, 68 m 01 cm from DR-5-START, same as G-WGM-23, but approx. 3 m perpendicular distance from the drainage route.
G-WGM-25	Bypass Road	P	11-Aug-16	200	62.4985	-114.38509	Forest Canopy Outcrop	Reddish Brown	Mostly clay with some sand, damp	7.8	1.5	9.4	8.7	7.2	6.43	DR-6-1, 0 m 00 cm from DR-6-START, small soil pocket on outcrop, short pine trees nearby, moss and pine needles.
G-WGM-26	Bypass Road	P	11-Aug-16	200	62.4985	-114.38522	Outcrop	Brown	Clayey sand with gravel sized pieces	7	0	1.5	14.6	14.6	3.63	DR-6-2, 7 m 20 cm from DR-6-START, small soil pocket on outcrop with several short pine trees, many pine needles and some moss.
G-WGM-27	Bypass Road	P	11-Aug-16	201	62.49849	-114.38528	Outcrop	Light Brown to Orangey Brown	Clayey with a bit of silt and sand	23.1	0	22.4	8.4	8.4	4.62	DR-6-3, 10 m 39 cm from DR-6-START, moderate soil pocket, pine trees, pine needles and groundcover.
G-WGM-28	Bypass Road	P	11-Aug-16	201	62.49847	-114.38535	Outcrop	Beige	Clay and some sand	0	0	16.7	16.7	16.7	5.00	DR-6-4, 14 m 82 cm from DR-6-START, small soil pocket with pine trees, pine needles and moss, lots of foreign rock.
G-WGM-29	Bypass Road	P	11-Aug-16	200	62.49847	-114.38535	Outcrop	Light Brown to Orangey Brown	Clayey with a little bit of sand	12.8	0	10.3	15.7	15.7	4.31	DR-6-5, 16 m 60 cm from DR-6-START, small soil pocket with pine trees, pine needles, grasses and groundcover.
G-WGM-30	Bypass Road	P	11-Aug-16	200	62.49847	-114.38541	Forest Canopy Outcrop	Brown	Sandy clay with boulders, cobbles and pebbles	14.1	0.5	10.3	17.4	16.9	4.08	DR-6-6, 19 m 60 cm from DR-6-START, narrow soil pocket with large trees on either side, lots of pine needles and some groundcover.
G-WGM-31	Bypass Road	P	11-Aug-16	199	62.49842	-114.38548	Forest Canopy Outcrop	Orangey Brown	Clayey with a bit of sand, lots of pebbles and cobbles	21.3	1.5	20.8	10.7	9.2	4.74	DR-6-7, 21 m 54 cm from DR-6-START, narrow soil pocket with lots of pine needles, pine trees and birch, some leaf litter, groundcover and moss.
G-WGM-31-Dup	Bypass Road	FD	11-Aug-16	199	62.49844	-114.38543	Forest Canopy Outcrop	Orangey Brown	Clayey with a bit of sand, lots of pebbles and cobbles	10.2	0	N/a	9.8	9.8	5.00	DR-6-8, 21 m 80 cm from DR-6-START, narrow soil pocket with lots of pine needles, pine trees and birch, some leaf litter, groundcover and moss.
G-WGM-32	Bypass Road	P	11-Aug-16	199	62.49843	-114.38548	Outcrop	Orangey Brown	Clayey with some sand and gravel sized pieces	2.5	3.1	2	13.3	10.2	4.77	DR-6-9, 25 m 60 cm from DR-6-START, small soil pocket on outcrop, bush nearby, moss, leaf litter, some pine needles.
G-WGM-33	Bypass Road	P	11-Aug-16	201	62.49837	-114.3848	Outcrop	Dark Brown to Black	Silty and clayey with organics	0	0	0	15.3	15.3	5.00	Small soil pocket with birch tree in it, moss, pine needles and leaf litter.
G-WGM-34	Bypass Road	P	11-Aug-16	200	62.49831	-114.38441	Outcrop	Deep Brown	Clayey sand with gravel sized pieces, very moist	13.8	1.8	11.9	18	16.2	4.48	Moderate soil pocket near end of drainage route, several pine trees, moss and pine needles.

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G-WGM-35	Bypass Road	P	11-Aug-16	201	62.49858	-114.38457	Outcrop	Dark Brown	Clayey silt, damp	22.7	1.5	21.6	8.6	7.1	4.33	Very small soil pocket with birch tree in it, moss and minor leaf litter.
G-WGM-36	Bypass Road	P	11-Aug-16	200	62.49878	-114.38445	Outcrop	Light Brown (Grayish)	Mostly clay with some silt	11.1	1.3	11.5	8.8	7.5	5.28	Moderate soil pocket, short pine trees, lots of peat and moss, soil mound in swampy area with grasses.
G-WGM-37	Bypass Road	P	11-Aug-16	201	62.49885	-114.38452	Outcrop	Pinkish Red Brown	Sandy	0	0	9.8	9.8	9.8	5.00	Small soil pocket with large chunk of sandstone in it, moss and pine trees.
G-WGM-38	Bypass Road	P	11-Aug-16	200	62.49881	-114.38491	Forest Canopy Outcrop	Brown	Clayey with little bit of sand, rocky	10.3	1	7.5	20.9	19.9	4.38	Moderate soil pocket with many pine trees, moss and pine needles.
G-WGM-39	Bypass Road	P	11-Aug-16	200	62.49891	-114.38499	Outcrop	Orangey Reddish Brown	Clay with tiny bit of sand	12.3	0	10	19	19	4.46	Small soil pocket, sample near two small pine trees, lots of groundcover, some moss and pine needles.
G-WGM-40	Bypass Road	P	11-Aug-16	202	62.49903	-114.385	Outcrop	Light Gray	Clayey, little bit of sand	8.2	0.5	7.8	14.5	14	4.86	Moderate soil pocket with pine trees and a bush, moss, pine needles and some leaf litter.
G-WGM-41	Bypass Road	P	13-Aug-16	212	62.4989	-114.38531	Outcrop	Brown	Clayey sand, damp	19.6	0	19	11.1	11.1	4.74	Small soil pocket on outcrop with Jack Pine, heavy pine needle layer and some moss.
G-WGM-41-Dup	Bypass Road	FD	13-Aug-16	203	62.49892	-114.38529	Outcrop	Brown	Clayey sand, damp	4.2	0.8	3	9.1	8.3	4.37	Small soil pocket on outcrop with Jack Pine, heavy pine needle layer and some moss.
G-WGM-42	Bypass Road	P	13-Aug-16	203	62.49895	-114.38554	Forest Canopy	Light Brown	Very fine sand (silt?)	3.8	3.8	0	30.4	26.6	4.38	Large forested are at edge of outcrop, mostly spruce trees, moss, grass and some pine needles, short willow bushes present.
G-WGM-43	Bypass Road	P	13-Aug-16	202	62.49873	-114.38485	Outcrop	Black	Sand, organic rich, moist	0	0	0	13.5	13.5	5.00	Exposed, small soil pocket on outcrop with small pine tree, grass and moss, some pine needles.
G-WGM-44	Bypass Road	P	13-Aug-16	206	62.49862	-114.38435	Outcrop	Brown with Orange tint	Clayey sand	0	0	0	19.3	19.3	5.00	Moderate to small soil pocket with several Jack Pines, lots of wood debris and boulders, moss and thick mat of pine needles.
G-WGM-45	Bypass Road	P	13-Aug-16	206	62.49846	-114.38441	Outcrop	Light Brown	Very sandy, bit of clay	0	0	0	17.1	17.1	5.00	Small narrow soil pocket with birch tree, moss, leaf litter and twigs, exposed.
G-WGM-46	Bypass Road	P	13-Aug-16	201	62.49834	-114.38483	Forest Canopy Outcrop	Orangey Light Brown to Light Brown	Sandy clay with gravel pieces	19.4	0.8	11.2	10.8	10	2.75	Forested small soil pocket on edge of outcrop, pine and birch trees, groundcover, moss, pine needles and leaf litter.
G-WGM-47	Bypass Road	P	13-Aug-16	205	62.49845	-114.38466	Outcrop	Reddish Brown	Silty clay, some sand present	4.8	0.7	0	12.8	12.1	3.58	3 large pine trees in small soil pocket, heavy pine needle layer.
G-WGM-48	Bypass Road	P	13-Aug-16	204	62.49835	-114.38418	Outcrop	Orangey-Brown	Clayey sand with gravel sized clasts and cobbles, organics	1	1	0	20.4	19.4	4.75	Narrow, long soil pocket with pine trees and trunks, moss and some pine needles.
G-WGM-49	Bypass Road	P	13-Aug-16	202	62.49812	-114.38406	Outcrop	Brown to Dark Brown	Clayey with lots of organics	9.1	1	9	11.3	10.3	4.95	Small outcrop soil pocket filled with small pine trees, moss and pine needles plus minor leaf litter.
G-WGM-50	Bypass Road	P	13-Aug-16	205	62.49879	-114.38416	Outcrop	Brown	Cobble-sized clasts and gravel, mix of sand, silt and clay, wet	8.6	1.1	0	23.3	22.2	3.60	Exposed, moderate soil pocket with short pine and groundcover, moss and some pine needles.
G-WGM-51	Bypass Road	P	13-Aug-16	203	62.49896	-114.38429	Outcrop	Orangey Reddish Brown	Sandy clay	20.4	1	17.6	11	10	3.91	Small soil pocket with pine and birch, moss, twigs, pine needles and leaf litter, cobbles.
G-WGM-51-Dup	Bypass Road	FD	13-Aug-16	203	62.49896	-114.38428	Outcrop	Orangey Reddish Brown	Sandy clay	19.5	1	17	10.8	9.8	3.98	Small soil pocket with pine and birch, moss, twigs, pine needles and leaf litter, cobbles.

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G-WGM-52	Bypass Road	P	13-Aug-16	200	62.49841	-114.38522	Forest Canopy Outcrop	Orangey Beige	Clayey with a bit of sand, some gravel	4.6	0	0	15.3	15.3	3.84	Moderate soil pocket on outcrop slope with many pine and birch trees, heavy layer of pine needles and leaf litter, twigs.
G-WGM-53	Bypass Road	P	13-Aug-16	203	62.4986	-114.38552	Outcrop	Orangey Brown	Clayey silt with some sand	24.4	2.5	14	7.4	4.9	1.60	Small soil pocket with pine trees, boulders, moss, groundcover and pine needles.
YK-11	Bypass Road	P	19-Jul-16	206	62.48338	-114.40267	Outcrop	Brown	Silty sandy	12.7	3	11.2	18.7	15.7	4.56	Soil pocket in outcrop, several trees and some moss in it, dry.
YK-12	Bypass Road	P	19-Jul-16	211	62.49178	-114.40793	Outcrop	Black	Clayey	17.9	1.5	15	15	13.5	4.12	Organic rich, peat and grasses, damp.
YK-12-Dup	Bypass Road	FD	19-Jul-16	211	62.49178	-114.40793	Outcrop	Black	Clayey	1	1	0	16	15	4.69	Same as YK-12-Dup.
YK-13	Bypass Road	P	19-Jul-16	210	62.49324	-114.37843	Outcrop	Brown	Clayey sand	7.4	2	3.3	25	23	4.24	Small soil pocket with a little tree and contains some organics.
YK-14	Bypass Road	P	19-Jul-16	206	62.49593	-114.37537	Outcrop	Dark Brownish-Black	Clayey	19.6	2	18.7	12.4	10.4	4.60	Small soil pocket in outcrop with one small tree, damp.
YK-22	Bypass Road	P	29-Jul-16	197	62.5122	-114.36465	Outcrop	Brown	Clayey soil with lots of organics	16.4	2.6	15.4	7.8	5.2	4.19	Small outcrop soil pocket with low lying shrubs and groundcover.
YK-23	Bypass Road	P	29-Jul-16	195	62.51228	-114.36477	Forest Canopy Outcrop	Light Brown	Silty, lots of organics	3.5	6	6	14.2	8.2	7.19	Large soil pocket with several trees, core taken at base of a dead one.
YK-72	Detah Road	P	17-Aug-17	158	62.49736	-114.30286	Forest Canopy	light brown	top 5 cm organic rich, below is silt	32.1	4.4	26	22	17.6	3.71	Forested area near trail; a lot of leaf and pine needle litter. Dense forest; black spruce and Jack Pine.
YK-73	Detah Road	P	17-Aug-17	172	62.496839	-114.28264	Forest Canopy	brown	silt, 6cm of organics on top	9.5	0	2.1	21.3	21.3	3.71	Forest area near marsh; aquatic grass, a lot of leaf litter. Alder trees and woody debris. Young black spruce.
YK-77	Detah Road	P	18-Aug-17	166	62.422889	-114.30938	Forest Canopy Outcrop	brown	organic rich silty clay	14.3	0	11.1	13.9	13.9	4.06	Birch and spruce trees, metasediment (?); moss plus leaf litter surrounding sample.
YK-78	Detah Road	P	18-Aug-17	161	62.41884	-114.31395	Outcrop	brown	silty-sand, some pebbles material is loose	5.5	1.1	2	12.1	11	3.79	Sample taken on o/c near GSB, facing Yellowknife, lots of berry bushes and a few spruce trees.
YK-79	Detah Road	P	18-Aug-17	174	62.434809	-114.30523	Forest Canopy Outcrop	brown	organic rich silt	12.6	3.5	5.1	21.5	18	3.53	Birch, Jack Pine, shrubs, lots of leaf litter.
YK-79-Dup	Detah Road	FD	18-Aug-17	174	62.434809	-114.30523	Forest Canopy Outcrop	brown	organic rich silt	17.9	3.4	6.6	11.1	7.7	2.03	Birch, Jack Pine, shrubs, lots of leaf litter.
YK-15	Gar Lake	P	28-Jul-16	197	62.51907	-114.37957	Forest Canopy Outcrop	Light Brown	Clayey, brown organic layer, light brown soil layer	4.4	4.4	0	12.8	8.4	3.28	Outcrop soil pocket, moss & several trees, relatively close to lake.
YK-16	Gar Lake	P	28-Jul-16	191	62.51905	-114.37877	Forest Canopy Outcrop	Light Brown with Light Gray Pockets	Clayey with some silt, approx. 2 cm lichen layer	5.8	5.8	0	30.6	24.8	4.05	Forest canopy outcrop soil pocket, several trees, groundcover, dead leaf litter.
YK-17	Gar Lake	P	28-Jul-16	192	62.51868	-114.37825	Forest Canopy	Gray	Clayey, organics layer (no A layer; straight to C), can't see the entire hole	6.7	6.7	1	30.4	23.7	4.03	Forest canopy, many trees and bushes, leaf litter and minor groundcover.
YK-18	Gar Lake	P	28-Jul-16	191	62.51844	-114.37779	Forest Canopy	Light Brown and Gray	Layers present, clayey and silty	2.1	2.1	0.5	30.4	28.3	4.73	*Less forested than YK-17, trees, lichen, minor groundcover/grass.
YK-19	Gar Lake	P	28-Jul-16	198	62.51653	-114.37569	Outcrop	Light Brown to Orangey Brown	Silty, dry	18.7	1.5	21	12.1	10.6	6.39	Outcrop soil pocket with lichen, tree and pine needles.
YK-20	Gar Lake	P	28-Jul-16	192	62.51719	-114.37551	Outcrop	Dark Brown	Organic rich, clayey	10.3	1.5	11.1	9.5	8	5.56	Small soil pocket on outcrop, a couple small trees and minor groundcover.

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YK-20-Dup	Gar Lake	FD	28-Jul-16	192	62.51719	-114.37551	Outcrop	Dark Brown	Organic rich, clayey	21.6	1	20.5	9.1	8.1	4.40	Small soil pocket on outcrop, a couple small trees and minor groundcover.
YK-21	Gar Lake	P	28-Jul-16	189	62.51712	-114.37503	Forest Canopy	Gray	Clayey, thick organic layer	9.7	9.7	0	30.5	20.8	3.41	Forested, many trees, some lichen, leaf litter and moss, near outcrop edge but no outcrop visible around it.
YK-45	Gar Lake	P	14-Aug-17	187	62.526348	-114.37809	Forest Canopy	Dark brown	Organic rich clay for the top 9 cm, below silty clay	30	0	19.5	19.2	19.2	3.23	Organic rich layer on top of light brown-beige silty material (below 9cm). Some moss on top. Leaf litter and woody debris.
YK-46	Gar Lake	P	14-Aug-17	188	62.525413	-114.37921	Forest Canopy	Dark brown	Organic rich clay	31.5	1.4	16.9	19.4	18	2.76	Grass, bear-berry shrubs, black spruce, moss.
YK-47	Gar Lake	P	14-Aug-17	186	62.522764	-114.38646	Forest Canopy	Brown to Dark Brown	Silty clay-organic rich	34.1	4.3	27.6	20.7	16.4	3.58	Lighter brown soil at depth, pine needles/leaf litter cover, black spruce.
YK-48	Gar Lake	P	14-Aug-17	188	62.52327	-114.38672	Forest Canopy	Dark brown	Organic rich clay	20.4	2.1	0	32	29.9	2.97	4-5 cm moss layer. Soil is moist, very high in clay. Jack Pine and tamarack trees, some bear berry bushes.
YK-49	Gar Lake	P	14-Aug-17	200	62.524092	-114.39575	Forest Canopy	Dark brown	Organic rich clay	12.5	3.1	0	25.8	22.7	3.22	Leaves, roots, pine needle cover. Higher density forest.
YK-50	Gar Lake	P	14-Aug-17	192	62.522749	-114.39126	Forest Canopy	Dark brown	Organic rich clay	13.9	4.4	2.9	21	16.6	3.01	Bear berry, black spruce, moss, aquatic grasses.
YK-50-Dup	Gar Lake	FD	14-Aug-17	192	62.522749	-114.39126	Forest Canopy	Dark brown	Organic rich clay	19	3.7	0	14.7	11	1.83	Sample compressed more than the parent sample.
YK-51	Gar Lake	P	14-Aug-17	191	62.514024	-114.37516	Forest Canopy	Black to light brown	Organic rich clay and clayey-silt	10.8	1.9	0	22.7	20.8	3.29	Top 9cm: organic rich clay, dark brown-black. Below 9cm: light brown clay-silt. Cover: black spruce, leaf litter, pine needles/moss.
YK-52	Gar Lake	P	14-Aug-17	189	62.51384	-114.37473	Forest Canopy	Brown-beige	Organic rich to silt	6.6	2.1	0	25.8	23.7	3.91	Moss, less pine needles, aquatic grasses. Below the top 5cm, silty material very soft, light brown to beige.
YK-53	Gar Lake	P	14-Aug-17	191	62.514615	-114.37389	Forest Canopy	Dark brown to light brown	Organic rich clay	23.2	2.6	20.7	12.1	9.5	3.96	Cranberry bushes, moss, little soil. A lot of dead wood in area. Outcrop nearby.
YK-01	Highway 3	P	18-Jul-16	166	62.52756	-114.94437	Forest Canopy Outcrop	Brown	Silty sandy	12.9	1	13.6	18.8	17.8	5.20	Edge of outcrop, lots of trees & some groundcover, recently rained (damp sample).
YK-02	Highway 3	P	18-Jul-16	194	62.45553	-114.53828	Forest Canopy Outcrop	Light Brown	Silty sandy	2	2	0	12.1	10.1	4.17	Dry, outcrop soil pocket with many trees and groundcover, core tube not cut.
YK-02-Dup	Highway 3	FD	18-Jul-16	194	62.45553	-114.53828	Forest Canopy Outcrop	Light Brown	Silty sandy	16.6	1	20.6	16.7	15.7	6.71	Same as YK-02, a duplicate for QA/QC, dry.
YK-03	Highway 3	P	18-Jul-16	194	62.46483	-114.51555	Outcrop	Light Brown	Mostly silty, some sand	13	1	16.5	10.7	9.7	7.82	Outcrop soil pocket, near a tree.
YK-26	Highway 3	P	5-Aug-16	171	62.51732	-114.93088	Outcrop	Brown	Silty clay	15.1	1.1	15.5	16	14.9	5.14	Moderate soil pocket, bare patch of soil near moss and groundcover.
YK-27	Highway 3	P	5-Aug-16	173	62.51226	-114.84879	Forest Canopy	Brown	Clay, some sand	19	0	15.4	12.9	12.9	3.91	Forested area near a swampy area, lots of groundcover.
YK-28	Highway 3	P	5-Aug-16	179	62.51461	-114.80362	Forest Canopy Outcrop	Light Brown-Brown	Silty with a bit of sand	8	1	0	10.7	9.7	2.74	Moderate sized soil pocket on outcrop with lots of Jack Pines, pine needles and some moss.
YK-29	Highway 3	P	5-Aug-16	173	62.49183	-114.77948	Forest Canopy Outcrop	Light Brown	Silty clay	6.2	0	0	24.2	24.2	3.98	Soil at edge of outcrop with many trees and groundcover, leaf litter and moss, edge of outcrop by swampy area.
YK-30	Highway 3	P	5-Aug-16	181	62.49746	-114.77422	Forest Canopy Outcrop	Brown	Clayey silt	14.7	2	12.1	18	16	4.30	Soil pocket with Jack Pines, pine needles and some moss.
YK-30-Dup	Highway 3	FD	5-Aug-16	179	62.49745	-114.77422	Forest Canopy Outcrop	Brown	Clayey silt	0	0	0	14.5	14.5	5.00	Soil pocket with Jack Pines, pine needles and some moss.
YK-31	Highway 3	P	5-Aug-16	187	62.47297	-114.6608	Outcrop	Brown	VERY SANDY (approx. 10 cm of sediment on top)	10	1	5.4	27	26	4.25	Soil pocket with low shrubs, moss and groundcover, trees nearby.

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YK-32	Highway 3	P	5-Aug-16	181	62.4687	-114.66291	Forest Canopy Outcrop	Light Brown to Light Orange	Mostly silt with some clay and sand, also has pebble sized clasts	1	1	0	11.9	10.9	4.58	Edge of outcrop, several pine and spruce trees, pine needles, moss and some groundcover.
YK-33	Highway 3	P	9-Aug-16	189	62.46381	-114.56289	Outcrop	Light Brown	Very sandy with gravel to pebble sized clasts, some silt	6.8	0.8	1.1	13.5	12.7	3.45	Moderate sized soil pocket with pine needles and some groundcover, near base of Jack Pine.
YK-33-Dup	Highway 3	FD	9-Aug-16	189	62.46378	-114.60113	Outcrop	Light Brown	Very sandy with gravel to pebble sized clasts, some silt	17.4	1.3	17.9	14.3	13	5.20	Moderate sized soil pocket with pine needles and some groundcover, near base of Jack Pine. Root blocking bottom of sample (1 cm gap at bottom), could have gone deeper.
YK-34	Highway 3	P	9-Aug-16	195	62.4659	-114.56289	Outcrop	Brown	Clayey silt, organics present	21.8	1.5	18.2	10.2	8.7	3.54	Small soil pocket (lots of peat), with some groundcover, pine needles and leaf litter, some trees.
YK-36	Ingraham Trail	P	17-Aug-16	211	62.51455	-113.75059	Forest Canopy Outcrop	Light Gray	Light silt	5.2	0	0	26.2	26.2	4.17	Moderate sized forested outcrop, all pine/spruce, moss and thick pine needle carpet.
YK-37	Ingraham Trail	P	17-Aug-16	184	62.51836	-113.79458	Outcrop	Light Brown	Silty clay with sand, gravel, cobble sized clasts	11.8	0	4.5	17	17	3.50	Soil on outcrop slope, thick pine needle layer, roots and moss, exposed.
YK-38	Ingraham Trail	P	17-Aug-16	184	62.53669	-114.19323	Outcrop	Orangey Brown	Mostly silty with gravel to cobble sized clasts	15.8	1.7	6.2	16	14.3	2.99	Exposed soil pocket with stump, grass and groundcover, leaf litter and many twigs/roots.
YK-39	Ingraham Trail	P	18-Aug-16	213	62.5522	-114.9401	Outcrop	Brown	VERY light, silty (very fine) slightly damp, layer of moss on top approx. 4 cm	10.1	0	5.3	20.4	20.4	4.05	Small soil pocket with pine tree, grass, moss and some pine needles, top of outcrop.
CM-01	Kam Lake	P	19-Jul-16	188	62.41551	-114.4288	Outcrop	Orangey-Brown	Sandy silt with cobble & gravel sized pieces	20.6	3.3	16.8	8.6	5.3	2.91	Outcrop soil pocket with trees and moss, slightly damp soil.
CM-02	Kam Lake	P	19-Jul-16	186	62.41116	-114.4315	Outcrop	Brown	Silty sandy with cobble sized pieces	12.4	2.2	20.8	18.6	16.4	10.25	Outcrop soil pocket with trees and moss, dry soil, outcrop surrounded by forest.
CM-03	Kam Lake	P	12-Aug-16	173	62.4016	-114.42393	Forest Canopy Outcrop	Light Brown	Clayey sand, maybe some silt, damp	3.8	3.8	0	30.4	26.6	4.38	Moderate soil pocket with several pine and birch trees, lots of pine needles and some moss.
CM-04	Kam Lake	P	12-Aug-16	185	62.4054	-114.41413	Forest Canopy Outcrop	Brown	Top layer is approx. 5 cm of organics, clay with sand, damp	10.7	0	2.6	20.9	20.9	3.60	Small soil pocket with pine and birch tree, pine needles, leaf litter and groundcover.
CM-05	Kam Lake	P	12-Aug-16	182	62.41031	-114.4074	Outcrop	Dark Brown	Clayey sand	9.7	0.5	0	24.6	24.1	3.57	Small soil pocket on steep slope into Kam Lake, pine trees and dead birch, pine needles, moss and leaf litter.
CM-06	Kam Lake	P	12-Aug-16	177	62.41344	-114.4057	Outcrop	Brown	Clayey silt with many organics	21.1	1	20	11.2	10.2	4.51	Narrow soil pocket with pine trees, moss, pine needles and some leaf litter.
CM-07	Kam Lake	P	12-Aug-16	176	62.41424	-114.40325	Outcrop	Light Brown	Clayey sand	9.4	1.4	0	23.7	22.3	3.52	Small soil mound in pocket with small pine and birch, large dead pine, lots of groundcover and moss some pine needles.
CM-08	Kam Lake	P	12-Aug-16	173	62.41548	-114.3977	Forest Canopy	Brown	Clayey sand, very thick (15 cm?) organics layer	16.1	0	8.7	15.5	15.5	3.38	Soil found at interface between outcrop and forest, pine, willow and birch trees, extensive groundcover, low shrubs, moss, pine needles and leaf litter.
CM-09	Kam Lake	P	12-Aug-16	178	62.41446	-114.39748	Forest Canopy Outcrop	Brown to Dark Brown	Clayey silt	5.2	0.5	0.5	8.9	8.4	3.21	Moderate soil pocket on outcrop, drainage route?, several pine trees, lots of pine needles and little moss, on slope AWAY from Con Mine, some sample fell out of bottom.

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CM-10	Kam Lake	P	12-Aug-16	187	62.41528	-114.39545	Outcrop	Dark Brown to Black	Clay interspersed with lots of organics	12.8	0	8.8	17	17	4.05	Small soil pocket with pine tree, moss and pine needles, dead grass, on top of outcrop.
CM-10-Dup	Kam Lake	FD	12-Aug-16	187	62.41526	-114.39548	Outcrop	Dark Brown to Black	Clay interspersed with lots of organics	0	0	0	19.9	19.9	5.00	Small soil pocket with pine tree, moss and pine needles, dead grass, on top of outcrop.
CM-11	Kam Lake	P	12-Aug-16	178	62.41603	-114.39453	Outcrop	Brown	Clay with lots of organics	12.6	0	5.8	18.4	18.4	3.65	Soil pocket with pine and birch trees, grass and thick moss, pine needles and leaf litter, on shallow slope facing toward Con Mine.
CM-12	Kam Lake	P	12-Aug-16	177	62.4166	-114.38831	Outcrop	Brown	Pure clay, damp	17.7	0.7	16.5	13.3	12.6	4.57	Moderate soil pocket with groundcover (most dead), moss and few trees, very exposed.
CM-13	Kam Lake	P	8-Aug-16	183	62.41761	-114.37258	Outcrop	Dark Brown	Silty, very little clay	1.9	1.9	2.5	20.6	18.7	5.17	Moderate soil pocket with groundcover, moss, grass and shrubs.
CM-14	Kam Lake	P	8-Aug-16	176	62.42178	-114.36485	Outcrop	Brown to Dark Brown	Silt with little clay	10.1	0.5	10.5	8.7	8.2	5.26	Small soil pocket with moss and small bush, near a swampy area.
CM-15	Kam Lake	P	12-Aug-16	176	62.41932	-114.39178	Forest Canopy Outcrop	Brown Beige	Mix of clay and silt with some sand and gravel sized pieces	21.4	1.2	19.5	9.8	8.6	4.10	Soil pocket on edge of outcrop and forested area, some groundcover and low shrubs, lots of pine needles.
CM-16	Kam Lake	P	8-Aug-16	182	62.42012	-114.38382	Outcrop	Brown	Clayey silt	22.1	1.3	19.5	9.7	8.4	3.82	Small soil pocket on outcrop with moss and minor leaf litter.
CM-17	Kam Lake	P	8-Aug-16	182	62.42193	-114.37138	Outcrop	Dark Brown	Clayey silt, some organics	19.5	1.5	18.7	12.2	10.7	4.65	Small soil pocket with moss and a dead bush.
CM-17-Dup	Kam Lake	FD	8-Aug-16	182	62.42191	-114.3714	Outcrop	Dark Brown	Clayey silt, some organics	1.8	1.8	0	12.9	11.1	4.30	Small soil pocket with moss and a dead bush.
CM-18	Kam Lake	P	12-Aug-16	166	62.46218	-114.3953	Forest Canopy Outcrop	Brown	Clayey silt with thick organic layer on top, cobbles present	16.5	0	13	14.3	14.3	4.02	Large soil pocket with many pine and birch trees, moss, grass, and some pine needles, on an island near Con Mine.
CM-19	Kam Lake	P	12-Aug-16	168	62.4273	-114.39271	Outcrop	Brown to Light Brown	Clayey silt, some organics on top	3.8	3.8	0	30.4	26.6	4.38	Small soil pocket with short (baby) pine tree and short shrub, lots of groundcover, close to shore very exposed.
CM-20	Kam Lake	P	8-Aug-16	177	62.42464	-114.36266	Forest Canopy Outcrop	Dark-Brown to Black	Clayey, organic rich	20.5	0.5	18.7	11.3	10.8	4.29	Edge of outcrop leading into forested area, some moss and groundcover, spruce nearby.
CM-21	Kam Lake	P	8-Aug-16	178	62.42655	-114.35408	Outcrop	Dark-Brown to Black	Clay	15.8	0	14.9	14.6	14.6	4.71	Small soil pocket with moss, grass and shrubs.
CM-23	Kam Lake	P	12-Aug-16	189	62.43634	-114.40022	Outcrop	Brown	Clayey silt, damp	14.7	0	12	16.8	16.8	4.31	Small soil pocket with tamarack tree, groundcover, grass and tamarack needles.
CM-24	Kam Lake	P	19-Jul-16	196	62.43974	-114.39259	Outcrop	Dark Brown	Clayey sand	12.7	1	12.6	11.5	10.5	4.95	Damp (rained last night), outcrop soil pocket.
CM-25	Kam Lake	P	19-Jul-16	180	62.44385	-114.35293	Outcrop	Dark Brown	Clayey	8.4	2	9.1	13.3	11.3	5.33	Organic rich, damp, soil pocket on outcrop, has a tree moss and a low bush.
CM-26	Kam Lake	P	8-Aug-16	180	62.42036	-114.38391	Forest Canopy	Brown	Clayey silt with some sand	14.9	1.4	12.3	17.5	16.1	4.30	Forested soil area at edge of outcrop, spruce and birch trees around, moss, groundcover and pine needles present.
Grace-01	Kam Lake	P	16-Aug-17	178	62.417965	-114.46479	Outcrop	brown	silty with some organics	4.2	4.2	0	19.2	15	3.91	High up on o/c, mature Jack Pine, young black spruce. Pine needle litter.
Grace-02	Kam Lake	P	16-Aug-17	174	62.417797	-114.46376	Forest Canopy	top brown, bottom was beige	organic rich clay on top, approx. 6cm down silty	8.2	0	5.4	23.7	23.7	4.47	A lot of deciduous leaf litter, cranberry shrub cover. Woody shrub, Jack Pine, black spruce. Sample from dirt mound at base of birch tree.

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Grace-03	Kam Lake	P	16-Aug-17	174	62.418587	-114.45795	Forest Canopy Outcrop	top 8 cm, brown; below is beige-white	top 8 cm organic rich silt; bottom just silt	8.8	0	4.7	22.7	22.7	4.24	A lot of leaf litter, Jack Pine, black spruce, cranberry bushes. Forested area on top of o/c.
Grace-04	Kam Lake	P	16-Aug-17	170	62.418767	-114.45152	Outcrop	top is brown; below is beige	top 3cm, organics; below is silty	15.3	0.8	11.5	17	16.2	4.05	On o/c, near water's edge. Sparse shrubs, rose bushes, woody shrubs. Woody debris and leaf litter.
Grace-05	Kam Lake	P	16-Aug-17	179	62.418767	-114.43695	Outcrop	brown	silty, with some organics	13.4	2.5	13.2	7.5	5	4.81	Granite o/c. Jack Pine, and a couple of black spruce. Small shrub cover and many pine needles. Hard to find enough soil for a core in area, very rocky.
Grace-06	Kam Lake	P	16-Aug-17	178	62.423349	-114.43757	Forest Canopy	brown, bottom is beige	organic rich silt (top 4 to 5 cm), below is very silty	18.7	2.1	13.8	14.4	12.3	3.58	A lot of Jack Pine and birch, some spruce. Sample in mound of organic material at top. A lot more leaf litter at this site compared to the other GRACE sites.
Grace-06-Dup	Kam Lake	FD	16-Aug-17	178	62.423349	-114.43757	Forest Canopy	brown, bottom is beige	organic rich silt (silty soil at 7 cm)	6.8	6.7	0	17.3	10.6	3.05	A lot of Jack Pine and birch, some spruce. Sample in mound of organic material at top. A lot more leaf litter at this site compared to the other GRACE sites. Sample taken on side of mound; sample taken 37cm from parent sample.
LL-01	Long Lake	P	17-Jul-16	202	62.48339	-114.47508	Outcrop	Light Brown	Silty	0	0	N/A	16	16	5.00	Dry, in soil pocket on outcrop, near a tree.
LL-02	Long Lake	P	17-Jul-16	204	62.48318	-114.47347	Outcrop	Gray Brown	Silty	6	N/A	14.2	20	14	12.07	Dry, in soil pocket on outcrop, near a tree.
LL-03	Long Lake	P	17-Jul-16	202	62.48085	-114.45974	Outcrop	Brown	Very fine silt	19.6	2	19.4	10.8	8.8	4.89	Dry, in soil pocket on outcrop, near a tree.
LL-04	Long Lake	P	17-Jul-16	206	62.47949	-114.44113	Outcrop	Brown	Silty	11.3	2.6	13.6	8	8.8	6.77	Dry, in soil pocket on outcrop, near a tree.
LL-05	Long Lake	P	17-Jul-16	205	62.48567	-114.44086	Outcrop	Light Brown	Silty	4.1	1	5.7	7.7	6.7	6.57	Dry, in soil pocket on outcrop, several trees in pocket.
LL-06	Long Lake	P	17-Jul-16	199	62.47812	-114.42954	Outcrop	Brown	Silty	15.9	3.3	15.4	17.4	14.1	4.83	Dry, outcrop soil pocket, trees and ground cover in pocket.
LL-07	Long Lake	P	17-Jul-16	208	62.47438	-114.42191	Outcrop	Brown	Silty	2.2	1	0	14.3	13.3	4.29	Dry, outcrop soil pocket, trees and shrubs in pocket.
LL-08	Long Lake	P	17-Jul-16	190	62.47426	-114.43736	Forest Canopy Outcrop	Light Brownish Gray	Clayey, sandy (mixed)	13.1	1	0	19.4	18.4	2.92	Tree covered outcrop, very close to lake, hole is 27 cm deep.
IL-01	North of Giant Mine Property	P	4-Aug-16	242	62.66084	-114.3857	Outcrop	Light Brown	Silty sand, many pine needles, minor moss	3.5	4	0.5	12.7	8.7	3.72	Small soil pocket by many trees, several pine just above it.
IL-02	North of Giant Mine Property	P	4-Aug-16	241	62.65665	-114.38779	Outcrop	Brown, Light Brown at Bottom	Silty clay, organic rich top, sandy silt at bottom	0	0	0	13.1	13.1	5.00	Small soil pocket on slope towards lake, very exposed, lots of moss, some grass.
IL-03	North of Giant Mine Property	P	4-Aug-16	237	62.65482	-114.39024	Forest Canopy Outcrop	Brown	Moist, sandy with some clay	14.1	0	2.6	17.3	17.3	3.00	On boundary between outcrop and forested area, lots of moss, groundcover and trees.
IL-04	North of Giant Mine Property	P	4-Aug-16	238	62.65122	-114.39581	Forest Canopy Outcrop	Light Brown	Sandy with pebble-sized clasts plus silt and clay, 2 cm moss layer	0	0	0	13.1	13.1	5.00	Soil pocket on outcrop with many trees, pine needles and some groundcover.
IL-05	North of Giant Mine Property	P	4-Aug-16	240	62.64843	-114.39964	Outcrop	Light Brown	Sandy with pebble-sized clasts, light, similar to IL-04	14.6	3	15.4	18.5	15.5	5.27	Soil pocket on outcrop, several trees nearby, groundcover, pine needles.
IL-06	North of Giant Mine Property	P	4-Aug-16	235	62.6477	-114.39968	Outcrop	Light Gray	Sandy silt	18.3	0	16.2	16.2	16.2	4.43	Soil pocket just above bush filled drainage of lake, some groundcover, few pine needles.
IL-07	North of Giant Mine Property	P	4-Aug-16	248	62.64892	-114.39419	Outcrop	Brown	Clayey with some sand, organic rich	15	1.5	13.3	13.3	11.8	4.37	Soil pocket with trees and some bush, many pine needles and thick organic layer.

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IL-08	North of Giant Mine Property	P	4-Aug-16	253	62.65375	-114.37937	Outcrop	Black	Clayey with some sand and organics, damp	16.4	0	15.3	15.6	15.6	4.67	Small soil pocket on outcrop, completely filled with low lying crowberry bush.
IL-09	North of Giant Mine Property	P	4-Aug-16	251	62.65784	-114.38042	Outcrop	Brown	Sandy with some clay, many organics	2.4	2.4	1.4	15.1	12.7	4.64	Small soil pocket with pine tree, pine needles and moss. Rock sample collected nearby.
IL-10	North of Giant Mine Property	P	4-Aug-16	237	62.65789	-114.37959	Forest Canopy Outcrop	Brown	Sandy with some silt	4.5	6.5	0	14.3	7.8	3.17	Forest patch near inlet of water to Icing Lake, lots of moss, and some groundcover, leaf litter and pine needles present.
IL-10-Dup	North of Giant Mine Property	FD	4-Aug-16	237	62.65789	-114.37959	Forest Canopy Outcrop	Brown	Sandy with some silt	0.5	3	0	12.4	9.4	4.75	Forest patch near inlet of water to Icing Lake, lots of moss, and some groundcover, leaf litter and pine needles present.
IL-11	North of Giant Mine Property	P	4-Aug-16	238	62.65919	-114.38014	Outcrop	Light Brown	Clayey silt	21.7	1.8	21.6	11.5	9.7	4.95	Soil pocket on outcrop at base of Jack Pine, moss and some needles. Rock sample collected nearby.
IL-12	North of Giant Mine Property	P	4-Aug-16	246	62.66108	-114.3777	Outcrop	Light Brown	Silty clay with organics on top	5.9	0	1	15.7	15.7	3.81	Soil pocket on outcrop, near Jack Pine, groundcover and moss present.
IL-13	North of Giant Mine Property	P	4-Aug-16	250	62.66587	-114.37823	Outcrop	Brown	Clayey sand	17.2	0	16.8	13.9	13.9	4.86	Small soil pocket with low shrubs, some Jack Pines and moss.
YK-24	North of Giant Mine Property	P	29-Jul-16	206	62.53589	-114.33989	Outcrop	Brown	Clayey and silty (evenly mixed)	19.4	1	18.2	12.9	11.9	4.54	Outcrop soil pocket with some lichen and grass.
YK-25	North of Giant Mine Property	P	29-Jul-16	199	62.54398	-114.35689	Outcrop	Orangey-Brown	Silty with some clay	4	6.2	2.5	18	11.8	4.44	Small soil pocket with trees, ground cover and pine needles.
YK-61	North of Giant Mine Property	P	15-Aug-17	224	62.756482	-114.32858	Forest Canopy	brown	silty-organic rich	14.2	1.1	0	17	15.9	2.64	Black spruce, woody shrubs, near o/c. A lot of leaf litter/cones/moss.
YK-61-Dup	North of Giant Mine Property	FD	15-Aug-17	224	62.756482	-114.32858	Forest Canopy	brown	silty-organic rich	14.7	1.8	0	13.5	11.7	2.22	Black spruce, woody shrubs, near o/c. A lot of leaf litter/cones/moss.
YK-62	North of Giant Mine Property	P	15-Aug-17	240	62.756047	-114.32827	Forest Canopy Outcrop	top is brown, bottom is brown to reddish	top is organic rich silt, bottom is silty with a bit of sand	13.5	1.5	7.7	12.5	11	3.27	Black spruce, woody shrubs, cranberry shrub, moss, lichen, half-way up o/c.
YK-63	North of Giant Mine Property	P	15-Aug-17	248	62.755461	-114.32834	Outcrop	brown, light brown towards bottom	silty with some organics	2.5	2.5	0	15.7	13.2	4.20	Near top of o/c, side of face; sparse Jack Pine and a birch tree. Lichen and cranberry cover.
YK-64	North of Giant Mine Property	P	15-Aug-17	157	62.614093	-114.23837	Forest Canopy	light brown	silty	17.3	2.1	15.6	15.7	13.6	4.44	A lot of leaf litter on top, deciduous woody shrub canopy, boulders present.
YK-65	North of Giant Mine Property	P	15-Aug-17	234	62.637085	-114.10172	Outcrop	brown	silty-clay with some organics	20.2	1	13.7	12.6	11.6	3.20	Lichen, cranberry shrub cover, black spruce and Jack Pine.
YK-70	North of Giant Mine Property	P	17-Aug-17	189	62.563958	-114.34819	Forest Canopy	light brown-beige	silty with thin layer of organics on top	27.3	5	26.2	28.4	23.4	4.78	Collected near ATV trail and forested area. Jack Pine and spruce, woody shrubs; cranberries, lichen. Sample taken on mound of organic rich material.
YK-70-Dup	North of Giant Mine Property	FD	17-Aug-17	189	62.563958	-114.34819	Forest Canopy	light brown-beige	silty with thin layer of organics on top	27.4	1.3	25.3	24.6	23.3	4.59	Collected near ATV trail and forested area. Jack Pine and spruce, woody shrubs; cranberries, lichen. Sample taken on mound of organic rich material. Collected 55cm from parent sample.
YK-71	North of Giant Mine Property	P	17-Aug-17	193	62.562315	-114.354	Outcrop	light brown	3cm organic layer, below is silty with little sand	19.1	0.5	14.8	12.5	12	3.68	Bottom of o/c, sparse birch trees and woody shrubs.
YK-40	Southeast and East of Yellowknife	P	19-Aug-16	195	62.47267	-114.18124	Outcrop	Light Brown to Orangey Brown	Pebble clasts, silty clay with trace amounts of sand	0	0	3.5	30.4	30.4	5.65	Small soil pocket on outcrop with birch tree nearby, plenty of groundcover, minor moss and leaf litter.

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YK-40-Dup	Southeast and East of Yellowknife	FD	19-Aug-16	195	62.47269	-114.18124	Outcrop	Light Brown to Orangey Brown	Pebble clasts, silty clay with trace amounts of sand	7.5	0	0	23.4	23.4	3.79	Small soil pocket on outcrop with birch tree nearby, plenty of groundcover, minor moss and leaf litter.
YK-41	Southeast and East of Yellowknife	P	19-Aug-16	208	62.47598	-114.17284	Outcrop	Dark Brown	Clay and organics, slightly damp	9.2	0.5	1.2	23.8	23.3	3.72	Small soil pocket with pine trees and some bushes, moss, twigs, pine needles and some leaf litter.
YK-42	Southeast and East of Yellowknife	P	19-Aug-16	186	62.48183	-114.19044	Outcrop	Brown	Silt	17.5	0.8	17.5	12.4	11.6	5.00	Moderate soil pocket in clearing at edge of birch forest and outcrop, groundcover, moss, leaf litter and some shrubs.
YK-43	Southeast and East of Yellowknife	P	19-Aug-16	185	62.47912	-114.22907	Forest Canopy Outcrop	Orangey (top), Brown (bottom)	Silt	17.5	1.3	16.3	15.2	13.9	4.60	Moderate soil pocket with many birch trees, leaf litter, twigs and very minor moss.
YK-44	Southeast and East of Yellowknife	P	19-Aug-16	182	62.48937	-114.23439	Forest Canopy Outcrop	Brown	MANY roots, gravelly, fine sand/silt	6.9	2.3	0	30.4	28.1	4.01	Small forested soil pocket on outcrop with birch, spruce, pine trees, groundcover, leaf litter, moss and twigs.
YK-66	Southeast and East of Yellowknife	P	15-Aug-17	201	62.430708	-113.99504	Forest Canopy	Brown - Dark Brown	organic rich texture (peat-like)	11.7	1.6	0	22.3	20.7	3.19	A lot of labrador tea, Caribous moss, black spruce, cloud berry leaves.
YK-67	Southeast and East of Yellowknife	P	15-Aug-17	206	62.430256	-113.99627	Forest Canopy Outcrop	Brown to Light Brown	silty-organic rich	3	5.1	0.9	14.5	9.4	4.09	Sample was approximately 45 degree angle; black spruce and birch and sparse woody shrubs; deciduous and pine needle litter.
YK-68	Southeast and East of Yellowknife	P	15-Aug-17	190	62.334475	-114.08163	Forest Canopy	brown	organic rich clay	22	3.7	5.1	15.7	12	2.08	A lot of roots; labrador tea, lichen, cranberries, black spruce.
YK-69	Southeast and East of Yellowknife	P	15-Aug-17	193	62.334659	-114.08207	Outcrop	brown	organic rich silt	20.7	1.5	18.1	11.3	9.8	3.95	Moss and a lot of leaf litter.
YK-54	Southwest and West of Yellowknife	P	15-Aug-17	161	62.354924	-114.64264	Forest Canopy	Brown to dark brown	Organic rich	25.6	2.3	5.1	27.8	25.5	2.77	Peat-like, a lot of roots. Labrador tea, cranberry shrubs, black spruce, moss and lichen cover.
YK-55	Southwest and West of Yellowknife	P	15-Aug-17	170	62.427992	-114.55613	Forest Canopy	Brown to Dark Brown	organic rich	35.5	7.2	13.5	22.4	15.2	2.04	Peat-like, a lot of roots. Labrador tea, cranberry shrubs, black spruce, moss and lichen cover.
YK-56	Southwest and West of Yellowknife	P	15-Aug-17	187	62.428472	-114.55693	Outcrop	top brown, lower 3rd brown-orange	organic rich clay with some silt	12.6	0	7.5	17.2	17.2	3.86	Granitic o/c with lichen cover, some moss and grass; spruce and labrador tea; golf ball found near vicinity of sample.
YK-57	Southwest and West of Yellowknife	P	15-Aug-17	169	62.427222	-114.69798	Forest Canopy	top 5 cm brown, below light brown	organic rich/silty for top 5cm, below is silt	39.1	5.6	35.9	17.4	11.8	3.93	Spruce/birch cover; a lot of dead wood and deciduous leaf litter.
YK-58	Southwest and West of Yellowknife	P	15-Aug-17	196	62.531346	-114.66218	Forest Canopy	brown	very silty with a little sand and some organics	2.8	2.8	0	20	17.2	4.30	Lichen and cranberry bushes, black spruce, pine needle leaf litter.
YK-59	Southwest and West of Yellowknife	P	15-Aug-17	220	62.60316	-114.66218	Forest Canopy Outcrop	brown	organic rich silt; 9 cm cobble	9.5	0	1	19	19	3.45	Spruce, birch, woody shrubs; part way up o/c a lot of deciduous leaf litter.
YK-60	Southwest and West of Yellowknife	P	15-Aug-17	229	62.602704	-114.52577	Outcrop	brown	silty, a lot of organics with some sand; 12 cm boulder of weather granite	9.2	1.3	0	12.2	10.9	2.71	Moss, lichen, Jack Pine, pine needle leaf litter.

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TX-01	TerraX Northbelt	P	2-Aug-16	220	62.66386	-114.27846	Outcrop	Brown	Clayey with a bit of silt, minor pebble sized clasts, organic rich	11	1	15	21.8	20.8	6.19	Soil pocket with grasses and moss, pine tree nearby (different pocket) dropping needles and cones into sampled one.
TX-02	TerraX Northbelt	P	2-Aug-16	217	62.65771	-114.28139	Forest Canopy Outcrop	Brown	Organic rich, clayey	14.5	1	12.7	8.4	7.4	4.02	Edge of outcrop near forest, rock neat surface, lots of trees, groundcover and grasses.
TX-03	TerraX Northbelt	P	2-Aug-16	199	62.65452	-114.2682	Outcrop	Light Brown to Orangey Brown	Clayey silt, 1-2 cm of moss on top	20.6	1.2	22.4	9.7	8.5	6.34	Small soil pocket with little trees, moss and some groundcover.
TX-04	TerraX Northbelt	P	2-Aug-16	228	62.61369	-114.39053	Outcrop	Black	Clayey, organic rich and damp	0	0	0	10.5	10.5	5.00	Soil pocket with grasses and nearby (different pocket) pine trees.
TX-05	TerraX Northbelt	P	2-Aug-16	241	62.6166	-114.37728	Outcrop	Black	Clayey, organic rich	13.2	2.3	5	19.4	17.1	3.38	Soil pocket with grasses and a bush.
TX-06	TerraX Northbelt	P	2-Aug-16	221	62.61062	-114.39077	Forest Canopy	Brown	Sandy clay, thick peat layer	13.1	3.5	1.1	19.8	16.3	2.88	Forested area near bog, many shrubs and groundcover, lots of peat.
TX-07	TerraX Northbelt	P	2-Aug-16	227	62.60955	-114.38054	Forest Canopy Outcrop	Light Brown	Sandy silty with pebble sized clasts	0	0	0	8.7	8.7	5.00	Soil pocket with pines, pine needles on surface.
TX-08	TerraX Northbelt	P	3-Aug-16	236	62.60926	-114.31299	Outcrop	Black	Clayey, organic rich, approx. 3 cm moss layer	15.6	2.2	13.2	16.8	14.6	4.29	Damp, small soil pocket with moss and grass.
TX-09	TerraX Northbelt	P	3-Aug-16	232	62.60233	-114.31711	Outcrop	Brown	Sandy silt with some pebble sized clasts	0	0	0	13.8	13.8	5.00	Small soil pocket with many small shrubs.
TX-10	TerraX Northbelt	P	3-Aug-16	216	62.59468	-114.32435	Forest Canopy Outcrop	Brown	Sandy clay	9.8	1	6.6	22.6	21.6	4.35	Moderate sized soil pocket on slope of outcrop, several trees, groundcover and some leaf litter.
TX-10-Dup	TerraX Northbelt	FD	3-Aug-16	215	62.59466	-114.32438	Forest Canopy Outcrop	Brown	Sandy clay	18.5	0	15.4	12.7	12.7	4.02	Moderate sized soil pocket on slope of outcrop, several trees, groundcover and some leaf litter.
TX-11	TerraX Northbelt	P	3-Aug-16	235	62.59298	-114.3299	Outcrop	Brown to Dark Brown	Loose, organic rich silty	1	1	0	18	17	4.72	Small soil pocket with groundcover and small shrub on very top of outcrop.
TX-12	TerraX Northbelt	P	3-Aug-16	198	62.58393	-114.30036	Outcrop	Light Brown to Orangey Brown	Silty clayey	14.6	1.3	13.3	17.1	15.8	4.62	Soil pocket with several Jack Pines some groundcover and pine needles.
TX-13	TerraX Northbelt	P	3-Aug-16	208	62.58352	-114.28513	Outcrop	Dark Brown/Black	Very organic rich, clayey, damp	2.2	2.2	0	14.8	12.6	4.26	Soil pocket with grass and bushes, approx. 2 cm thick moss layer.
TX-14	TerraX Northbelt	P	3-Aug-16	204	62.58323	-114.28483	Forest Canopy Outcrop	Black (top), Gray (bottom)	Top is very thick organic layer, clayey, bottom is sandy till-like	17.2	1	4.4	21	20	3.05	Large soil/peat patch filled with trees (like a forest on an outcrop).
TX-32	TerraX Northbelt	P	22-Aug-16	185	62.53207	-114.31738	Forest Canopy Outcrop	Brown	Sandy with some silty clay, cobbles present	7.3	0.5	3.1	23.8	23.3	4.24	Moderate soil pocket on top of outcrop, several spruce trees and Jack Pines, some low lying bushes, groundcover, grass, moss and pine needles.
TX-33	TerraX Northbelt	P	22-Aug-16	187	62.54353	-114.30701	Forest Canopy Outcrop	Light Gray	Very silty, bit of clay, minor roots and organics below the organic layer	12.8	0.5	5.1	18.5	18	3.50	Large soil pocket with spruce and willow trees, some moss, some groundcover, pine needles, twigs, leaf litter.
TX-34	TerraX Northbelt	P	22-Aug-16	195	62.54197	-114.30936	Outcrop	Brown	Silt	17.2	1.3	16.3	14.6	13.3	4.68	Moderate soil pocket on outcrop, spruce nearby, low lying shrubs, some groundcover, moss, twigs, grass.

Sample ID	Location	QA/QC	Date	Elevation (m) Recorded with GPS	Coordinates Decimal Degrees		Type	Soil Colour	Soil Texture	In Field Measurements					Public Health Layer	Sample Comments
										Top of Core to (cm):			Core Length (cm)	Sample Depth (cm)		
										Top of Sample		Ground Surface				
					Latitude	Longitude				In Ground	AC					
TX-35	TerraX Northbelt	P	22-Aug-16	178	62.54953	-114.29468	Forest Canopy Outcrop	Light Brown, Beigey	Cobble and pebble clasts, silty (some clay and sand)	10.2	1.5	0	24.1	22.6	3.45	Edge of large forested area on outcrop, birch and spruce, groundcover, leaf litter, twigs and moss.
TX-15	TerraX Southbelt	P	15-Aug-16	157	62.38305	-114.40686	Outcrop	Brown	Sand, some gravel clasts, damp	13.5	0	9.5	17.8	17.8	4.08	Small soil pocket with steep sides, groundcover, moss and some leaf litter, twigs and dead trunks (fallen over).
TX-16	TerraX Southbelt	P	15-Aug-16	178	62.38713	-114.39051	Outcrop	Black	Clayey silt with some gravel, organics present	19.2	0.8	22	17.8	17	5.99	Strong wind off of Great Slave Lake toward Con Mine, small exposed soil pocket on slope down into Great Slave Lake, low lying shrub.
TX-17	TerraX Southbelt	P	15-Aug-16	174	62.39064	-114.38279	Outcrop	Black and Dark Brown	Clayey organics, silty clay	5	0	0	15.4	15.4	3.77	Small soil pocket in crevice, willow and birch trees nearby, twigs, moss and leaf litter.
TX-18	TerraX Southbelt	P	15-Aug-16	170	62.37679	-114.43151	Outcrop	Brown	Clayey, silty clay, gravel clasts	13.6	1.4	4.4	19.8	18.4	3.33	Moderate soil pocket with birch tree, low lying shrubs and leaf litter.
TX-19	TerraX Southbelt	P	15-Aug-16	168	62.37768	-114.42976	Outcrop	Light Brown	Sandy with some clay, gravel to cobble or boulder sized clasts, lots of organics (makes it light)	13.7	0.4	2.9	17.9	17.5	3.09	Moderate soil pocket with spruce and birch, moss, groundcover and grass.
TX-20	TerraX Southbelt	P	15-Aug-16	166	62.38002	-114.42848	Outcrop	Dark Brown to Black	Clayey sand, gravelly	17.1	0.5	15.2	14.2	13.7	4.39	Long, relatively narrow outcrop soil pocket, spruce trees nearby, groundcover.
TX-20-Dup	TerraX Southbelt	FD	15-Aug-16	167	62.38004	-114.42851	Outcrop	Dark Brown to Black	Clayey sand, gravelly	12.9	0	7.9	18.2	18.2	3.92	Long, relatively narrow outcrop soil pocket, spruce trees nearby, groundcover.
TX-21	TerraX Southbelt	P	15-Aug-16	163	62.37762	-114.43984	Outcrop	Brown	Sandy clay, boulders and gravel	18.7	0.5	13.6	11	10.5	3.37	Small soil pocket on outcrop, moss, groundcover and some grass, relatively exposed.
TX-22	TerraX Southbelt	P	16-Aug-16	165	62.36502	-114.46928	Outcrop	Brown	Silty clay with a bit of sand, lots of roots	22.7	0.9	21.5	8.8	7.9	4.34	Narrow, small outcrop soil pocket with steep sides, exposed, short shrubs, moss, grass, groundcover and twigs.
TX-23	TerraX Southbelt	P	16-Aug-16	165	62.36543	-114.45959	Outcrop	Black (top), Brown (bottom)	Organic rich (top), clay (bottom)	20.2	0	19.1	10.5	10.5	4.53	Exposed soil pocket with large, very healthy crowberry brush, moss, grass and some groundcover.
TX-24	TerraX Southbelt	P	16-Aug-16	168	62.36791	-114.45573	Outcrop	Black (top), Brown (bottom)	Organic rich (top), clay (bottom)	8.5	1.3	6	14	12.7	4.18	Exposed soil pocket with crowberry bush, moss, groundcover, twigs.
TX-25	TerraX Southbelt	P	16-Aug-16	159	62.35776	-114.49741	Forest Canopy Outcrop	Gray Brown	Thick organic layer (approx. 5 cm), moist sand, some clay and gravel clasts	17.7	1.2	11.2	14.8	13.6	3.38	Small soil pocket at edge of outcrop by forested area, difficult to find soil, thick moss, groundcover, twigs, roots visible in hole.
TX-26	TerraX Southbelt	P	16-Aug-16	160	62.35695	-114.50116	Outcrop	Black	Clayey and organic rich, gravelly, silty clay present, cobbles, sand at bottom	6.4	1.3	6.4	9.8	8.5	5.00	Exposed soil pocket on outcrop, many dead and fallen trees, moss, groundcover and grass.
TX-27	TerraX Southbelt	P	16-Aug-16	160	62.35997	-114.49981	Forest Canopy Outcrop	Dark Brown	Clay, damp, high percentage of organics	17.7	1.8	13.5	13	11.2	3.64	Soil pocket close to edge of forested area, moss and groundcover, grass and shrubs, leaf litter and pine needles.
TX-28	TerraX Southbelt	P	16-Aug-16	163	62.35935	-114.50614	Outcrop	Dark Brown	Nearly all organics, light, loose	10.7	1.5	0	21	19.5	3.23	Crevice with soil, thick groundcover, peat and grass.

Sample ID	Location	QA/QC	Date	Elevation (m) Recorded with GPS	Coordinates Decimal Degrees		Type	Soil Colour	Soil Texture	In Field Measurements					Public Health Layer	Sample Comments
										Top of Core to (cm):			Core Length (cm)	Sample Depth (cm)		
										Top of Sample		Ground Surface				
					Latitude	Longitude				In Ground	AC					
TX-29	TerraX Southbelt	P	17-Aug-16	166	62.36968	-114.51122	Forest Canopy Outcrop	Brown	Sandy, small amount of clay, damp	12.9	0.3	9.8	9.7	9.4	3.76	Moderate, shallow soil pocket with many pine trees, moss, twigs, pine needles and cones, rocky.
TX-30	TerraX Southbelt	P	17-Aug-16	172	62.36881	-114.50188	Outcrop	Dark Brown	Clay with lots of organics	1.5	0	16.5	15	15	5.00	Exposed pocket on top of outcrop, moss, grasses and low lying bush.
TX-30-Dup	TerraX Southbelt	FD	17-Aug-16	172	62.3688	-114.5019	Outcrop	Dark Brown	Clay with lots of organics	5.2	0.8	5.1	14.4	13.6	4.96	Exposed pocket on top of outcrop, moss, grasses and low lying bush.
TX-31	TerraX Southbelt	P	17-Aug-16	163	62.37291	-114.491	Outcrop	Brown	Silty clay with a bit of sand	19.9	1.5	18.8	12.2	10.7	4.53	Soil pocket on edge of moderate sized forested outcrop pocket, dead branches, pine needles and roots, several rosehip bushes.
CM-22	Yellowknife	P	19-Jul-16	190	62.43639	-114.35109	Outcrop	Black	Clayey	21.2	1.8	24.8	10.7	8.9	8.40	Organic rich soil, outcrop pocket, groundcover growing in it. *forgot to measure SS so put back in ground.
YK-04	Yellowknife	P	5-Aug-16	195	62.44989	-114.50925	Forest Canopy Outcrop	Light Brown	Silty sand, some organics	18.6	0	18.9	13	13	5.12	Soil pocket with Jack Pines, pine needles and some moss.
YK-05	Yellowknife	P	5-Aug-16	192	62.44508	-114.49818	Forest Canopy Outcrop	Brown	Clayey silt	7.1	1	4.2	11.3	10.3	3.90	Moderate sized soil pocket with several trees and bush, lots of pine needles and some leaf litter.
YK-06	Yellowknife	P	5-Aug-16	195	62.44278	-114.47054	Outcrop	Brown	Clayey silt	12.9	0.5	0	18.3	17.8	2.90	Small soil pocket with dense low lying bush, groundcover and grasses, thick layer of peat/moss.
YK-07	Yellowknife	P	18-Jul-16	202	62.45548	-114.39761	Outcrop	Brown	Silty	6.6	1	1.6	8	7	2.92	Outcrop soil pocket near top of outcrop by Frame Lake.
YK-08	Yellowknife	P	18-Jul-16	198	62.46255	-114.38269	Outcrop	Light Brown	Silty sandy with gravel sized pieces	23.3	2	20.9	6.9	4.9	3.36	Outcrop soil pocket with several trees, difficult to find a good sized pocket, lost clump at top while cutting tube.
YK-09	Yellowknife	P	18-Jul-16	185	62.47049	-114.37187	Outcrop	Light Brown	Clayey	5.6	1.8	0	18.7	16.9	3.76	Outcrop soil pocket, aluminum tube at 45 degree angle, a few trees in pocket.
YK-10	Yellowknife	P	18-Jul-16	183	62.48144	-114.36208	Forest Canopy Outcrop	Light Brown	Clayey	0	0	0	13.8	13.8	5.00	Large forested area on an outcrop.
YK-35	Yellowknife	P	9-Aug-16	191	62.44157	-114.44637	Forest Canopy Outcrop	Light Brown (top and middle, Light Orange (Bottom)	Clayey with some silt all throughout	5.3	1.5	2.6	10.7	9.2	3.87	Soil pocket on outcrop with moss, groundcover and pine trees.
YK-74	Yellowknife River	P	18-Aug-17	165	62.509028	-114.32312	Forest Canopy	Brown to Light Brown	Silty	36.7	1.3	29.1	15.8	14.5	3.28	A lot of peat in area; sample has 5-6 cm of peat organic on top; spruce trees, moss, labrador tea.
YK-75	Yellowknife River	P	18-Aug-17	167	62.509313	-114.32693	Outcrop	Dark brown	Organic rich clay	27.6	1.6	27.9	9.7	8.1	5.19	Taken on o/c slope facing NE beside rose bushes and grasses. Spruce and juniper shrubs near by.
YK-76	Yellowknife River	P	18-Aug-17	165	62.509006	-114.32734	Outcrop	Dark brown (top 4 cm); below is light brown	Top 4cm organic rich silt, below is just silt	3.5	3.5	0	25.4	21.9	4.31	O/c sample amongst some shrubs plus a couple spruce; slope facing east.
YR-01	Yellowknife River	P	18-Aug-16	162	62.53706	-114.24494	Forest Canopy	Light Gray	Silty clay	11.9	0	0	20.3	20.3	3.15	Forested area off edge of YK river, spruce, pine, birch, willow trees, shrubs, groundcover, twigs, pine needles, moss and leaf litter.
YR-02	Yellowknife River	P	18-Aug-16	163	62.52006	-114.25792	Forest Canopy Outcrop	Light Gray	Very fine sand/silt?, gravel and cobble clasts	10.9	0	5.1	20.3	19.3	3.84	Small soil pocket on outcrop with large birch tree, moss, grass, minor groundcover, leaf litter, and twigs. Lost 1 cm of material from the bottom.
YR-03	Yellowknife River	P	18-Aug-16	188	62.53732	-114.28162	Outcrop	Black	Clay, damp	21.6	1.3	11.3	10.1	8.8	2.30	Small soil pocket on top of outcrop with pine trees, pine needles, moss and twigs present.
YR-03-Dup	Yellowknife River	FD	18-Aug-16	189	62.5373	-114.28165	Outcrop	Black	Clay, damp	0.6	0	0	20.2	20.2	4.86	Small soil pocket on top of outcrop with pine trees, pine needles, moss and twigs present.

Sample ID	Location	QA/QC	Date	Elevation (m) Recorded with GPS	Coordinates Decimal Degrees		Type	Soil Colour	Soil Texture	In Field Measurements					Public Health Layer	Sample Comments
										Top of Core to (cm):			Core Length (cm)	Sample Depth (cm)		
										Top of Sample		Ground Surface				
					Latitude	Longitude				In Ground	AC					
YR-04	Yellowknife River	P	18-Aug-16	176	62.53856	-114.29185	Forest Canopy Outcrop	Brownish-beige with Orange bits	Silty, light, some sand and clay	12.2	0	10.3	18.4	18.4	4.53	Moderate sized soil pocket on outcrop with birch and spruce trees, twigs, moss and some groundcover.
YR-05	Yellowknife River	P	22-Aug-16	184	62.54228	-114.29049	Forest Canopy Outcrop	Light Brown, Beigey	Silty, gravel and cobbles, root bound chunks	7.8	0.3	8.3	24.7	24.4	5.10	Moderate sized forested outcrop, spruce trees, groundcover, twigs and pine needles.
YR-06	Yellowknife River	P	22-Aug-16	169	62.54165	-114.29785	Outcrop	Light Brown	Gravel and cobble clasts, silty	12.9	0	9.1	17.8	17.8	4.12	Small soil pocket with spruce tree, pine needles and cones, exposed soil.
YR-07	Yellowknife River	P	29-Jul-16	175	62.51499	-114.30584	Outcrop	Orangey-Brown	Silty	16.8	0	15.8	13.3	13.3	4.65	Outcrop soil near forested edge, some trees, lichen and leaf litter.
YR-08	Yellowknife River	P	29-Jul-16	165	62.50847	-114.31244	Outcrop	Brown	Clayey silt	6.2	6.2	2	17	10.8	3.60	Small soil pocket on outcrop with a tree, bush and groundcover all from one point.

Abbreviations: FD = field duplicate; P = parent sample; AC = measurement taken after the core was cut.

Appendix B

Data Management

To organize samples collected and subsequent data, several data management techniques were employed. First, a tracking sheet was created to record which samples were analyzed, when the sample were analyzed, by which analytical technique, and the location of each sample at Queen's University (Table B-1). All remaining core samples are in a freezer located in the BioScience building at Queen's University on the 3rd floor, across from room 3218. Remaining PHL samples, down core samples (samples that were too small to remain in the core, so they were put into a Ziploc bag), pucks, and samples used for XANES analysis are stored in room 3218 in a drawer marked "Jon Oliver". Second, elemental data obtained from Analytical Services Unit (ASU; refer to Section 3.3.2) were retained in their original file; the data was copy into one spreadsheet for data interpretation. Third, quality assurance and quality control (QAQC; refer to Section 3.2) samples were kept in separate spreadsheets for their own analysis.

Table B-1: Tracking sheet for samples collected and analysis performed.

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
-	SS-1	Blank	25-Jan-17	9-Mar-17	ASU16111-S2								-	Yes	No
-	SS-2	Blank	25-Jan-17	9-Mar-17	ASU16111-S2								-	Yes	No
19-Jul-16	CM-01	P	25-Jan-17	24-Mar-17	ASU16111-S3								No	Yes	No
19-Jul-16	CM-02	LD	25-Jan-17	24-Mar-17	ASU16111-S3								No	Yes	No
19-Jul-16	CM-02	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes (only one half)	Yes	No
12-Aug-16	CM-03	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-03	SS	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
12-Aug-16	CM-04	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-05	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
12-Aug-16	CM-06	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
12-Aug-16	CM-07	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-08	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
12-Aug-16	CM-09	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
12-Aug-16	CM-10	FD	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-10	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-11	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
12-Aug-16	CM-12	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
08-Aug-16	CM-13	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
08-Aug-16	CM-13	SS	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
08-Aug-16	CM-14	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-15	P	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
12-Aug-16	CM-15	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
08-Aug-16	CM-16	LD	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
08-Aug-16	CM-16	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
08-Aug-16	CM-17	FD	25-Jan-17	24-Mar-17	ASU16111-S3	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
08-Aug-16	CM-17	P	25-Jan-17	24-Mar-17	ASU16111-S3								Yes	Yes	No
12-Aug-16	CM-18	P	25-Jan-17	24-Mar-17	ASU16111-S3				Yes	Yes	Yes		Yes	Yes	No
12-Aug-16	CM-19	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
08-Aug-16	CM-20	LD	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
08-Aug-16	CM-20	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
08-Aug-16	CM-21	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
19-Jul-16	CM-22	P	25-Jan-17	24-Mar-17	ASU16111-S4				Yes	Yes	Yes		Yes	Yes	No
12-Aug-16	CM-23	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
19-Jul-16	CM-24	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
19-Jul-16	CM-25	LD	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
19-Jul-16	CM-25	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
19-Jul-16	CM-25	SS	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
08-Aug-16	CM-26	P	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
16-Aug-17	Grace-01	LD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
16-Aug-17	Grace-01	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
16-Aug-17	Grace-02	P	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
16-Aug-17	Grace-03	P	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
16-Aug-17	Grace-03	SS	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
16-Aug-17	Grace-04	P	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
16-Aug-17	Grace-05	P	2-Oct-17	11-Oct-17	ASU16409-S2				Yes	Yes	Yes		No	Yes	PHL to 7.5

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
16-Aug-17	Grace-06	FD	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
16-Aug-17	Grace-06	P	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
20-Jul-16	G-SIT-01	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-02	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
20-Jul-16	G-SIT-03	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
20-Jul-16	G-SIT-04	LD	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
20-Jul-16	G-SIT-04	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
20-Jul-16	G-SIT-05	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
20-Jul-16	G-SIT-06	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes (x2)	No	No	Yes	Yes	Yes	No
20-Jul-16	G-SIT-07	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-08	LD	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
20-Jul-16	G-SIT-08	P	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
20-Jul-16	G-SIT-08	SS	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
20-Jul-16	G-SIT-09	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
20-Jul-16	G-SIT-10	FD	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
20-Jul-16	G-SIT-10	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
20-Jul-16	G-SIT-11	P	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
20-Jul-16	G-SIT-12	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-13	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
20-Jul-16	G-SIT-13	SS	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
20-Jul-16	G-SIT-14	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
20-Jul-16	G-SIT-15	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-16	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-17	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-18	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
20-Jul-16	G-SIT-18	SS	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
20-Jul-16	G-SIT-18	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
20-Jul-16	G-SIT-19	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
20-Jul-16	G-SIT-20	FD	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
20-Jul-16	G-SIT-20	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
21-Jul-16	G-SIT-21	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
21-Jul-16	G-SIT-22	LD	26-Sep-16	4-Oct-16	ASU15919-S2								No	Yes	PHL to 7
21-Jul-16	G-SIT-22	P	26-Sep-16	4-Oct-16	ASU15919-S2								No	Yes	PHL to 7
21-Jul-16	G-SIT-23	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-24	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					No	Yes	PHL to 6.5
21-Jul-16	G-SIT-25	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
21-Jul-16	G-SIT-26	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
21-Jul-16	G-SIT-26	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-27	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
21-Jul-16	G-SIT-28	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
21-Jul-16	G-SIT-29	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-30	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	No	No
21-Jul-16	G-SIT-31	FD	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-31	P	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
21-Jul-16	G-SIT-32	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
21-Jul-16	G-SIT-33	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
~~21-Jul-16~~	~~G-SIT-34~~	~~P~~	Sample Lost Prior to Shipment										Yes	Yes	No
21-Jul-16	G-SIT-35	LD	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
21-Jul-16	G-SIT-35	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-36	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	No	Yes	PHL to 7
21-Jul-16	G-SIT-36	SS	25-Jan-17	24-Mar-17	ASU16111-S6								No	Yes	PHL to 7
21-Jul-16	G-SIT-37	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes (x4)	No	No	Yes	Yes	Yes	No
21-Jul-16	G-SIT-38	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-39	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-40	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
21-Jul-16	G-SIT-41	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-42	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-43	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224				Yes	Yes	Yes	No
21-Jul-16	G-SIT-43	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-44	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
21-Jul-16	G-SIT-45	LD	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
21-Jul-16	G-SIT-45	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
21-Jul-16	G-SIT-46	FD	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					No	Yes	PHL to 8
21-Jul-16	G-SIT-46	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
13-Aug-16	G-SIT-47	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
13-Aug-16	G-SIT-47	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
13-Aug-16	G-SIT-48	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
13-Aug-16	G-SIT-49	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
13-Aug-16	G-SIT-50	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
13-Aug-16	G-SIT-51	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
13-Aug-16	G-SIT-52	FD	19-Sep-16	4-Oct-16	ASU15919-S1								Yes	Yes	No
13-Aug-16	G-SIT-52	P	26-Sep-16	4-Oct-16	ASU15919-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
13-Aug-16	G-SIT-53	P	19-Sep-16	4-Oct-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
13-Aug-16	G-SIT-54	P	19-Sep-16	4-Oct-16	ASU15919-S1								Yes	Yes	No
13-Aug-16	G-SIT-55	P	26-Sep-16	4-Oct-16	ASU15919-S2								Yes	Yes	No
10-Aug-16	G-WGM-01	P	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
10-Aug-16	G-WGM-02	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-03	FD	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
10-Aug-16	G-WGM-03	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-04	LD	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-04	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-05	P	10-Jan-17	10-Feb-17	ASU16084-S1				Yes	No	No		Yes	Yes	No
10-Aug-16	G-WGM-06	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-07	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
10-Aug-16	G-WGM-08	LD	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
10-Aug-16	G-WGM-08	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-08	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
10-Aug-16	G-WGM-09	P	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
10-Aug-16	G-WGM-10	P	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
10-Aug-16	G-WGM-11	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
10-Aug-16	G-WGM-12	FD	25-Jan-17	24-Mar-17	ASU16111-S4				Yes	No	No		Yes	Yes	No
10-Aug-16	G-WGM-12	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
10-Aug-16	G-WGM-12	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
11-Aug-16	G-WGM-13	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-14	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
11-Aug-16	G-WGM-15	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-16	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-17	P	25-Jan-17	24-Mar-17	ASU16111-S4				Yes	Yes	Yes		Yes	No	No
11-Aug-16	G-WGM-18	P	25-Jan-17	24-Mar-17	ASU16111-S4	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-19	LD	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
11-Aug-16	G-WGM-19	P	25-Jan-17	24-Mar-17	ASU16111-S4								Yes	Yes	No
11-Aug-16	G-WGM-20	P	25-Jan-17	24-Mar-17	ASU16111-S4				Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-20	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
11-Aug-16	G-WGM-21	FD	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
11-Aug-16	G-WGM-21	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
11-Aug-16	G-WGM-22	LD	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
11-Aug-16	G-WGM-22	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
11-Aug-16	G-WGM-23	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
11-Aug-16	G-WGM-24	P	10-Jan-17	10-Feb-17	ASU16084-S1				Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-25	P	25-Jan-17	24-Mar-17	ASU16111-S5								No	Yes	PHL to 8
11-Aug-16	G-WGM-26	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
11-Aug-16	G-WGM-27	P	25-Jan-17	24-Mar-17	ASU16111-S5				Yes	No	No		No	Yes	PHL to 8
11-Aug-16	G-WGM-28	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-28	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-29	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
11-Aug-16	G-WGM-30	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-31	FD	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-31	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-31	SS	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-32	P	25-Jan-17	24-Mar-17	ASU16111-S5				Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-33	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
11-Aug-16	G-WGM-34	LD	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-34	P	10-Jan-17	10-Feb-17	ASU16084-S1				Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-35	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
11-Aug-16	G-WGM-36	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-37	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-38	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
11-Aug-16	G-WGM-39	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-40	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
11-Aug-16	G-WGM-40	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
13-Aug-16	G-WGM-41	FD	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
13-Aug-16	G-WGM-41	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
13-Aug-16	G-WGM-42	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
13-Aug-16	G-WGM-43	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
13-Aug-16	G-WGM-44	LD	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
13-Aug-16	G-WGM-44	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
13-Aug-16	G-WGM-45	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
13-Aug-16	G-WGM-46	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
13-Aug-16	G-WGM-47	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No		Yes	Yes	No
13-Aug-16	G-WGM-48	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
13-Aug-16	G-WGM-49	LD	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
13-Aug-16	G-WGM-49	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
13-Aug-16	G-WGM-50	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
13-Aug-16	G-WGM-51	FD	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
13-Aug-16	G-WGM-51	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
13-Aug-16	G-WGM-52	P	10-Jan-17	10-Feb-17	ASU16084-S1				Yes	No	No		Yes	Yes	No
13-Aug-16	G-WGM-53	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-01	P	25-Jan-17	24-Mar-17	ASU16111-S5				Yes	Yes	Yes		Yes	Yes	No
04-Aug-16	IL-02	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-02	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-03	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-04	LD	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
04-Aug-16	IL-04	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
04-Aug-16	IL-05	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
04-Aug-16	IL-06	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
04-Aug-16	IL-07	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
04-Aug-16	IL-08	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-09	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-10	FD	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
04-Aug-16	IL-10	P	25-Jan-17	24-Mar-17	ASU16111-S5								No	Yes	PHL to 8
04-Aug-16	IL-11	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
04-Aug-16	IL-11	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
04-Aug-16	IL-12	P	25-Jan-17	24-Mar-17	ASU16111-S5								Yes	Yes	No
04-Aug-16	IL-13	P	25-Jan-17	24-Mar-17	ASU16111-S5	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
17-Jul-16	LL-01	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
17-Jul-16	LL-02	P	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
17-Jul-16	LL-03	P	19-Sep-16	29-Sep-16	ASU15919-S1								Yes	Yes	No
17-Jul-16	LL-04	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
17-Jul-16	LL-05	LD	19-Sep-16	29-Sep-16	ASU15919-S1								No	Yes	PHL to 6
17-Jul-16	LL-05	P	19-Sep-16	29-Sep-16	ASU15919-S1								No	Yes	PHL to 6
17-Jul-16	LL-05	SS	25-Jan-17	24-Mar-17	ASU16111-S6								No	Yes	PHL to 6
17-Jul-16	LL-06	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes	Yes	Yes	Yes	No
17-Jul-16	LL-07	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224	Yes	No	No	Yes	Yes	Yes	No
17-Jul-16	LL-08	P	19-Sep-16	29-Sep-16	ASU15919-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
02-Aug-16	TX-01	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
02-Aug-16	TX-02	P	25-Jan-17	9-Mar-17	ASU16111-S1				Yes	Yes	Yes		Yes	Yes	No
02-Aug-16	TX-03	P	25-Jan-17	9-Mar-17	ASU16111-S1								No	Yes	PHL to 10
02-Aug-16	TX-04	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
02-Aug-16	TX-05	LD	25-Jan-17	9-Mar-17	ASU16111-S1								No	Yes	PHL to 10
02-Aug-16	TX-05	P	25-Jan-17	9-Mar-17	ASU16111-S1								No	Yes	PHL to 10
02-Aug-16	TX-06	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
02-Aug-16	TX-07	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
03-Aug-16	TX-08	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
03-Aug-16	TX-08	SS	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
03-Aug-16	TX-09	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
03-Aug-16	TX-10	FD	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
03-Aug-16	TX-10	P	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
03-Aug-16	TX-11	P	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
03-Aug-16	TX-11	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
03-Aug-16	TX-12	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
03-Aug-16	TX-12	SS	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
03-Aug-16	TX-13	P	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
03-Aug-16	TX-13	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
03-Aug-16	TX-14	P	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
15-Aug-16	TX-15	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
15-Aug-16	TX-16	LD	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
15-Aug-16	TX-16	P	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
15-Aug-16	TX-17	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
15-Aug-16	TX-18	P	25-Jan-17	9-Mar-17	ASU16111-S1								Yes	Yes	No
15-Aug-16	TX-19	P	25-Jan-17	9-Mar-17	ASU16111-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
15-Aug-16	TX-20	FD	25-Jan-17	9-Mar-17	ASU16111-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
15-Aug-16	TX-20	P	25-Jan-17	9-Mar-17	ASU16111-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
15-Aug-16	TX-21	LD	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
15-Aug-16	TX-21	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-22	P	25-Jan-17	9-Mar-17	ASU16111-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
16-Aug-16	TX-22	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
16-Aug-16	TX-23	LD	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-23	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-23	SS	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-24	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-25	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-26	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
16-Aug-16	TX-27	P	25-Jan-17	9-Mar-17	ASU16111-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
16-Aug-16	TX-28	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
17-Aug-16	TX-29	P	25-Jan-17	9-Mar-17	ASU16111-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
17-Aug-16	TX-30	FD	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
17-Aug-16	TX-30	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
17-Aug-16	TX-30	SS	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
17-Aug-16	TX-31	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
22-Aug-16	TX-32	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
22-Aug-16	TX-33	LD	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
22-Aug-16	TX-33	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
22-Aug-16	TX-34	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
22-Aug-16	TX-35	P	25-Jan-17	9-Mar-17	ASU16111-S2								Yes	Yes	No
18-Jul-16	YK-01	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
18-Jul-16	YK-02	FD	10-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
18-Jul-16	YK-02	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
18-Jul-16	YK-03	P	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
18-Jul-16	YK-03	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
18-Jul-16	YK-03	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
05-Aug-16	YK-04	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
05-Aug-16	YK-05	P	10-Jan-17	10-Feb-17	ASU16111-S7				Yes	Yes	Yes		Yes	Yes	No
05-Aug-16	YK-06	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
18-Jul-16	YK-07	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					No	Yes	PHL to 8
18-Jul-16	YK-08	LD	10-Jan-17	10-Feb-17	ASU16084-S1								No	Yes	PHL to 7
18-Jul-16	YK-08	P	10-Jan-17	10-Feb-17	ASU16084-S1								No	Yes	PHL to 7
18-Jul-16	YK-09	P	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
18-Jul-16	YK-10	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
19-Jul-16	YK-11	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
19-Jul-16	YK-12	FD	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
19-Jul-16	YK-12	P	10-Jan-17	10-Feb-17	ASU16084-S1	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
19-Jul-16	YK-13	P	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
19-Jul-16	YK-14	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
28-Jul-16	YK-15	P	10-Jan-17	10-Feb-17	ASU16084-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
28-Jul-16	YK-16	LD	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
28-Jul-16	YK-16	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
28-Jul-16	YK-17	P	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
28-Jul-16	YK-18	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
28-Jul-16	YK-19	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
28-Jul-16	YK-20	FD	10-Jan-17	10-Feb-17	ASU16084-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
28-Jul-16	YK-20	LD	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
28-Jul-16	YK-20	P	25-Jan-17	24-Mar-17	ASU16111-S6				Yes	Yes	Yes		Yes	Yes	No
28-Jul-16	YK-21	P	10-Jan-17	10-Feb-17	ASU16084-S2	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
29-Jul-16	YK-22	P	10-Jan-17	10-Feb-17	ASU16084-S2								No	Yes	PHL to 7.4
29-Jul-16	YK-23	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
29-Jul-16	YK-23	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
29-Jul-16	YK-24	P	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
29-Jul-16	YK-25	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	No	No
05-Aug-16	YK-26	P	25-Jan-17	24-Mar-17	ASU16111-S6				Yes	Yes	Yes		Yes	Yes	No
05-Aug-16	YK-26	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-27	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-28	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-29	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-30	FD	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-30	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-31	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
05-Aug-16	YK-32	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
09-Aug-16	YK-33	FD	25-Jan-17	24-Mar-17	ASU16111-S6								No	Yes	PHL to 13
09-Aug-16	YK-33	P	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
09-Aug-16	YK-34	LD	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
09-Aug-16	YK-34	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
09-Aug-16	YK-35	P	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
17-Aug-16	YK-36	P	25-Jan-17	24-Mar-17	ASU16111-S6				Yes	Yes	Yes		Yes	Yes	No
17-Aug-16	YK-37	P	25-Jan-17	24-Mar-17	ASU16111-S6	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
17-Aug-16	YK-37	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
17-Aug-16	YK-37	LD	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
17-Aug-16	YK-38	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
18-Aug-16	YK-39	P	10-Jan-17	10-Feb-17	ASU16084-S2	21-Apr-17	25-May-17	ASU16224	Yes	Yes	Yes		Yes	Yes	No
19-Aug-16	YK-40	FD	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
19-Aug-16	YK-40	P	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
19-Aug-16	YK-41	P	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
19-Aug-16	YK-42	LD	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
19-Aug-16	YK-42	P	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
19-Aug-16	YK-42	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
19-Aug-16	YK-43	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
19-Aug-16	YK-44	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
14-Aug-17	YK-45	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-45	SS	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
14-Aug-17	YK-46	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-47	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-48	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-49	LD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-49	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-50	FD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-50	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-51	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-52	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
14-Aug-17	YK-53	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-54	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-55	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-56	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-57	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-58	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-59	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-60	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-61	FD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-61	LD	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
15-Aug-17	YK-61	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-61	SS	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
15-Aug-17	YK-62	LD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-62	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-63	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-64	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-65	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-66	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-67	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
15-Aug-17	YK-68	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
15-Aug-17	YK-69	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
17-Aug-17	YK-70	FD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
17-Aug-17	YK-70	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
17-Aug-17	YK-71	LD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
17-Aug-17	YK-71	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No

Date	Sample ID	QAQC	Analytical Services Unit			Total Organic Carbon			SEM-AM			Xanes Analysis	Core	PHL Sample	Down core sample (cm)
			Submitted	Results Received	Lab Report #	Submitted	Results Received	Lab Report #	Pucks made	Polished	SEM Completed				
17-Aug-17	YK-72	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
17-Aug-17	YK-73	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
17-Aug-17	YK-73	SS	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
18-Aug-17	YK-74	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
18-Aug-17	YK-74	SS	2-Oct-17	11-Oct-17	ASU16409-S2								Yes	Yes	No
18-Aug-17	YK-75	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
18-Aug-17	YK-76	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
18-Aug-17	YK-77	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
18-Aug-17	YK-78	P	2-Oct-17	11-Oct-17	ASU16409-S1				Yes	Yes	Yes		Yes	Yes	No
18-Aug-17	YK-79	FD	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
18-Aug-17	YK-79	P	2-Oct-17	11-Oct-17	ASU16409-S1								Yes	Yes	No
18-Aug-16	YR-01	P	25-Jan-17	24-Mar-17	ASU16111-S7	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
18-Aug-16	YR-02	P	25-Jan-17	24-Mar-17	ASU16111-S7	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
18-Aug-16	YR-03	FD	10-Jan-17	10-Feb-17	ASU16084-S1								Yes	Yes	No
18-Aug-16	YR-03	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
18-Aug-16	YR-04	P	25-Jan-17	24-Mar-17	ASU16111-S7	21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
18-Aug-16	YR-04	SS				21-Apr-17	25-May-17	ASU16224					Yes	Yes	No
22-Aug-16	YR-05	LD	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
22-Aug-16	YR-05	P	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
22-Aug-16	YR-06	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No
22-Aug-16	YR-06	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
29-Jul-16	YR-07	LD	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
29-Jul-16	YR-07	LD	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
29-Jul-16	YR-07	P	25-Jan-17	24-Mar-17	ASU16111-S7								Yes	Yes	No
29-Jul-16	YR-07	SS	25-Jan-17	24-Mar-17	ASU16111-S6								Yes	Yes	No
29-Jul-16	YR-08	P	10-Jan-17	10-Feb-17	ASU16084-S2								Yes	Yes	No

Notes: Cores are located in BioScience freezer; PHL, SEM-MLA, and XANES samples are located in BioScience 316; down core sample indicates if no core is present, the depth of soil material is indicated, these samples are included in the same location as PHL samples.

Abbreviations: FD = field duplicate; LD = lab duplicate; P = parent sample; SS = split sample; SEM-AM = scanning electron microscope - automated mineralogy.

Appendix C

QAQC Tables

Quality assurance and quality control (QAQC) methods were employed to ensure the accuracy, reproducibility of analytical results, and sample homogeneity. Four types of QAQC samples were used to complete this process: field duplicates, lab duplicates, split samples, and certified blanks. The original sample, defined as the parent sample and the QAQC sample was evaluated by calculating the relative percent difference (RPD) by the following calculation:

$$\mathrm{RPD} = \frac{Absolute\ value\ (Parent - QAQC)}{Average\ (Parent, QAQC)} \times 100$$

Field duplicates were collected in the field at the same location as the parent sample, often within one metre. Laboratory duplicates were chosen at random from the samples submitted by ASU prior to analysis. Split samples were prepared by dividing a single sample evenly into multiple samples and submitting these with unique sample names to the laboratory. The accuracy of the analytical results was tested by analyzing certified standards: SS-1, SS-2, MESS-3 and MESS-4. SS standards are from SCP Science, Quebec; MESS standards are based on the National Research Council Canada (2016) certified values for *Marine Sediment Reference Material for Trace Metals and other Constituents*. ASU's expected result of 18 mg/kg of arsenic for MESS-3 and MESS-4 is based on an average of results obtained for partial digestion.

QAQC Type	Sample ID	Parent Sample	QAQC Result	RPD (%)
Field Duplicate	CM-10	34	53	44
Field Duplicate	CM-17	390	450	14
Field Duplicate	Grace-06	83	47	55
Field Duplicate	G-SIT-10	560	130	125
Field Duplicate	G-SIT-20	390	160	84
Field Duplicate	G-SIT-31	170	130	27
Field Duplicate	G-SIT-46	37	310	157
Field Duplicate	G-SIT-52	32	66	69
Field Duplicate	G-WGM-03	1900	2200	15
Field Duplicate	G-WGM-12	990	1700	53
Field Duplicate	G-WGM-21	4700	1900	85
Field Duplicate	G-WGM-31	540	690	24
Field Duplicate	G-WGM-41	1200	1100	9
Field Duplicate	G-WGM-51	710	1700	82
Field Duplicate	IL-10	10	25	86
Field Duplicate	TX-10	170	170	0
Field Duplicate	TX-20	650	1200	59
Field Duplicate	TX-30	24	34	34
Field Duplicate	YK-02	35	65	60
Field Duplicate	YK-12	220	660	100

QAQC Type	Sample ID	Parent Sample	QAQC Result	RPD (%)
Field Duplicate	YK-20	760	800	5
Field Duplicate	YK-30	49	19	88
Field Duplicate	YK-33	58	55	5
Field Duplicate	YK-40	47	43	9
Field Duplicate	YK-50	43	66	42
Field Duplicate	YK-61	1.6	1	46
Field Duplicate	YK-70	16	16	0
Field Duplicate	YK-79	12	5.9	68
Field Duplicate	YR-03	16	82	135
Lab Duplicate	CM-02	210	230	9
Lab Duplicate	CM-16	180	180	0
Lab Duplicate	CM-20	73	83	13
Lab Duplicate	Grace-01	81	85	5
Lab Duplicate	G-SIT-04	260	300	14
Lab Duplicate	G-SIT-08	330	350	6
Lab Duplicate	G-SIT-22	380	380	0
Lab Duplicate	G-SIT-35	230	210	9
Lab Duplicate	G-SIT-45	510	530	4
Lab Duplicate	G-WGM-04	1000	1000	0
Lab Duplicate	G-WGM-19	580	630	8
Lab Duplicate	G-WGM-22	350	320	9
Lab Duplicate	G-WGM-34	57	58	2
Lab Duplicate	G-WGM-44	62	31	2
Lab Duplicate	G-WGM-49	160	100	46
Lab Duplicate	IL-04	140	140	0
Lab Duplicate	LL-05	110	99	11
Lab Duplicate	QC-03	140	140	0
Lab Duplicate	QC-09	100	100	0
Lab Duplicate	QC-22	43	43	0
Lab Duplicate	QC-25	340	360	6
Lab Duplicate	QC-30	1.7	2	16
Lab Duplicate	TX-05	34	34	0
Lab Duplicate	TX-16	93	100	7
Lab Duplicate	TX-21	72	73	1
Lab Duplicate	TX-33	140	94	39
Lab Duplicate	YK-08	260	240	8
Lab Duplicate	YK-16	320	490	42
Lab Duplicate	YK-20	760	600	24
Lab Duplicate	YK-34	100	100	0
Lab Duplicate	YK-37	55	11	133
Lab Duplicate	YK-42	30	30	0
Lab Duplicate	YK-49	6.6	6.5	2
Lab Duplicate	YK-62	5.6	4.3	26
Lab Duplicate	YK-71	90	65	32
Lab Duplicate	YR-05	73	97	28
Lab Duplicate	YR-07	47	45	4
Split Sample	CM-03	90	51	55
Split Sample	CM-13	170	57	100
Split Sample	CM-25	570	560	2
Split Sample	Grace-03	85	90	6
Split Sample	G-SIT-08	340	390	14
Split Sample	G-SIT-13	220	220	0
Split Sample	G-SIT-18	110	110	0
Split Sample	G-SIT-36	1100	1200	9
Split Sample	G-SIT-47	1100	1300	17
Split Sample	G-WGM-08	990	970	2
Split Sample	G-WGM-12	990	740	29
Split Sample	G-WGM-20	2000	1900	5
Split Sample	G-WGM-31	540	690	24
Split Sample	G-WGM-40	140	250	56
Split Sample	IL-11	13	12	8
Split Sample	LL-05	180	190	5
Split Sample	TX-08	21	48	78
Split Sample	TX-12	83	71	16
Split Sample	TX-23	86	87	1

QAQC Type	Sample ID	Parent Sample	QAQC Result	RPD (%)
Split Sample	TX-30	24	40	50
Split Sample	YK-03	57	57	0
Split Sample	YK-23	1600	1600	0
Split Sample	YK-26	22	15	38
Split Sample	YK-37	55	12	128
Split Sample	YK-42	30	32	6
Split Sample	YK-45	130	160	21
Split Sample	YK-61	1.6	1.7	6
Split Sample	YK-73	130	180	32
Split Sample	YK-74	230	290	23
Split Sample	YR-06	120	130	8
Split Sample	YR-07	47	47	0

QAQC Type	Sample ID	Expected Result	Result Obtained	RPD (%)
Blank	ASU15919-S1	<1.0	<1.0	0
Blank	ASU15919-S1	<1.0	<1.0	0
Blank	ASU15919-S2	<1.0	<1.0	0
Blank	ASU15919-S2	<1.0	<1.0	0
Blank	ASU16084-2	<1.0	<1.0	0
Blank	ASU16084-S1	<1.0	<1.0	0
Blank	ASU16084-S1	<1.0	<1.0	0
Blank	ASU16111-S1	<1.0	<1.0	0
Blank	ASU16111-S2	<1.0	<1.0	0
Blank	ASU16111-S2	<1.0	<1.0	0
Blank	ASU16111-S3	<1.0	<1.0	0
Blank	ASU16111-S4	<1.0	<1.0	0
Blank	ASU16111-S5	<1.0	<1.0	0
Blank	ASU16111-S5	<1.0	<1.0	0
Blank	ASU16111-S6	<1.0	<1.0	0
Blank	ASU16111-S6	<1.0	<1.0	0
Blank	ASU16111-S7	<1.0	<1.0	0
Blank	ASU16409-S1	<1.0	<1.0	0
Blank	ASU16409-S1	<1.0	<1.0	0
Blank	ASU16409-S2	<1.0	<1.0	0
MESS Standard	MESS-3	18	16	12
MESS Standard	MESS-3	18	20	11
MESS Standard	MESS-3	18	17	6
MESS Standard	MESS-3	18	17	6
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	19	5
MESS Standard	MESS-4	18	19	5
MESS Standard	MESS-4	18	19	5
MESS Standard	MESS-4	18	19	5
MESS Standard	MESS-4	18	20	11
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	17	6
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	17	6
MESS Standard	MESS-4	18	16	12
MESS Standard	MESS-4	18	18	0
MESS Standard	MESS-4	18	18	0
Reference Standard	SS-1	23	26	12
Reference Standard	SS-2	3.3	3	10

Appendix D

Soil Sample Preparation

The following describes the steps taken to process each soil core. These steps were followed to process the cores in a standardized way, ensuring each sample received the same treatment. Processing was completed in the BioScience building at Queen's University.

Step 1 Brown paper was placed on a table to minimize cleanup and prevent contamination; the sample name was written on the paper. A light was used to aide in pictures and soil descriptions.

Step 2 The core was split using a ceramic knife; the blade was cleaned after each insertion to prevent contamination down the core.

Step 3 A picture was taken with a tape measure between each half core (Figure D-1).

Step 4 The depth of each soil horizon was measured. Horizons were distinguished based on organic content, texture, and soil colour.

Step 5 The colour of each soil horizon was recorded based on the Munsell soil colour chart, including hue, chroma, and value (Munsell Color, 1990).

Step 6 Each horizon was given a classification based on the Canadian System of Soil Classification (Soil Classification Working Group, 1998).

Step 6 A description of each soil horizon was recorded, including soil texture (silt, sand, clay, or a combination), colour change, organic content, and relative level of moisture.

Step 7 Next, the Public Health Layer (PHL), which is defined as the top 5 cm of soil by Health Canada (Rencz et al., 2011) was extracted. The PHL was determined in a few steps. First, compaction was calculated. Compaction occurred when the samples were collected, as described in Section 3.1.2. Compaction was calculated by the following Equation 1; the PHL was then calculated by Equation 2.

$$Compaction = \frac{Sample\ depth}{((Sample\ depth + Depth\ of\ core) - Soil\ Surface} \qquad \text{Equation 1}$$

$$PHL = 5\ x\ Compaction \qquad \text{Equation 2}$$

Sample depth is the length of soil sample; depth of core is the length from the top of the core to the top of the soil sample inside the core; and soil surface is the length from the top of the core to the ground surface. All lengths are in centimetres. See Figure D-2 for a depiction of each of these definitions.

Step 8 The PHL of the sample was then homogenized the PHL in a plastic Ziploc freezer bag. A minimum of 1 gram was measured and submitted to ASU for bulk geochemistry.

Step 9 The remaining PHL sample was left in the freezer bag for future sample analysis; the freezer bags were placed in a walk-in freezer. Each half core was wrapped in plastic wrap, labeled, and placed in freezer.

Figure D-1: Example of a soil core after it has been split.

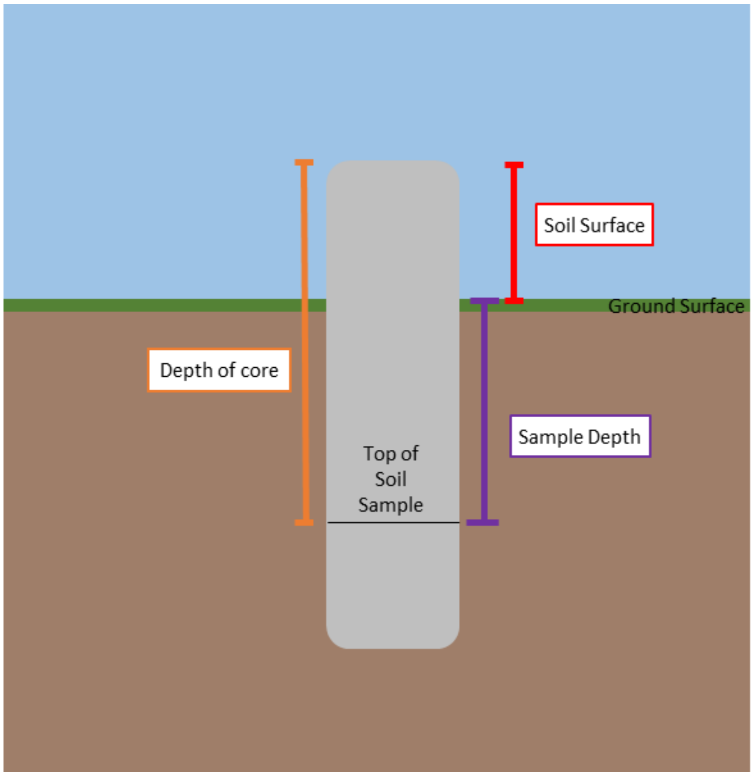

Figure D-2: Depiction of the definitions used for calculation compaction.

References

Munsell Color. 1990. Munsell Soil Color Charts. MACBETH Division of Kollmorgen Instruments Corportation, Baltimore, Maryland. 1990 Edition Revised.

Rencz, A., Garrett, R., Kettles, I., Grunsky, E., and McNeil, R., 2011. Using soil geochemical data to estimate the range of background element concentrations for ecological and human-health risk assessments; Geological Survey of Canada, Current Research 2011 – 9, 22 pages. doi:10.4095/288746.

Soil Classification Working Group. 1998. The Canadian System of Soil Classification. Agriculture and Agri-Food Canada. Publ. 1646 (Revised). 187 pp.

Appendix E

Soil Horizon Descriptions

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
CM-01	25-Jan-17	2.91	5.00	3.10	Matthew's Metals	10YR	2	2	3	L	leaf litter and moss, some clay	10YR	2	2	6	Ae	pebbles, roots, silty. very loose, PHL may be misrepresented												
CM-02	25-Jan-17	5.00	7.40	4.42	Matthew's Metals	10YR	1	2	7	F	moss, matted roots, clay, decomposed organics	10YR	3	4	11.5	Ah	moss (for some reason), silty, some pebbles and roots												
CM-03	25-Jan-17	4.38	5.00	4.29	Matthew's Metals	10YR	1	2	1.5	F	moss on top with some organic rich clay,	2.5Y	6	5	9.5	Ae	clayey silt, a few pebbles, roots at bottom of layer	2.5Y	3	6	17.5	Bf	silty, with some pebbles, a couple roots, compact towards bottom of the layers						
CM-04	25-Jan-17	3.60	5.00	6.02	Matthew's Metals	10YR	1	2	3.5	Om	leaf litter on top, matted roots (fibric looking),	10YR	3	3	4.5	Ah	clay, some roots, pebble clasts present	7.5YR	6	4	11	Bf	sandy with a bit of roots and pebbles						
CM-05	25-Jan-17	3.57	5.00	2.24	Matthew's Metals	10YR	2	2	2.5	L	leaf litter, pine needles, clay	10YR	1	2	3	Ah	organic rich clay	10YR 10YR	2 1	3 2	5 14	Bh	organic rich clay, some silt, lots of roots, some bark, other woody structures						
CM-06	25-Jan-17	4.51	7.40	3.85	Matthew's Metals	10YR	1	2	2.5	H	decomposed organics with some clay	10YR	3	3	2.5	Ah	matted roots, evidence of both reduction and oxidation (colour change)	10YR	4	3	4	Bf	silty sand, some roots (1-2 mm dia.) some pebbles						
CM-07	25-Jan-17	3.52	5.00	4.20	Matthew's Metals	10YR	1	2	3	F	moss, roots, and decomposing organics, clay	10YR	3	4	4	Ah	thick matted roots, silt, some sand	10YR	3	4	8	Bf	cobbles, silt, some roots, more sand than A horizon	10YR	2	5	9	C	hard clay, orange blotches, some sand
CM-08	25-Jan-17	3.38	5.00	2.49	Matthew's Metals	10YR	1	2	2.5	F	leaf litter, decomposed organics and organic rich clay	7.5YR	4	3	7	Ah	organic rich clay, compact, roots												
CM-09	25-Jan-17	3.21	5.00	3.08	Matthew's Metals	10YR	2	2	4.5	Oh	decomposed fibric material, roots, some leaf litter and moss, and clay	10YR	1	2	1.5	Ah	organic rich clay	10YR	3	4	10	Bf	hard clay, some roots						
CM-10	25-Jan-17	4.05	5.00	3.08	Matthew's Metals	10YR	1	2	4	H	matted roots and clay, a little moss on top	10YR	2	2	2	Ah	organic rich, clay	10YR	1	2	9	Bh	organic rich clay, lots of roots						
CM-10-Dup	25-Jan-17	5.00	5.00	4.11	Matthew's Metals	10YR	1	2	6	H	organic rich clay, matted roots, at bottom of layer roots are 1-2 mm in diameter	10YR	2	2	13.5	Ah	organic rich, clay, matted roots, compact, about 4 different shades spanning brown to black, horizontal roots												
CM-11	25-Jan-17	3.65	5.00	2.28	Matthew's Metals	10YR	2	2	2.5	F	decomposing leaf litter and roots	10YR	1	2	16.5	Ah	organic-rich clay, matted roots, roots up to ~4mm thick												
CM-12	25-Jan-17	4.57	5.00	4.30	Matthew's Metals	10YR	1	2	4	H	decomposed organics, organic rich clay, a little moss, some roots	7.5YR	2	3	9.5	Ah	organic rich clay, matted roots, roots up to ~3mm thick, some pebbles												
CM-13	25-Jan-17	5.00	5.00	4.30	Matthew's Metals	10YR	3	3	3	F	some moss on top, some roots (1 mm dia.) matted roots and silt	10YR	2	2	16	Ah	matted roots, silt, bottom 3 cm may be B horizon, all organic rich, absence of pebbles and sand												
CM-14	25-Jan-17	5.00	5.00	5.72	Matthew's Metals							10YR	3	3	9	Ah	thick matted roots, silty, couple pebbles												

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
CM-15	25-Jan-17	4.10	5.00	3.86	Matthew's Metals	10YR	1	2	2.5	F	decomposed leaf litter, 1 root ~5mm	10YR	4	4	7.5	Ae	sandy-silt, some pebbles, roots, and other organics												
CM-16	25-Jan-17	3.82	7.40	6.50	Matthew's Metals	10YR	3	3	4	F	moss and leaf litter with matted roots and silt, pebble clast present	10YR 10YR	1 8	2 5	6	Ah	high organic content (roots), 8 mm diameter root, silty sand, split down the middle (colour change is vertical), due to angle of core in the ground?												
CM-17	25-Jan-17	4.65	5.00	1.97	Matthew's Metals	10YR	3	3	3.5	H	silty, matted roots	5YR	2	2.5	10	Ah	organic rich clay, lots or matted roots												
CM-17-Dup	25-Jan-17	4.30	10.00	3.58	Matthew's Metals							10YR	2	2	13	Ah	clayey-silt, matted roots												
CM-18	25-Jan-17	4.02	5.00	4.20	Matthew's Metals	10YR	1	2	4.5	F	organic rich clay, decomposed organics, leaf litter, moss	10YR	2	6	2	Ae	silty, some organics, looks to be leached	10YR	3	4	12	Bf	silty-sand, some root material	10YR	2	7	11.5	C	hard silt, some sand
CM-19	25-Jan-17	4.38	5.00	2.69	Matthew's Metals	10YR	2	2	3	F	moss on top, clay, decomposing organics	10YR	1	2	3	Ah	organic-rich clay, matted roots.	10YR	4	3	8.5	Bh	organic rich clay, matted roots, some pebbles, ~2mm roots						
CM-20	25-Jan-17	4.29	5.00	2.98	Matthew's Metals	10YR	1	2	4	F	lots of leaf litter, some clay and decomposed organics	10YR	2	2	7.5	Ah	matted roots and clay												
CM-21	25-Jan-17	4.71	5.00	2.28	Matthew's Metals							10YR	2	2	15	Ah	organic rich clay, lots of roots, no pebbles, one sand clast												
CM-22	25-Jan-17	5.00	5.00	3.65	Matthew's Metals							10YR	1	2	11	Ah	organic-rich clay, a couple pebbles												
CM-23	25-Jan-17	4.31	5.00	3.35	Matthew's Metals	10YR	1	2	3.5	F	moss on top, decomposed organics, clay	7.5YR	3	3	3	Ah	organic rich clay, thin matted roots and thick roots	7.5YR	3	3	10.5	Bf	sandy, some roots 1-2mm thick						
CM-24	25-Jan-17	4.95	5.00	8.93	Matthew's Metals	10YR	1	2	3	F	organic rich clay, a little moss	10YR	2	2	8.5	Ah	organic rich clay, some roots												
CM-25	25-Jan-17	5.00	5.00	4.91	Matthew's Metals	10YR	1	2	2	H	humic material, a couple pieces of moss, clay and matted roots	10YR	2	2	11.5	Ah	organic rich silty-clay, matted roots and roots ~2mm thick												
CM-26	25-Jan-17	4.30	10.00	3.92	Matthew's Metals	10YR	2	2	2.5	F	moss, leaf litter, some clay	10YR	3	4	9	Ah	silty, roots - both thick and thin	10YR	2	6	6	Bf	silty, little organics						
GRACE-01	2-Oct-17	3.91	10.00	2.29	Table Saw	10YR	1	2	3	F	leaf liter, little soil, decomposing organics,	10 YR	2	4	15	Aeg	sandy silt, some roots, granitic pebbles, metasediment pebble, near bottom appears to be oxidation as soil is brown/orange color (10YR-6-4).												
GRACE-02	2-Oct-17	4.47	5.00	3.62	Table Saw	10YR	1	2	2	F	little leaf litter on top, decomposing organics, little clay	10YR	2	5	12	Aeg	very silty, one large root (1.5cm in diameter), thin wispy roots, some sand, no clay	10YR	2	5	10	Bg	very hard/compact, silty, lens of darker colored silt/clay						
GRACE-03	2-Oct-17	4.24	10.00	3.25	Table Saw	10YR	2	2	2	F	leaf liter, some matted roots with clay, one acron,	2.5Y	2	5	3	Aeg	appears to be a transition zone between A and B horizons, very silty, a couple roots (1-2mm diameter), thin matted roots	2.5Y	2	7	18	Bg	very silty, some twigs and organics , some thin roots near bottom with some dark brown soil, material appears to have been heavily leached						

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
GRACE-04	2-Oct-17	4.05	10.00	3.63	Table Saw	10YR	2	2	2	F	leaf liter, decomposing organics and some clay	10YR	2	6	10.5	Ahe	silty, thin wispy roots, some roots 2-3 mm diameter, some lenses of dark brown silt,	10YR	4	5	6	Bm	silty, with lenses of dark brown and black and orange, silt, bark from a twig, hard and compact						
GRACE-05	2-Oct-17	4.81	10.00	3.20	Table Saw	10TY	1	2	2	F	leaf liter, some decomposing organics with clay,	10YR	3	4	5.5	Ahe	organic rich silty-clay, one pebble (3cm length), some roots and leaf liter, and possibly some eluviation at bottom												
GRACE-06	2-Oct-17	3.58	15.00	3.29	Table Saw	10YR	2	2	3	F	leaf liter, decomposing organics, bark, very little soil	10YR 10YR	6 2	5 4	5	Ahe	Top of horizon is very organic rich silt (orangey), below is leached organic rich silt that is more grey colored.	10YR	2	6	7	Bg	very silty, lenses of dark brown and black silt and light orange, one pebble, there are a few roots (thin), a little sand						
GRACE-06-Dup	2-Oct-17	3.05	10.00	1.65	Table Saw	10YR	3	3	4	F	leaf liter, some thin wispy roots, loose, little clay, and decomposing organics	10YR	2	4	3.5	Ahe	organic rich clay with thin matted roots, charred debris, between O and A is thin grey layer that becomes brown and progressively becomes darker brown down to the B.	10YR	2	5	5	Bg	appears that this layer has been leached (not sure if it is actually B, may be A). Material is very silty, thin wispy roots, and one root 3 mm diameter,						
G-SIT-01	26-Sep-16	1.98	5.00	2.27	Table Saw	10R	2	2	2.5	F	some leaf litter at surface, one root 8mm diameter, decomposed organic material	5YR	1	2	11	Ah	organic rich clay, alternating dark brown and brown layers throughout horizon												
G-SIT-02	19-Sep-16	4.14	12.40	2.47	Table Saw	5YR	2	3	4.5	Of	grass/root material, some silt attached to roots, some moss	5YR	6	4	3	Aeg	silt, range of colours (browns, gray), roots												
G-SIT-03	19-Sep-16	2.81	5.00	1.35	Table Saw	5YR	1	3	3	L	pine needles, loose, leaf litter with a bit of clay, many small twigs	5YR	2	4	6	Ah	many roots (wispy to 2-3 mm), clay, loose and light. main difference between this and O layer is lack of moss, pine needles and leaf litter.	5YR	2	6	3	Bh	siltier than other horizons, wispy roots, gravel clasts						
G-SIT-04	26-Sep-16	4.15	5.00	2.34	Table Saw	5YR	2	4	1.8	L	dominantly leaf litter, some twigs, a little bit of clay	10YR	4	4	7.9	Afj	silty with some sand, one large cobble clast, some organics (not a lot), some roots												
G-SIT-05	26-Sep-16	4.74	5.00	1.24	Table Saw	5YR	2	4	5.5	L	mostly all leaf litter, some twigs	5YR	2	3	2.5	Ah	organic rich soil, decomposed organics, silt	5YR	2	4	4.4	Bh	silty soil with some organics (thin and thicker roots), some gravel clasts						
G-SIT-06	26-Sep-16	5.00	5.00	1.30	Table Saw	5YR	1	4	7	F	twigs and leaf litter at surface, decomposed organics 4 to 7cm	10YR	1	6	3	Ag	silt, reduced iron, some organics (roots)	5YR	6	4	5.5	Bf	iron rich silt, some organics (roots)						
G-SIT-07	19-Sep-16	3.91	7.50	1.49	Table Saw	5YR	1	2	2.5	Om	some moss, decomposed organics, some clay	5YR	1	3	2.5	Ah	thin wispy roots, some thicker roots (~1mm), clayey material	5YR	2	3	6	Bh	mostly clayey material, slight change in colour, some roots and woody pieces.						

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
G-SIT-08	19-Sep-16	4.78	5.00	4.25	Table Saw							5YR	1	2	1	Ah	a little moss, some roots and pine needles, clayey	5YR	1	2	9.5	Bh	clayey, moist (affecting colour?), gravel clasts, thin wispy and 0.5 cm thick roots						
G-SIT-09	26-Sep-16	4.95	5.00	1.69	Table Saw	5YR	22	3	2.4	Om	some moss, decomposed organics, some clay	5YR	4	5	7.6	Ah	silty organic rich soil, decomposed organics at top of horizon												
G-SIT-10	19-Sep-16	4.11	5.00	1.70	Table Saw	5YR	2	4	2.2	F	loose partially decomposed organics, some leaf litter and moss	5YR	2	3	7.8	Ah	loose clay, some organic material	5YR	2	3	7	Bh	a few thick roots, clay; the main feature distinguishing A from B is B is very compact, hard.						
G-SIT-10-Dup	19-Sep-16	3.61	7.00	0.13	Table Saw	10YR	6	5	4.5	F	decomposed humic material, discernable leaf litter	5YR	2	3	4.9	Ah	organic rich clay	5YR	1	2	7.6	Bg	mainly compact organic rich clay; various other colours, as mottles and as thin layers						
G-SIT-11	19-Sep-16	4.06	5.00	1.53	Table Saw	5YR	1	3	2.5	H	little clayey soil mixed with thin root material, decomposing plant material	10R	4	3	5.5	Ah	clayey, lots of root material	10YR	2	3	9.5	Bfj	Clayey with lots of organic material with lots of roots, slight colour change in the B horizon						
G-SIT-12	19-Sep-16	4.12	5.00	1.41	Table Saw	10R	1	2	4.5	L	grass-like vegetation, roots, silty soil	5YR	1	2	3	Ah	clayey, thin roots	10YR	1	2	7	Bg	moist (may have caused it to appear darker), clayey, gravel clasts. much less organics than A horizon						
G-SIT-13	26-Sep-16	4.11	5.00	3.80	Table Saw	5YR	1	3	3	Of	thin moss layers, roots, clay material	5YR	1	2	5	Ah	clay, organic rich	5YR	1	2	9.8	Bh	clay, organic rich, the difference b/w A and B is B is more compact and hard						
G-SIT-14	19-Sep-16	3.23	5.00	1.31	Table Saw	5YR	1	2	1.5	H	organic clay, moss	10YR	2	5	2.5	Ah	silty, root material, decomposed organics	5YR	2	3	6.5	Bg	clayey, compact, some roots						
G-SIT-15	26-Sep-16	3.66	5.00	1.33	Table Saw	5YR	1	2	5	L	leaf litter all the way through	10YR	4	4	7.8	Ag	light brown to gray, some organics (roots), some gravel clasts, silty												
G-SIT-16	26-Sep-16	3.93	7.50	1.40	Table Saw	10R	4	3	4.5	H	decomposed organics with humic material	10YR	2	8	3.5	Ahe	reduction zone (light gray silt) with darker soil on either side	5YR	4	4	4	Bm	various shades of dark brown to light brown indicating periodic reduction, silt with some organics						
G-SIT-17	26-Sep-16	3.62	5.00	2.07	Table Saw	10R	3	2	5	F	lots of leaf litter, minor moss on top, decomposing organics below surface, some clay	5YR 5YR	4 4	4 5	5	Ah	two shades of brown, possibly due to reduction, silty, organic rich, root material with random dark pieces	5YR	2	5	5.5	Bm	pebble clast showing foliation (gneiss?) at boundary between A and B, silty, some organics (likely from the A layer), similar rocks to the clast but 1 cm in size, (till?)						
G-SIT-18	26-Sep-16	4.88	5.00	3.94	Table Saw							5YR	1	2	15.5	Afj	clay soil with roots, iron rich.												

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
G-SIT-19	26-Sep-16	5.00	5.00	1.86	Table Saw	5YR	2	3	3	F	leaf litter, decomposed organics	5YR	4	4	10	Afj	some decomposed organics, roots, gradually becoming grayer with depth, silt; one boulder size rock												
G-SIT-20	19-Sep-16	2.79	15.00	2.35	Table Saw	5YR	2	3	2.5	Om	moss, leaf litter, grass, some clay	5YR	2	3	2.5	Ah	clay, lots of thin roots holding material in place	5YR	1	2	8.5	Bg	clay, not a lot of organics, several different colours -> dark brown to orange/brown to light brown to dark brown						
G-SIT-20-Dup	26-Sep-16	3.78	5.00	2.81	Table Saw	5YR	1	3	6	H	humic material, decomposed organics, material held together possibly by thin roots	5YR	2	3	9.5	Afj	silt-clay, some sand and several gravel clasts; some organics (roots) near top of horizon, progressively less organics with depth	5YR	1	2	5.5	Bfj	clay with minimal organics, moist						
G-SIT-21	26-Sep-16	4.04	5.00	1.95	Table Saw	5YR	1	2	3	Om	moss, a little organic clay attached to roots	10R	2	2	7	Afj	moist, silty-clay with some sand, some organics, iron-rich												
G-SIT-22	26-Sep-16	4.32	5.00	2.48	Table Saw				3.5			5YR	1	2	7	Ah	organic rich clay, very uniform												
G-SIT-23	19-Sep-16	5.00	7.50	2.29	Table Saw	5YR	1	2	3.5	F	leaf litter, some decomposed, some bark	10R	2	2	4.5	Ah	loose organics with some silt. Mostly thin roots, some ~1mm roots	5YR	4	4	6	Bh	clay, some roots and decomposed organics						
G-SIT-24	26-Sep-16	4.75	5.00	6.22	Table Saw							10R	2	3	6.5	Agj	fine silt, some sand pieces, changing hues of browns (dark near the top, followed by a light brown [5YR/4/4]), some organics, tiny bit of moss at surface, no organics at the bottom												
G-SIT-25	26-Sep-16	4.09	5.00	2.22	Table Saw	5YR	1	2	2.8	Om	some moss at surface, roots and decomposing organics, some clay	5YR	2	3	6.2	Ah	very organic rich, some discernable organics (leaf litter), mostly decomposed, some roots	10YR	1	4	3.5	Bg	dampness may have darkened colour, silty, some pebble sized clasts, little organics						
G-SIT-26	19-Sep-16	4.11	5.00	2.36	Table Saw	5YR	1	2	1.5	Om	some moss and roots, partially decomposed	5YR	1	2	11	Aeg	organic rich clay, mottling, lots of roots, compact												
G-SIT-27	26-Sep-16	3.68	5.00	1.70	Table Saw	5YR	2	3	5	F	leaf litter on the surface, decomposed organics underneath	10R	6	3	6	Afj	organic rich soil, lots of roots ranging from 1 to 5 mm diameter, iron rich silt-clay												
G-SIT-28	26-Sep-16	4.77	5.00	2.49	Table Saw	5YR	1	2	2.5	F	some leaf litter, grassy material (very short), decomposing organics below the surface	5YR	2	3	9	Ah	few pebble and cobble, organic rich, lots of roots, some leaf litter has penetrated down, main soil is silty clay, slightly damp												

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G-SIT-29	26-Sep-16	4.70	5.00	1.54	Table Saw	5YR	2	3	3	F	decomposed organic material with discernible leaf litter	5YR	1	2	3	Ah	organic rich soil, decomposed organics, clay	5YR	2	4	4	Bf	organic rich silt						
G-SIT-30	26-Sep-16	1.26	5.00	1.35	Table Saw	5YR	1	2	5	F	some leaf litter, decomposed organics, clay	5YR	2	3	6	Ah	organic rich silt, roots,												
G-SIT-31	19-Sep-16	2.19	5.00	1.59	Table Saw	5YR	1	2	3	L	lots of roots, some pine needles, grasses, leaves, some clay, fine roots,	5YR	2	3	11	Ah	a large (1 cm dia.) root at 13 cm depth, thin roots, bark, clayey soil												
G-SIT-31-Dup	26-Sep-16	2.01	5.00	2.76	Table Saw	5YR	1	2	6	L	lots of leaves and leaf litter, twigs and roots, small amount of clay	5YR	4	4	7	Ah	predominantly organics, soil is silt												
G-SIT-32	26-Sep-16	5.00	5.00	2.50	Table Saw	5YR	1	2	3	F	leaf litter, some moss, decomposed organics	10R	1	3	7	Afj	silt, some organics (roots), iron rich, a few sand clasts	10R	1	2	3.3	Bh	organic rich clay						
G-SIT-33	26-Sep-16	3.15	5.00	3.61	Table Saw	5YR	1	2	1.5	F	some moss and decomposed organics	5YR	2	3	6.5	Afj	silt, moist, some organic material												
G-SIT-34	SAMPLE LOST																												
G-SIT-35	19-Sep-16	5.00	7.60	3.28	Table Saw	5YR	2	4	2.5	H	decomposed leaf litter and ground cover	5YR	1	2	11.5	Ah	silty-clay, organic rich, thin roots holding everything together												
G-SIT-36	19-Sep-16	5.00	5.00	1.78	Table Saw							5YR	1	2	4	Ah	organic rich clay, some leaf litter	10R	6	3	3	Bh	clayey material, hard, doesn't appear to be a lot of organics; however, clayey looks to be held together with thin roots						
G-SIT-37	26-Sep-16	4.72	5.00	3.11	Table Saw	5YR	1	2	3	Of	moss (caribou moss?) with some organic rich, clay soil	5YR	2	3	7	Afj	silt, some organics (roots), iron rich, a few sand clasts												
G-SIT-38	26-Sep-16	3.49	5.00	1.28	Table Saw	5YR	1	2	4	F	lots of leaf litter, formation of clay soil beneath	5YR	2	3	5	Ah	thin wispy roots, not very compact (light), clay	5YR	4	4	6	Bmj	silty to a decomposed root, thin layer of brown, thin layer of gray, and then alternating browns from dark to light, brown layers are all silt, thin grey layer has some sand [5YR/1/5]						
G-SIT-39	19-Sep-16	3.57	7.40	1.32	Table Saw	5YR	1	4	2	Om	moss with decomposing organics	5YR	1	2	6	Ah	organic rich, clay material. ~1mm roots, pieces of wood	5YR	1	4	7	Bm	dark brown at top of layer, changing to brown and orange brown towards the bottom, mostly clay-silt material with thin wispy roots	5YR	2	5	15 to 18	Cg	fine clay-silt, no organics
G-SIT-40	26-Sep-16	3.76	5.00	1.76	Table Saw	5YR	1	2	2.5	Om	some leaf litter and rooty material, decomposing organics	5YR	2	3	10	Ah	clayey silt, some organics (roots), some pebble clasts												
G-SIT-41	26-Sep-16	3.99	10.00	1.78	Table Saw	5YR	2	3	3.5	F	leaf litter and twigs at surface, decomposed organics below.	10YR	2	5	4.5	Ahe	darker organic layers on either side of a light gray silty layer with some organics.	5YR	1	2	6.5	Bh	organic rich, leaf litter and roots, clay						

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
G-SIT-42	19-Sep-16	2.84	7.40	1.32	Table Saw	5YR	1	2	1.5	L	pine needles, leaf litter, woody material, pine cone (young)	5YR	1	2	1.5	Ah	root material, clay, many organics, a large branch piece,	5YR	1	5	4.5	Bh	organic material, charred wood?, root material (wispy), brown-orange splotches of similar consistency (silty clay),	5YR	2	6	5	Cg	gravel clasts, some root material, much reduced organics content, some sand, mostly silt,
G-SIT-43	19-Sep-16	4.38	22.40	5.48	Table Saw	10R	2	8	1.5	Of	moss	5YR	1	2	5.5	Ah	organic rich, silt-clay, root material	5YR	2	3	11.5	Bm	organic root material holding clay-silt and thicker roots in place						
G-SIT-44	19-Sep-16	5.00	7.40	4.61	Table Saw	5YR	1	2	1.5	Of	moss with organic rich clay	5YR	2	3	8.5	Ah	organic rich, silt-clay, root material												
G-SIT-45	26-Sep-16	3.66	5.00	4.78	Table Saw	5YR	1	2	3	Om	some moss at surface, bark, twigs and many decomposing organic materials	5YR	2	3	7	Ah	organic rich clay, roots 1-2 mm in diameter, some sand clasts, not completely compact (gaps near the bottom)												
G-SIT-46	26-Sep-16	3.82	5.00	1.56	Table Saw	5YR	1	2	2.5	F	decomposing leaf litter, surface is discernable	5YR	2	4	3.5	Ah	organic rich, lots of root material (1 mm in diameter), some wood pieces, silty soil	5YR	1	5	2.3	Bh	same as horizon A, just grayer colour						
G-SIT-46-Dup	26-Sep-16	5.00	5.00	3.70	Table Saw	5YR	1	2	3	F	lots of leaf litter and roots near surface, decomposing organics below, clayey material	5YR	4	5	5	Ag	silty, some organics, minor mottling (5YR/6/4), steeply angled contact between the O and A layer												
G-SIT-47	26-Sep-16	5.00	2.50	3.42	Table Saw							5YR	2	3	15.5	Afj	moist, clayey soil, some organics - roots mostly, slight different shades of brown	5YR	2	4	5	Bg	moist, clay soil, much less organics than horizon A						
G-SIT-48	26-Sep-16	3.12	2.50	2.20	Table Saw	5YR	2	1	2.5	Of	moss with roots and clay	5YR	1	2	4.5	Ah	moist organic rich silt-clay, a few roots ~2mm diameter	5YR	2	3	4	Bh	moist organic rich silt-clay, a few roots ~2mm diameter						
G-SIT-49	26-Sep-16	5.00	5.00	7.68	Table Saw							5YR	2	3	9.5	Ah	wet, clay, organic rich, dark brown layer (5YR/1/2), near bottom there is a layer of lighter brown (5YR/4/5), one large root (8 mm dia.) at 6 cm depth, layering of organic content (high to low etc.)												
G-SIT-50	26-Sep-16	3.37	5.00	1.69	Table Saw	5YR	2	3	3	F	leaf litter on top, decomposing organics below the surface	5YR	2	3	1.5	Ah	clayey, organic rich, thin wispy roots, some leaf litter and decomposed organics	5YR	2	3	13	Bh	clay, thin roots (few), hard and compact, some thin layers of dark brown (5YR/1/2) ranging from 0.5-1 cm thick						

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
G-SIT-51	26-Sep-16	2.93	5.00	2.20	Table Saw	10R	1	2	3	Om	some fibrous material, wood moss, decomposing organics, clay	5YR	1	2	5.5	Ah	clayey organic rich, light brown layer (5YR,4,4)	5YR	1	2	4.8	Bh	clay, organic rich; the difference b/w A and B is B is more compact and hard						
G-SIT-52	26-Sep-16	3.06	7.40	1.50	Table Saw	5YR	2	4	7	F	mixture of decomposed organic matter, leaf litter, roots (~1 to 4mm)	5YR	2	5	7	Ag	light and loose silt, light gray, progressively less organics as the horizon gets deeper	10YR	4	5	2.5	Bf	browner than horizon A, silt and slightly more compact						
G-SIT-52-Dup	19-Sep-16	3.64	7.40	1.60	Table Saw	5YR	1	2	2.5	Om	moss rooty material, leaf litter, twigs, some silt	5YR	2	4	3.5	Ah	roots holding decomposed organics and clay together	5YR	2	3	2	Bg	thin layer, more silt and reduced than A horizon; some roots and organic material	10YR	2	7	12.5	Cc	compact silt, soft, no organics
G-SIT-53	19-Sep-16	3.00	7.50	1.24	Table Saw	5YR	1	3	2	Om	mostly decomposed organics, some green fibrous on top	5YR	2	4	3	Ah	decomposed organics, clayey soil, leaf litter ~7mm diameter root	5YR	6	4	5	Bm	mostly clay, some thin wispy roots	10YR	2	5	4	Cg	compact clay, no organics
G-SIT-54	19-Sep-16	3.81	5.00	1.46	Table Saw	10R	2	2	2	Of	pine needles, little green moss, bark	10R	1	2	1.5	Ah	organic rich, thin small roots and bigger roots, clayey	10R	4	3	5.5	Bf	silty, fine organics, rock fragments, crunchy when poked with a knife						
G-SIT-55	26-Sep-16	3.33	5.00	1.88	Table Saw	5YR	1	2	6	F	roots (thin wispy and ~1 - 3 mm) and decomposed organic matter	5YR	2	4	4	Afj	silty-clay, some thin roots, few gravel clasts, 5YR,1,2 at top of horizon, brown at bottom of horizon												
G-WGM-01	25-Jan-17	4.87	5.00	4.00	Table Saw	10YR	3	3	5	F	decomposing leaf litter, a light coloured woody structure - kind of like an egg carton texture	10YR	3	3	6	Ae	silty, a little sand, a few pebbles												
G-WGM-02	10-Jan-17	5.00	5.00	3.54	Table Saw	10YR	1	2	1.5	F	thin, shirt miss in top, decomposed organics, matted roots and clay	10YR	2	5	7	Ae	sandy-silty, no organics												
G-WGM-03	10-Jan-17	3.65	5.00	3.03	Table Saw							10YR	2	5	3.5	Ae	silty, some decomposed organics and pebbles	10YR	4	6	8.5	Bm	silty, some sand, pebbles, and thin roots						
G-WGM-03-Dup	25-Jan-17	3.52	5.00	1.74	Table Saw	10YR	3	3	3	L	leaf litter and twigs	10YR	3	7	6	Ae	silty, 5 cm gravel clast, fine roots, orange hue increase towards base												
G-WGM-04	10-Jan-17	4.05	5.00	2.29	Table Saw				3	L	all leaf litter, no soil	10YR	6	5	5.5	Ae	silty, 1 pebble, little organics												
G-WGM-05	10-Jan-17	4.57	5.00	2.11	Table Saw	10YR	1	2	3	F	decomposing leaf litter, some clay	10YR	3	4	5	Ae	silty-clay, some matted roots												
G-WGM-06	10-Jan-17	5.00	10.00	2.06	Table Saw	10YR	2	2	7	L	leaf litter, woody structures, some clay	10YR	1	2	2	Ah	organic rich clays	10YR	4	5	3	Bm	silt, little to no organics						
G-WGM-07	10-Jan-17	5.00	5.00	2.41	Table Saw	5YR	2	3	3.5	F	decomposing organics with moss on top, clay	5YR	1	2.5	1.5	Ah	Organic rich, clay material.	10YR	3	6	11.5	Bf	silty, some sand, little organics						
G-WGM-08	10-Jan-17	5.00	5.00	2.41	Table Saw	10YR	2	6	8.5	F	some silty-clay above and below organics, leaf litter decomposing,	10YR	2	6	7	Ae	mostly silt, some organics, roots	10YR	6	4	2	Bf	silty, some sand, little organics						
G-WGM-09	25-Jan-17	4.33	5.00	2.84	Table Saw	10YR	1	2	3	F	some moss, mostly decomposed organics, some clay	10YR	4	3	3.5	Ae	sandy-silt, some decomposed organics	10YR 10YR	2 6	4 5	7.5	Bg	silty, some sand and pebbles						

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	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
G-WGM-10	25-Jan-17	3.80	7.40	7.10	Table Saw	10YR	1	2	3	F	some moss on top and decomposed organics, silt and clay	10YR	2	6	7	Bf	sandy-silt, little to no organics												
G-WGM-11	10-Jan-17	4.67	5.00	3.04	Table Saw	10YR	1	2	5.5	F	decomposing leaf litter and moss	10YR	4	5	10	Ae	silty, some pebbles, little organics, colour is not consistent	10YR	6	5	15	Bf	silty, some pebbles						last 3.5cm might be c horizon
G-WGM-12	10-Jan-17	4.43	5.00	3.23	Table Saw	10YR	1	2	2	F	decomposing leaf litter some clay-silt	10YR	2	6	3	Aeg	silt, some organics	10YR	8	6	14	Bf	silty, some pebbles and organics, 1 root at bottom of horizon 5mm thick	2.5Y	4	6	11.5	C	silty, no organics, consistent colour and texture
G-WGM-12-Dup	25-Jan-17	4.51	10.00	3.24	Matthew's Metals	10YR	2	2	2.5	L	leaf litter	10YR	1	2	2.5	Ae	organics rich clay	10YR	4	6	7	Bm	top few cm of this layer transition (leaching, oxidation), then sand-silt with some roots	2.5Y	4	6	13.5	C	silty, a cobble, a few roots
G-WGM-13	10-Jan-17	3.82	5.00	3.32	Table Saw	10YR	1	2	4	F	decomposing leaf litter	10YR	1	4	9	Ae	Silty with some sand,. A couple granite (?) pebbles showing a little rust and visible mica												
G-WGM-14	25-Jan-17	3.92	5.00	3.18	Table Saw	10YR	2	2	4	F	leaf litter, some decomposition, little clay, white cob-web-like material (mildew?)	7.5YR	4	3	7.5	Ae	Silty clay, some sand and pebbles, reddish band indicates oxidation, various shades of brown (banding)												
G-WGM-15	25-Jan-17	3.22	15.00	4.37	Table Saw	10YR	1	2	4.5	L	leaf litter	5YR	1	2.5	6	Ae	clayey-silt, some roots and other organics, 1 large unknown organic	10YR	2	6	1	Bf	silty						
G-WGM-16	10-Jan-17	4.43	7.50	1.61	Table Saw	10YR	2	2	7.5	L	leaf litter, woody structures, some clay	10YR	1	2	1.5	Ah	organic rich silt-clay	10YR	2	4	13	Bf	gray at top, browning to bottom, sandy, little to no organics						
G-WGM-17	25-Jan-17	2.54	7.40	2.92	Table Saw	10YR	2	2	5	L	leaf litter, very little clay	10YR	1	2	0.5	Ah	organic rich clay	2.5YR	3	6	6	Bf	silty, little sand, no organics						
G-WGM-18	25-Jan-17	4.29	5.00	2.88	Table Saw	10YR	2	2	3.5	F	decomposing leaf litter	10YR	1	2	3	Ah	organic rich clay	10YR	3	3	13.5	Bf	silty-sand, pebbles, no organics, browning with depth						
G-WGM-19	25-Jan-17	4.62	5.00	3.52	Table Saw	10YR	2	2	4.5	Om	moss on top (1-5 cm), decomposing organics and matted roots, some clay	10YR	1	2	5	Ah	organic rich clay, roots, decomposing organics	10YR	2	5	12	Bf	compact, hard clay or silt, some pebbles, some thin roots						
G-WGM-20	25-Jan-17	4.00	5.00	2.80	Table Saw	10YR	1	2	2	F	decomposing leaf litter, clay,	10YR	1	2	12	Ah	organic rich clay, roots, decomposing organics, pebbles and cobbles	10YR	2	5	8	Bm	silty, periodic reduction						
G-WGM-21	25-Jan-17	3.98	5.00	3.00	Table Saw							10YR 7.5YR	2 6	2 4	3	Ae	orange-compact, clay. Dark brown- loose, clay, organic rich	10YR	3	3	9.5	Bf	silty-sand, pebbles, little organics	10YR	3	6	7	C	hard, compact, evidence of oxidation
G-WGM-21-Dup	25-Jan-17	4.00	5.00	3.12	Table Saw	10YR	2	2	4	F	organic-rich, leaf litter, decomposing, clayey	10YR 7.5YR	1 6	2 4	1.5	Ae	transition layer, black to orange to brown, some thin roots	10YR	2	3	11	Bf	clayey, some pebbles						
G-WGM-22	25-Jan-17	4.04	5.00	4.61	Table Saw	10YR	1	2	3.5	F	clay, matted roots	10YR	4	3	11.5	Ae	silty-sand, no organics	10YR	2	4	10.5	Bf	sandy-silt no organics						

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	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour: Hue	Colour: Chroma	Colour: Value	Depth (cm)	Class	Description	Colour: Hue	Colour: Chroma	Colour: Value	Depth (cm)	Class	Description	Colour: Hue	Colour: Chroma	Colour: Value	Depth (cm)	Class	Description	Colour: Hue	Colour: Chroma	Colour: Value	Depth (cm)	Class	Description
G-WGM-23	10-Jan-17	3.99	5.00	2.09	Table Saw	10YR	2	2	2	L	leaf litter	10YR	1	2	2	Ah	decomposed organics, clay	10YR	6	3	10.5	Bf	silty-clay, some pebbles, some organics						
G-WGM-24	10-Jan-17	4.71	5.00	3.07	Table Saw	10YR	2	2	2	F	some leaf litter, decomposed organics, clay	5YR	3	4	4	Ae	silty clay, some root material	10YR	4	6	16	Bm	very silty, some organics						
G-WGM-25	25-Jan-17	5.00	5.00	6.09	Table Saw	10YR	1	2	0.5	F	moss and clay	10YR	6	3	8	Ae	silty-sand, some thin roots												
G-WGM-26	25-Jan-17	3.63	5.00	3.88	Table Saw	10YR	2	2	1.5	L	leaf litter	7.5YR	4	3	12.5	Ae	clayey-silt, a little sand, pebbles, and roots												
G-WGM-27	25-Jan-17	4.62	5.00	3.80	Table Saw	10YR	2	2	3	F	decomposed leaf litter, some clays	10YR	4	5	5	bf	silty, no organics or sand (B-horizon?)												
G-WGM-28	25-Jan-17	5.00	5.00	5.40	Table Saw													10YR	4	6	16.5	Bm	sandy silt, some roots (1-2 mm diameter), some pebbles, compact, thin skim of organics on top with leaf litter, lighter towards the bottom (various shades of beige)						
G-WGM-29	25-Jan-17	4.31	5.00	4.12	Table Saw	10YR	2	2	3	F	leaf litter on top, some moss and mostly decomposed organics, clay soil	10YR	6	6	1.5	Ae	Silt, with a small amount of matted roots	10YR	8	5	9	Bf	Silty with some pebbles, little organics						
G-WGM-30	10-Jan-17	4.08	5.00	3.54	Table Saw	10YR	1	2	3	L	leaf litter, some clay	10YR	1	2	2	Ah	Silt-clay, organic rich	10YR	4	3	12	Bf	sandy-silt, some roots						
G-WGM-31	25-Jan-17	4.74	5.00	4.12	Table Saw	10YR	2	2	2.5	L	leaf litter, little clay	10YR	6	5	7.5	Ae	silty, some thin roots, some pebbles, minor mottling												
G-WGM-31-Dup	10-Jan-17	5.00	5.00	3.89	Table Saw	10YR	1	2	3	L	leaf litter, roots, twigs, some clay	10YR	3	4	7	Ah	0YR												
G-WGM-32	25-Jan-17	4.77	5.00	5.06	Table Saw							10YR	2	2	5.5	Ah	silty-clay with some sand, organic rich	10YR	6	4	7	Bf	clay with some sand, little to no organics						
G-WGM-33	25-Jan-17	5.00	5.00	2.26	Table Saw	10YR	2	2	4	F	decomposing leaf litter, silty	10YR	1	2	7	Ah	organic rich, matted roots, silty-clay	10YR	2	2	1.5	Bg	same as Horizon A, except silica sand (possibly salts)						
G-WGM-34	10-Jan-17	4.48	2.50	4.68	Table Saw							7.5YR	4	3	18	Ah	Wet, silty, some sand and clay, some organics, blotches of black (organics?), core is consistent in texture												
G-WGM-35	25-Jan-17	4.33	5.00	5.72	Table Saw	10YR	1	2	2.5	H	organic rich clay, decomposed organics	10YR	2	2	6	Ae	silty clay with sand and pebbles, thin roots												
G-WGM-36	10-Jan-17	5.00	5.00	2.40	Table Saw							10YR	2	3	3	Ah	Matted roots, silty	7.5YR	2	6	6	Bg	similar structure as the A horizon, but colour is much lighter						
G-WGM-37	10-Jan-17	5.00	2.50	3.19	Table Saw	10YR	1	2	1.8	H	decomposed organics, some clay-silt	10YR	4	6	8.2	Ae	sand, little organics												
G-WGM-38	25-Jan-17	4.38	5.00	3.82	Table Saw	10YR	2	2	3	L	leaf litter, twigs bark, little clay	10YR	1	2	1	Ah	organic rich clay	10YR	4	3	15	Bf	sandy silty clay, some twigs, some other organics, turning more brown/red towards bottom						

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
G-WGM-39	10-Jan-17	4.46	5.00	2.11	Table Saw	10YR	1	2	4	F	decomposing leaf litter some clay-silt	5YR	6	4	9	Ae	Clayey-silt, some organics, some roots and other organics material	10YR	4	5	6	Bm	mostly silt, little organics						
G-WGM-40	10-Jan-17	4.86	2.50	2.85	Table Saw	10YR	1	2	1.5	F	decomposing leaf litter, silt	10YR	3	6	13	Aeg	silty, organic material (roots), compact near the bottom, some clay												
G-WGM-41	25-Jan-17	4.74	5.00	5.08	Table Saw	10YR	2	2	1.5	F	decomposing moss	7.5YR	3	3	9	Ae	clayey-sand, no or little organics												
G-WGM-41-Dup	10-Jan-17	4.37	2.50	2.81	Table Saw	10YR	1	2	3	F	decomposing organics, silty-clay	7.5YR	3	3	6.5	Ae	silty-clay, some sand and pebbles, little organics												
G-WGM-42	25-Jan-17	4.38	5.00	5.36	Table Saw	10YR	2	2	2	F	decomposing organics, silty-clay						does not appear to be an A horizon	2.5Y	3	5	25	Bf	very silty, compact, little to no organics, some sand and possibly pebbles						
G-WGM-43	10-Jan-17	5.00	2.50	3.13	Table Saw	2.5YR	2	2.5	1.5	F	some moss on top and decomposed organics	10YR	1	2	12	Ah	silty-sand, moist, organics												
G-WGM-44	10-Jan-17	5.00	5.00	5.13	Table Saw	5YR	1	2.5	2.5	F	decomposing leaf litter, a little moss on top, some clay	5YR	2	3	1.5	Am	Clayey-silt, some sand. Red blotches	10YR	4	3	16	Bm	Silty with some sand, little organics						
G-WGM-45	10-Jan-17	5.00	2.50	3.23	Table Saw	10YR	1	2	3	Oh	silty-sand, lack of organics	10YR	3	3	14	Am	Silty sand, little organics, changing colours down core												
G-WGM-46	10-Jan-17	2.75	5.00	1.70	Table Saw	5YR	2	1	2.5	L	leaf litter, twigs, some clay, roots	10YR	6	5	4.5	Ah	Silty, a little sand, roots	10YR	4	5	4	Bf	A few pebbles, clay, roots						
G-WGM-47	10-Jan-17	3.58	5.00	2.23	Table Saw	10YR	1	2	1.5	F	decomposing leaf litter, some clay	7.5YR	4	3	11.5	Ah	sandy-clayey-silt, some root organic material												
G-WGM-48	10-Jan-17	4.75	5.00	4.19	Table Saw	10YR	1	2	3.5	F	decomposing leaf litter, matted roots, some clay	10YR	4	6	17	Ae	silty with some sand and pebbles, some thin roots												
G-WGM-49	25-Jan-17	4.95	5.00	2.50	Table Saw	10YR	2	2	4.5	F	leaf litter on top with mostly matted roots with silty clay	7.5YR	2	3	6	Ah	clay and matted roots, few sand pieces, leaf litter at bottom?												
G-WGM-50	10-Jan-17	3.60	5.00	2.11	Table Saw	10YR	1	2	6.5	L	leaf litter, moss, some rooty structures, silty	5YR	1	2.5	1.1	Ah	Silty, some organics	10YR	2	4	12.9	Btj	Silty clay, with sand particles and 1 cobble	2.5Y	3	5	3	C	Silty with some sand, compact
G-WGM-51	10-Jan-17	3.91	5.00	5.66	Table Saw							7.5YR	3	3	6	Ah	sandy-silt, organics (roots)	10YR	6	3	5	Bm	similar to A but less organics and slightly lighter colour						
G-WGM-51-Dup	25-Jan-17	3.98	5.00	7.05	Table Saw	10YR	1	2	3	F	moss with decomposing organics, clayey soil	10YR	6	3	7.5	Ae	silty with some sand and pebbles, little organics, few roots												
G-WGM-52	10-Jan-17	3.84	5.00	4.50	Table Saw	10YR	1	2	3	F	decomposing leaf litter, some clay	10YR	4	5	12	Ae	silty, some roots, some pebbles												
G-WGM-53	25-Jan-17	1.60	5.00	1.53	Table Saw	10YR	2	2	3	F	leaf litter, twigs and decomposing organics with clay	10YR	6	4	3.5	Ae	clayey silt, some fine roots, a pebble												
IL-01	25-Jan-17	3.72	5.00	2.92	Matthew's Metals	10YR	1	2	2.5	L	leaf litter, a little clay						does not appear to be an A horizon	10YR	2	6	6	Bg	evidence of oxidation (orange and red colours), silty, pebbles, some thin roots						
IL-02	25-Jan-17	5.00	5.00	2.36	Matthew's Metals	10YR	2	3	2.5	F	some moss, leaf litter, sand-silt, matted roots	10YR	2	2	11	Ah	matted roots silty, some woody structures, compact near bottom												

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
IL-03	25-Jan-17	3.00	14.40	3.03	Matthew's Metals	10YR	2	2	5.5	F	woody materials, matted roots, clay, leaf litter, decomposing organics	10YR	1	2	4.5	Ah	silty-clay, matted roots, 1 root 1cm thick	10YR	1	4	3.5	Bg	Silty-sand, little organics	10YR	1	3	4.5	C	silty-sand, little to no organics, more compact than B, possibly more silt. ~0.5cm black layer separating two layers
IL-04	25-Jan-17	5.00	5.00	2.32	Matthew's Metals	10YR	1	2	5	F	moss on the surface, roots and decomposing organics, organic-rich clay below	10YR	4	5	8	Ae	sandy-silt, matted roots												
IL-05	25-Jan-17	5.00	10.00	3.06	Matthew's Metals	10YR	2	2	5.5	F	mixed bag, leaf litter and a pine cone on top, matted roots and silty below with different shades of brown/gray	10YR	1	2	4.5	Ah	matted roots, silty, roots ~7mm thick	10YR 10TR	3 6	6 6	7	Bf	silty, some roots and pebbles						
IL-06	25-Jan-17	4.43	7.40	1.95	Matthew's Metals	10YR	2	2	4.5	F	decomposed organics, leaf litter, clay	10YR	1	2	1	Ah	organic rich clay	10YR 10YR	2 6	7 6	8.5	Bm	appears to be reduced (leached?) at top of layer, and oxidized near bottom. Mostly silt, some roots						
IL-07	25-Jan-17	4.37	14.40	3.40	Matthew's Metals	10YR	2	2	3.5	Of	decomposing fibric moss, little clay	10YR	2	2	2.5	Ah	silty, organic rich, matted roots and some thicker roots (~1-3mm)	10YR	2	2	10	Bf	fine silt, compact, orange shade near bottom, then changes to dark brown/black						
IL-08	25-Jan-17	4.67	5.00	2.79	Matthew's Metals	5YR	2	3	4.5	Of	matted roots with a little clay, some leaf litter	10YR	1	2	12	Ah	organic rich clay, thin roots, some pebbles (silica?)												
IL-09	25-Jan-17	4.64	15.00	4.45	Matthew's Metals	10YR	1	2	3.5	L	moss, a little clay	10YR	1	3	12	Ae	silty-sand, some organics												
IL-10	25-Jan-17	3.17	2.50	2.25	Matthew's Metals	10YR	2	2	2	L	leaf litter, clay	10YR 10YR	3 3	5 4	4	Ae	Silty-sandy, thin matted roots	10YR	6	5	1.5	Bf	Silty-sand, little organics						
IL-10-Dup	25-Jan-17	4.75	7.40	4.15	Matthew's Metals	10YR	2	2	2	L	leaf litter	10YR	2		2	Ah	organic rich clay	10YR	4	3	5.5	Bf	sandy-silt, roots ~7mm thick, a thin line of graying between A and B horizon						
IL-11	25-Jan-17	4.95	5.00	4.40	Matthew's Metals							10YR	3	4	11	Ah	silty, lots of roots												
IL-12	25-Jan-17	3.81	7.40	2.54	Matthew's Metals	10YR	1	2	2.5	F	moss, leaf litter, decomposing organics, lay	10YR	2	5	3	Ae	silty, 1 root ~1cm thick, little other organics	10YR	4	5	11	Bf	silty, some roots, 1 root ~5mm, some orange hues in spots (oxidation?)						
IL-13	25-Jan-17	4.86	15.00	3.08	Matthew's Metals	10YR	2	2	3	Of	decomposing fibric roots, little clay	10YR	2	3	5.5	Ah	silty-clay, organic-rich, roots ~2mm thick	10YR	2	2	5.5	Bf	sandy-silt, some root material. Various shades of brown (light to dark)						
LL-01	19-Sep-16	5.00	2.50	2.21	Table Saw	5YR	2	3	1	L	leaf litter, ground cover, wood bits	5YR	2	5	1.5	Ah	Rooty, silty, compact	5YR	4	5	8.5	Bf	Silty, some gravel, bark, roots, fairly loose						
LL-02	19-Sep-16	5.00	3.75	1.54	Table Saw	5YR	1	2	1.5	L	silt, pine needles, charred wood pieces, leaf litter	5YR	1	2	1.5	Ah	Silty, held together by thin roots	5YR	4	2	12.5	Bfj	Silty, held together by thin roots (Bm?)						
LL-03	19-Sep-16	4.89	2.50	2.27	Table Saw							10YR	4	4	4	Afj	Minor moss, mainly silty, very little organics	10YR	6	5	7	Bf	Silty, kind of loose and light, some roots (not many), gravel clasts, some sand						

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
LL-04	19-Sep-16	5.00	2.50	1.83	Table Saw							5YR	2	4	8	Ah	Silty, lots of thin roots, few roots ~1mm roots, bark												
LL-05	19-Sep-16	5.00	7.50	6.82	Table Saw													5YR	4	5	6	Bfj	Silt, lots of roots holding material together, some pebble clasts						
LL-06	19-Sep-16	4.83	3.75	1.48	Table Saw	5YR	2	4	3	L	leaf litter, bark, silty clay	5YR	1	2	2	Ah	Organic rich, wispy roots, hard to discern the layer, silty	5YR	8	4	11.5	Bfj	Thin roots, some 2 mm dia roots, sand, mostly silt, gravel clasts						
LL-07	19-Sep-16	4.29	5.00	1.32	Table Saw	5YR	1	4	3	L	silty, pine needles, leaf litter	5YR	1	4	3	Ah	Less organics than the O horizon, mainly roots holding silt together	5YR	2	5	8	Bf	Silt, lots of roots holding material together, some pebble clasts						
LL-08	19-Sep-16	2.92	6.25	1.30	Table Saw	5YR	1	3	2	L	pine needles, grass, leaf litter, bark, some silt	5YR 5YR	1 2	2 5	5.5	Ah	Organic rich, lots of roots, changing colours, light silty material, roots ~1mm and very thin	5YR 5YR 5YR	1 8 4	6 4 5	12	Bg	Silty material with sparse organics throughout. Various layers; the reason there is no "C" horizon is due to organics. Roots throughout.						
TX-01	25-Jan-17	5.00	14.40	3.25	Matthew's Metals	10YR	2	2	3	Of	matted roots, fibric, moss on top, clay	10YR 10YR	3 2	3 6	6.5	Ah	brown silt at top, light brown/gray on bottom of layer, organic rich with lots of roots	10YR	3	3	12.5	Bh	organic rich silty, lots of roots						
TX-02	25-Jan-17	4.02	7.40	3.63	Matthew's Metals	10YR	2	2	4	F	leaf litter and decomposed organics, clay	5YR	2	3	5	Ah	matted roots, organic rich clay, root ~4mm												
TX-03	25-Jan-17	5.00	7.50	2.94	Matthew's Metals							10YR 10YR	2 3	3 5	10	Ah	dark brown organic rich and clay, light brown silty, different colours/matrix mixed												
TX-04	25-Jan-17	5.00	5.00	5.46	Matthew's Metals	10YR	2	2	2.5	Om	fibric, matted roots, clay, leaf litter and moss	10YR 10YR	2 1	2 2	9	Ah	thick matted roots and clay												
TX-05	25-Jan-17	3.38	15.00	1.69	Matthew's Metals	10YR	3	3	6	Of	moss and woody structures	10YR	1	2	14	Ah	organic rich clay, matted roots, a few pebbles												
TX-06	25-Jan-17	2.88	15.00	3.75	Matthew's Metals	10YR	3	3	3	Of	thick matted roots, moss on top, clay	10YR	1	2	7	Ah	organic rich clay, lots of roots, 1 root 1cm thick	10YR	4	5	6.5	Bf	sand with cobbles and pebbles						
TX-07	25-Jan-17	5.00	5.00	3.80	Matthew's Metals	10YR	3	3	2	L	leaf litter with some clay,	10YR	1	4	1.5	Ae	appears to be reduced, silty clay with matted roots,	10YR	8	6	5	Bf	sandy silt, some pebbles						
TX-08	25-Jan-17	4.29	5.00	4.14	Matthew's Metals				2	L	moss and cedar (?) leaves; no soil	10YR	1	2	7	Ah	organic rich clay, matted roots, roots ~3mm thick.	10YR	3	3	6.5	Bf	silty-clay, some thin roots						
TX-09	25-Jan-17	5.00	5.00	2.82	Matthew's Metals	10YR	2	2	1.5	F	leaf litter and twigs, decomposed organics, clay	10YR	2	3	7.5	Ae	sandy-silt, pebbles, thin roots	10YR	4	5	5	Bf	silty, some pebbles, some root and organic material						
TX-10	25-Jan-17	4.35	5.00	3.89	Matthew's Metals	10YR	1	2	3.5	L	mostly leaf litter and twigs, small amount of clay, some thin roots	7.5YR	3	3	19.5	Ah	sandy silt with lots of matted roots, some pebbles												
TX-10-Dup	25-Jan-17	4.02	5.00	2.67	Matthew's Metals	10YR	2	2	2.5	L	leaf litter, roots, decomposed organics, little clay	7.5YR	3	3	10.5	Ah	sandy-silt, thin roots, one roots ~4mm												
TX-11	25-Jan-17	4.72	5.00	2.50	Matthew's Metals	10YR	1	2	2	H	organic rich clay, very small amount of leaf litter	7.5YR	3	3	16	Ah	matted roots, silty, some pebbles												

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
TX-12	25-Jan-17	4.62	5.00	6.04	Matthew's Metals	10YR	2	2	3	L	cedar leaves with roots and other leaf litter, little soil	10YR	1	4	0.5	Ae	silt, colouring indicates leaching	10YR	8	5	14	Bh	silty, organic rich, matted roots with roots up to 204 mm thick, been oxidized						
TX-13	25-Jan-17	4.26	5.00	3.77	Matthew's Metals	10YR	2	2	1.5	F	thick matted roots, moss on top, clay	10YR	1	2	11.5	Ah	thick matted roots, clay, some pebbles, 1 root ~8mm thick												
TX-14	25-Jan-17	3.05	10.00	2.09	Matthew's Metals	10YR	2	2	12.5	F	leaf litter, clay, decomposed organics, 1 root ~1cm thick	10YR	1	2	1.5	Ah	organic rich clay	10YR	3	3	7	Bf	silty sand, pebbles, little organics						
TX-15	25-Jan-17	4.08	5.00	5.69	Matthew's Metals	10YR	1	2	1.5	F	decomposed organics with a little moss on top, clay	7.5YR	2	3	1	Ah	organic rich clay, matted roots	7.5YR	2	4	15.5	Bf	sand. No to little organics. Little matrix so colour may not be accurate						
TX-16	25-Jan-17	5.00	15.00	6.50	Matthew's Metals	7.5YR	3	3	3	Of	thick miss and fibric material	10YR	1	2	8.5	Ah	organic rich clay, pebbles, roots												
TX-17	25-Jan-17	3.77	5.00	2.48	Matthew's Metals	10YR	1	2	6.5	F	leaf litter, organic rich clay, matted roots, roots ~1cm thick	10YR	2	3	3	Ae	clay with some roots, a little orange (oxidized zone?)	10YR	1	2	6	Bh	organic rich clay, some roots						
TX-18	25-Jan-17	3.33	7.40	3.35	Matthew's Metals	10YR	1	2	4.5	F	leaf litter, roots, matted roots and silt, decomposed organics	10YR	2	2	15.5	Ae	Silty-clay, pebbles, matted roots. Some pebbles appear to have broken down to form smaller pebbles and sand												
TX-19	25-Jan-17	3.09	10.00	2.98	Matthew's Metals	10YR	2	2	8.5	F	organic rich clay, roots, both thin and thick (~1.5cm), leaf litter and decomposed organics	10YR	4	3	9.5	Ah	sandy-silt, pebbles, matted roots												
TX-20	25-Jan-17	4.39	5.00	3.19	Matthew's Metals	10YR	1	2	3.5	H	organic clay, decomposed organics	10YR	2	3	11	Ah	organic rich clay, some sand and pebbles, thin roots and roots ~2-3mm thick												
TX-20-Dup	25-Jan-17	3.92	5.00	3.08	Matthew's Metals							10YR	1	2	14.5	Ah	organic rich clay, matted roots, roots ~3mm thick, pebbles	10YR	1	4	4	Bg	clay, pebbles, little organics						
TX-21	25-Jan-17	3.37	5.00	3.35	Matthew's Metals	10YR	1	2	2	F	organic rich clay, moss	10YR	3	3	6	Ae	sandy-clayey-silt, some root organic material and pebbles	10YR	2	4	3	Bm	sandy, some roots, pebbles and possibly clay						
TX-22	25-Jan-17	4.34	5.00	3.08	Matthew's Metals	10YR	1	2	5	F	moss and leaf litter, clay	7.5YR	3	3	4	Ah	organic rich, 1 root 1cm thick, some thick roots												
TX-23	25-Jan-17	4.53	2.50	4.85	Matthew's Metals	10YR	1	2	3	H	decomposed organic rich clay, some non-identifiable leaf litter	10YR	3	3	8	Ah	organic rich clay, some roots and pebbles												
TX-24	25-Jan-17	4.18	5.00	2.89	Matthew's Metals	10YR	1	2	8	F	a little moss on top, most organic rich clay and decomposed organics	10YR	2	2	6	Ah	organic rich clay, some roots ~1-2mm												
TX-25	25-Jan-17	3.38	5.00	2.26	Matthew's Metals	10YR	1	2	4.5	F	organic rich clay, matted roots, some leaf litter and moss, some decomposed organics	10YR	1	2	2	Ah	organic rich clay	10YR	2	4	8	Bf	clay, cobbles and pebbles, some organics						
TX-26	25-Jan-17	5.00	5.00	4.94	Matthew's Metals							10YR	1	2	10	Ah	organic rich clay, matted roots, slight different shades of brown, some silt												

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
TX-27	25-Jan-17	3.64	5.00	3.12	Matthew's Metals	10YR	1	2	4.4	F	decomposed organics, organic rich clay, cedar leaves on top	10YR	1	2	9	Ah	organic rich clay, more compact, roots both thin and thicker (~2-3mm)												
TX-28	25-Jan-17	3.23	7.40	3.16	Matthew's Metals	10YR	2	2	4	F	organic rich clay, roots, some leaf litter on top	10YR	1	2	11.5	Ah	organic rich clay, matted roots	10YR	2	5	6.5	Bf	silty with clay in top 3 cm of layer, no organics						
TX-29	25-Jan-17	3.76	5.00	3.03	Matthew's Metals	10YR	1	2	2.5	F	decomposing moss and leaf litter, some clay	10YR	4	3	7.5	Ae	separating O and A are several large sandstone pebbles. Organic rich silty-sand, ~2mm roots												
TX-30	25-Jan-17	5.00	5.00	3.60	Matthew's Metals	10YR	2	2	4.5	F	a little moss on top, matted roots, and clay	10YR	1	2	10	Ah	organic rich clay, 1 cobble, matted roots												
TX-30-Dup	25-Jan-17	4.96	5.00	3.26	Matthew's Metals	10YR	2	2	3.5	H	matted roots and humic material, clay	10YR 7.5YR	1 4	2 3	3 3.5	Ah	organic rich, matted roots, clay	10YR	1	2	6.5	Bh	organic rich clay, matted roots, some pebbles, ~1mm roots						
TX-31	25-Jan-17	4.53	10.00	3.75	Matthew's Metals	10YR	1	2	2.5	H	decomposed organic material, clay, loose	10YR	2	2	3.5	Ah	lots of roots, organic rich clay	10YR	3	3	6.5	Bf	silty, some roots and woody structures						
TX-32	25-Jan-17	4.24	5.00	4.45	Matthew's Metals	10YR	1	2	4	F	roots, leaf litter, decomposed organics clay, matted roots						maybe mixed with O	10YR	3	4	17	Bf	silty sand, some roots and pebbles	10YR	2	5	3	C	mostly silt, possibly a little sand
TX-33	25-Jan-17	3.50	15.00	3.78	Matthew's Metals	10YR	1	2	2.5	F	decomposing leaf litter, little clay	10YR	1	2	3.5	Ah	organic rich clay, matted roots, roots ~1mm thick	10YR	2	7	5.5	Bg	mostly silt, one root ~1cm	10YR	2	6	8	C	silty, some pebbles, no organics
TX-34	25-Jan-17	4.68	7.40	4.28	Matthew's Metals	10YR	1	2	6	F	clayey, matted roots, roots ~3mm thick, decomposed organics, a little moss	10YR	4	3	8.5	Ah	silty, matted roots,												
TX-35	25-Jan-17	3.45	15.00	3.37	Matthew's Metals	10YR	2	2	9	F	leaf litter, twigs, roots of a couple mm diameter, matted roots, clay	10YR	4	6	4	Aeg	silt, reduced (eluviated), pebble clast present	10YR	6	5	11	Bf	bark, cobble clasts, silty, some roots and other organics, oxidized						
YK-01	10-Jan-17	5.00	5.00	2.29	Matthew's Metals	10YR	1	2	5	F	leaf litter on top, decomposing organics on bottom	10YR	3	5	9	Ah	Sandy, roots up to 5mm thick	10YR	6	4	4.5	Bf	Sandy, some organics						
YK-02	25-Jan-17	4.17	7.50	6.46	Matthew's Metals	10YR	2	3	1.5	F	leaf litter with clay	10YR	4	5	10.5	Ae	sandy-silt, roots up to 5mm diameter												
YK-02-Dup	25-Jan-17	5.00	5.00	2.70	Table Saw	10YR	1	2	8	F	a layer of leaf litter and decomposed organics, then silty matted roots, then another layer of matted roots/leaf litter and clay	10YR	4	5	6	Ae	sandy silty, little organics												
YK-03	25-Jan-17	5.00	5.00	3.50	Table Saw							10YR	4	4	10.4	Ae	silty, some organics												
YK-04	10-Jan-17	5.00	5.00	2.60	Table Saw	10YR	1	2	3.5	L	organic rich-leaf litter some clays	10YR	3	6	9.5	Ae	silty, a little sandy, some organics												
YK-05	25-Jan-17	5.00	10.00	3.83	Table Saw	10YR	2	2	3	F	decomposing leaf litter, clay, at bottom of layer light brown	10YR	3	3	2	Aeg	evidence of oxidation and possibly reduction, organic rich, clayey, some silt and sand	10YR	6	3	6	Bf	silty, some roots and pebbles						
YK-06	10-Jan-17	2.90	7.50	1.71	Table Saw				1	L	moss	5YR	2	2.5	10	Ag	mostly silt, some organics, roots	2.5YR 5YR	2 1	2.5 2.5	8.5	Bm	Alternating layers of red and dark brown; clay and compact						
YK-07	10-Jan-17	2.92	5.00	1.70	Table Saw							10YR	4	3	8	Ah	Silty, thin roots												

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						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-08	10-Jan-17	3.36	2.50	3.12	Table Saw							10YR	3	5	7	Ae	sandy-silt, some pebbles, no organic matter												
YK-09	25-Jan-17	3.76	5.00	4.75	Table Saw							2.5Y 2.5Y	3 3	4 6	17.5	Ae	silty, few organics, single root halfway down,												
YK-10	25-Jan-17	5.00	5.00	9.86	Table Saw							2.5Y	3	5	9	Ae	very silty, some pebbles and root material, may be some decomposed organics and clay	2.5Y	4	6	4.5	Bf	very silty, some roots (up to 5 mm diameter), some pebbles						
YK-11	10-Jan-17	4.56	2.50	1.69	Table Saw	10YR	3	5	3.5	L	leaf litter, some silt	10YR	3	5	15	Ah	silt, some root material, very dry and dusty, some sand												
YK-12	10-Jan-17	4.12	5.00	3.46	Table Saw	10YR	2	2	4.5	Om	decomposing fibric material	10YR	1	2	10.5	Ah	organic rich-roots, silty-clay												
YK-12-Dup	10-Jan-17	4.69	5.00	3.51	Table Saw	10YR	1	2	4	Om	decomposed organics, clay, moist, roots	10YR	1	2	12.5	Ah	layers of faint dark red, organic rich, moist, compact, clay												
YK-13	10-Jan-17	4.24	7.50	2.19	Table Saw	10YR	2	2	4.5	L	leaf litter, silty	10YR	1	2	20	Ah	silty, some sand, some roots												
YK-14	10-Jan-17	4.60	10.00	1.98	Table Saw	10YR	2	2	6.5	L	leaf litter and twigs, very little actual soil	10YR	1	2	1.5	Ah	Silty, fine roots, some pebbles	5YR	2	2.5	4.5	Bh	Silty clay, compact, some sand. Some organics						
YK-15	10-Jan-17	3.28	5.00	2.40	Table Saw	10YR	1	2	2.5	L	moss, pine cone, some clay	7.5YR	3	5	8	Ae	Silty, little organics												
YK-16	10-Jan-17	4.05	10.00	2.10	Table Saw	10YR	1	2	2.5	L	leaf litter, some clays at bottom of layer	10YR	1	2	1.5	Ah	decomposed organics, clayey soil, leaf litter	5YR	1	6	3	Bg	gray, leached soil, silty	10YR	4	6	20.5	C	silty-sand, little to no organics, varying hues of oragne and brown
YK-17	25-Jan-17	4.03	10.00	2.37	Matthe's Metals	10YR	2	2	2	L	leaf litter, little clay	10YR	2	3	5	Ah	matted roots, silty-clay	10YR	2	7	18	Bf	At top of layer, pebbles of clay, does not look natural. mostly silt, little organics. Could possibly be c horizon						
YK-18	10-Jan-17	4.73	2.50	1.69	Table Saw	10YR	1	2	3	L	leaf litter, some clays at bottom of layer	10R10YR	34	64	3	Ag	pinkish sand and brown silt, little organics	10YR	3	6	24.5	Bf	very silty, some organics						
YK-19	10-Jan-17	5.00	2.50	1.81	Table Saw	10YR	2	3	3	Om	decomposing fibric material, silty material	7.5YR	4	5	9	Ah	very silty, root material 1-3mm diameter												
YK-20	25-Jan-17	5.00	5.00	3.08	Table Saw	10YR	2	2	5	L	leaf litter, woody structures, roots, some clay	10YR	1	2	1	Ah	organic rich clay	10YR	2	2	2	Bf	Silty, some organics						
YK-20-Dup	10-Jan-17	4.40	5.00	1.90	Table Saw	10YR	2	2	3	L	mostly organics, leaf litter, little soil	10YR	2	4	6	Ah	various colours, soil held together with matted roots, silty												
YK-21	10-Jan-17	3.41	5.00	2.06	Table Saw	10YR	2	2	3	L	leaf litter, little clay	10YR	1	2	4.5	Ah	organic rich, roots, clay-silt	10YR	2	6	13	Bm	potentially in part C horizon, very silty, no organics, some pebbles						
YK-22	10-Jan-17	4.19	10.00	2.30	Table Saw	10YR	1	2	3	L	leaf litter, looks like the beginning of decomposing, some silt	10YR	2	2	4.4	Ah	roots, organics, very silty												
YK-23	10-Jan-17	5.00	5.00	1.31	Table Saw							7.5YR	6	4	4.5	Ah	matted, organic rich, silty												

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YK-24	25-Jan-17	4.54	5.00	2.72	Matthew's Metals	10YR	2	2	2	L	leaf litter, some clay	10YR	6	3	11	Ah	silty, matted roots, no sand or pebbles												
YK-25	25-Jan-17	4.44	7.50	1.89	Matthew's Metals					L	just leaf litter, no clay or matrix	10YR	4	3	11	Ae	silty, some pebbles, matted roots, thicker roots (5-6mm)												
YK-26	25-Jan-17	5.00	2.50	2.90	Matthew's Metals							10YR	2	4	6	Ae	silt, little else	10YR	2	2	12	Bh	organic-rich silt, roots ~5mm thick						
YK-27	25-Jan-17	3.91	5.00	4.56	Matthew's Metals	10YR	2	5	2	L	leaf litter and moss, a clay on bottom; note, organic rich clay wasn't dark, light brown	10YR	2	3	5	Ah	mass of roots, clay	10YR	2	3	6	Bf	mostly clay, 1 sand clast						
YK-28	25-Jan-17	2.74	7.40	2.98	Matthew's Metals	10YR	1	2	4	F	silty, leaf litter and moss, decomposed organics	10YR	4	6	6.5	Ae	silty, matted roots, a few pebbles												
YK-29	25-Jan-17	3.98	5.00	2.98	Matthew's Metals	7.5YR	2	3	5	F	decomposing roots and leaf litter, some clay	10YR	2	7	19.3	Ae	silty, some organics (roots), pebbles and cobbles, this might be B horizon												
YK-30	25-Jan-17	4.30	2.50	2.45	Matthew's Metals							10YR	3	4	12	Ae	very silty, some matted roots and roots up to ~3mm thick	10YR	3	5	6.5	Bf	very silty, little organics, possibly none. Compact and hard, no pebbles or sand						
YK-30-Dup	25-Jan-17	5.00	5.00	5.68	Matthew's Metals							10YR	3	4	14.5	Ah	silty, matted thin roots and roots ~1-3mm thick												
YK-31	25-Jan-17	4.25	7.40	248.00	Matthew's Metals	10YR	1	2	7	F	leaf litter and woody structures, decomposing organics, some clay	10YR	1	2	4	Ah	organic rich clay, lots or matted roots				16	Bf	sand. No colour specified b/c mixture of sand, no matrix						
YK-32	25-Jan-17	4.58	5.00	2.69	Matthew's Metals	10YR	1	2	4	F	organic rich clay, roots, decomposing organics	10YR	3	5	3	Ae	silty-sand, pebbles, little organics	10YR	6	7	5.5	Bf	silty-sand, pebbles, little organics						
YK-33	25-Jan-17	3.45	10.00	4.87	Matthew's Metals	10YR	1	3	3.5	F	mostly decomposed organics, some moss, 1 large pebble, leaf litter and roots, silt and sand	10YR	3	6	10	Ae	sandy-silt, pebbles and cobbles, some thin roots and twigs												
YK-33-Dup	25-Jan-17	5.00	5.00	4.08	Matthew's Metals	10YR	2	3	1	H	matted roots and some clay	10YR	4	3	12	Ae	sandy-silt, some pebbles, lots of thin roots, one root ~2cm												
YK-34	25-Jan-17	3.54	7.40	2.35	Matthew's Metals	10YR	2	2	8	F	leaf litter on top, some matted roots, clay, some silt	10YR	1	4	3	Ae	silty with matted roots, leached material, some sand												
YK-35	25-Jan-17	3.87	5.00	6.12	Table Saw	10YR	3	5	1	Om	moss on top, thick matted roots, silty	10YR	2	6	6	Ae	matted roots, a large (5 mm diameter) root, very silty	10YR	8	7	2.5	Bf	Silty, one root present (1 mm in diameter)						
YK-36	25-Jan-17	4.17	5.00	3.18	Matthew's Metals	10YR	1	2	3	L	leaf litter and twigs, little clay	10YR	8	5	4	Ae	colour not consistent throughout, organics - matted roots and some thicker roots	10YR	2	7	19	Bf	silty, some roots, 1 cobble, some pebbles, mostly compact						
YK-37	25-Jan-17	3.50	2.50	4.13	Matthew's Metals							10YR	4	5	3.5	Ae	silty, little organics, some sand	10YR	6	5	14	Bf	sandy-silt, a few pebbles, some roots up to ~3mm thick						
YK-38	10-Jan-17	2.99	5.00	1.27	Table Saw	5YR	1	2	2	L	loose organics, mostly leaf litter, some roots	5YR	2	3	6	Ah	Silty clay, organic rich, matted with roots	10YR	4	5	8	Bf	Sandy soil with a range of grain size (~1mm to 4cm).						

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-39	10-Jan-17	4.05	5.00	2.18	Table Saw	10YR	1	2	3	F	leaf litter and decomposing organics	10YR	3	3	11	Ae	Silty, little organics	10YR	2	2	6	Bm	various colours (dark brown, red blotch, light brown), silty						
YK-40	25-Jan-17	5.00	5.00	3.00	Table Saw	10YR	1	2	3	F	beginnings of decomposing leaf litter, cobwebs(?) around some surface leaf litter, some clay.	10YR	6	4	14	Ae	silty with pebbles and organics	2.5Y 5YR	3	6	10.5	Bm	silty, some organics (roots?), various shades of brown throughout						
YK-40-Dup	10-Jan-17	3.79	5.00	3.27	Table Saw	5YR	1	2	2	L	leaf litter	10YR	4	4	3	Ah	Silty, organic rich	10YR	6	5	4	Bf	Silty, less root material than in the A horizon	10YR	6	7	15	C	Clay, beginning of layer sandy material, some root material
YK-41	25-Jan-17	3.72	5.00	2.91	Table Saw	10YR	1	2	5	L	leaf litter and clay, bottom ~1cm decomposed organics, black	10YR	2	3	10	Ae	clay, some roots, couple different shades of brown	10YR	2	2	9	Bm (?)	clay, does not appear to be any organics, the bottom ~2cm might be C-horizon, or part of B-horizon to meet Bm. Across the A and B horizon, shiny/sparkle copper coloured specs						
YK-42	25-Jan-17	5.00	5.00	6.92	Table Saw	10YR	2	2	1.5	F	decomposing organics with some moss and leaf litter, clay	10YR	4	3	3	Ae	silty, few roots	10YR	4	5	6.5	Bf	sandy silt, no organics						
YK-43	10-Jan-17	4.60	10.00	3.22	Table Saw	5YR	1	2.5	4	F	decomposing leaf litter, surface is discernable	7.5YR	8	5	2	Am	thin layer, orange-red hue, silty, thin roots	10YR	4	5	9	Bh	Silty, roots, some clay, sand particles						
YK-44	10-Jan-17	4.01	7.50	1.71	Table Saw	5YR	1	2	5.5	L	leaf litter, some roots, some clayey organics	5YR	2	4	4.5	Ah	Sandy, some thicker roots and some thin roots	10YR	6	5	17.5	Bf	Silty-sand, some root material, some pebbles						
YK-45	2-Oct-17	3.23	5.00	2.14	Table Saw	10YR	1	2	4	F	organic rich clay, thick matted roots, one root 5 mm diameter, a little moss and leaf liter on top	10YR 10YR	2 2	2 6	2.5 4	Ah Ahe	Top part is organic rich clay with matted roots. Below is clay, little organics, compact.	7.5YR	2	5	9.5	Bf	compact clay, little organics, some small lenses of black streaks (clay probably).						
YK-46	2-Oct-17	2.76	15.00	3.06	Table Saw	10YR	2	2	3	Of	leaf litter, grass on top, matted roots, some decomposing organics,	10YR	1	2	16	Ah	organic rich clay, thin matted roots and roots 1-2mm thick diameter, clay lens, compact, some woody structures, at 4 cm depth in layer there is reddish hue, at bottom of layer lens of red clay	10YR	2	3	1	Bg	compact clay, little sand, no organics						
YK-47	2-Oct-17	3.58	15.00	2.41	Table Saw	10YR	1	2	2	Om	moss, thick roots with little clay, fibrous, decomposing organics	10YR	2	2	14	Ah	top is thin wispy roots with clay. Layer has progressively less roots and turns from brown to dark brown to black with depth, all soil is clay	10YR	2	6	3	Bg	silty, little to no organics, internal layering based on coloration						
YK-48	2-Oct-17	2.97	10.00	4.38	Table Saw	10YR	2	2	3	Of	fibrous moss, partially decomposed organics, little clay	10YR	1	2	16	Ah	organic rich clay, roots up to 4mm in diameter, thin wispy roots, hard and compact	10YR	3	4	13	Bg	no organic, hard and compact, silty clay, moist, spots of orange brightness						

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-49	2-Oct-17	3.22	12.50	1.83	Table Saw	10YR	2	2	7	F	leaf liter, some decomposing organics, clay, root about 5mm thick diameter, loose material,	10YR	1	2	4	Ah	organic rich clay, thin roots, compact,	10YR	2	4	12.5	Bg	sandy, one large pebble, mottling, sand moist-if dry might lighter colored, streaks of orange and red showing oxidation, little to no organics						
YK-50	2-Oct-17	3.01	12.50	1.64	Table Saw	10YR	2	2	3	F	aquatic grasses and mosses and leaf liter on top, decomposing organics and a little clay below, a thin leached layer marks the O-A boundary	10YR 10YR	2 1	2 2	6 11.5	Ah Ah	A1: silty clay, organic rich, is bark woody structure, thin wispy roots, A2:organic rich clay, damp, thin wispy roots, at bottom roots that are 2-3 mm diameter, more compact than A1												
YK-50-Dup	2-Oct-17	1.83	10.00	2.15	Table Saw	10YR	2	2	7	F	Moss and grasses on top, an acorn, below is decomposing organics, matted roots, clay	10YR	1	2	6	Ah	almost black, organic rich clay, some thin roots												
YK-51	2-Oct-17	3.29	7.50	4.26	Table Saw	N/A			1	L	pine needles and a little moss, some leaf liter, no soil.	10YR	1	2	9	Ah	Organic rich clay, A-B boundary there are two roots (5-10 mm diameter) and appears to be leached soil	10YR 7.5YR	3 3	5 5	5 7	Bm	very clay rich, hard and compact, few pebbles, some thin roots, top of layer is more light brown/grey and transition with depth to more reddish brown. In red/brown part there is a 1x3cm lenses of sand near bottom. Near top there is also sand						
YK-52	2-Oct-17	3.91	10.00	2.81	Table Saw	10YR	2	2	4.5	L	Leaf liter, a couple roots, little clay,	10YR	2	7	11.5	Aeg	Very silty, some roots,	7.5YR	3	4	10	Bm	compact clay, couple of sand grains and one pebble, little to no organics, reddish hue						
YK-53	2-Oct-17	3.96	12.50	2.56	Table Saw						No O	10YR	2	2	8	Ah	organic rich silty clay, a little moss on top (not enough to define an O horizon), thin matted twigs, some twigs up to 3 mm diameter,	10YR	2	4	4.5	Bg	clay with pebbles that are 2-3cm in length, thin matted roots, appears that the soil has been eluviated,						
YK-54	2-Oct-17	2.77	10.00	4.20	Table Saw	10YR	2	2	3	F	Has moss on top, thin matted roots, and clay, a little leaf liter	10YR	1	2	12	Ah	peat like soil, thick matted roots, several roots that are 2-3 mm diameter, organic rich clay, at A-B boundary there is thin layer of black silty-clay and some bark	10YR	1	4	13	Bg	very clayey and damp, compact, at top of horizon some brown clay, appears to be transition zone between A and B						
YK-55	2-Oct-17	2.04	15.00	2.01	Table Saw	10YR	3	3	5	F	some leaf liter, and moss, thin wispy roots, little soil, some decomposing organics,	10YR	1	2	12.5	Ah	organic rich clay, compact, 2cm thick root, thin wispy roots,												

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-56	2-Oct-17	3.86	10.00	3.12	Table Saw	10YR	2	3	6	F	leaf liter on top, with twigs decomposing organics, and silt below,	7.5YR	3	3	7	Ah	organic rich clay, thin wispy roots, streaks of black clay that are more vertical than horizontal,	5YR	2	2.5	5	Bh	organic rich clay, with streaks of black clay, compact, a little sand (3 grains, one pebble						
YK-57	2-Oct-17	3.93	11.25	1.49	Table Saw	10YR	2	2	6	F	Leaf litter, decomposing organics, some clay, some thin roots	10YR	3	3	3	Ae	clayey silt, thin matted roots, at O-A boundary there are thick roots (3-4mm),	10YR	6	3	6.5	Bhf	silty-clay, organics present, some roots, partial oxidation,						
YK-58	2-Oct-17	4.30	7.50	2.22	Table Saw	10YR	2	2	2	L	very little soil, mostly leaf litter and moss	10YR	3	3	6	Ah	thick matted roots, silty, a little sand, some decomposing organics	10YR	4	4	11	Bm	silty sand, at the A-B interface there is a large (granitic?) pebble, some thin roots throughout						
YK-59	2-Oct-17	3.45	12.50	1.94	Table Saw	7.5YR	2	3	8.5	F	leaf liter, twigs, matted roots with twigs, little clay, woody structures	10YR	2	4	5	Aag	there is thin layer of black organics at top and quickly leaches out below. The black materials is decomposing organics, some wooddy structures. Leached out material is clayey-silt with thin roots	10YR	6	5	6.5	Bf	large cobble (6.5cm) takes up most of layer. Soil that is present is silty with a few roots, some sand						
YK-60	2-Oct-17	2.71	7.50	0.94	Table Saw	10YR	2	2	6	L	caribou moss and some pine needles, and a little clay with decomposing organics,	10YR	4	3	5	Ah	sandy silt, some leaf litter and organic material, there is a cobble (6cm length x 5 cm width), A horizon might be deeper but because of the large cobble likely the core would not go any further into the ground												
YK-61	2-Oct-17	2.64	15.00	2.46	Table Saw	10YR	2	2	9	F	Leaf liter, twigs acrons, decomposing organics, some thin matted roots with little soil,	10YR	2	2	4	Ah	Organic rich clay, woody structure, some roots (1-2mm diameter), similar to O horizon except more intact,	10YR 10YR	2 1	2 1	2.5 2.5	Bm	Clay material, thin roots, horizontal layers of black clay with one layer of light brown clay in between, compact,						
YK-61-Dup	2-Oct-17	2.22	10.00	1.65	Table Saw	10YR	2	2	4.5	Om	some leaf liter, and acron, decomposing organics form fibric structures, little clay,	10YR	2	2	9.5	Ah	organic rich clay, thin roots and roots that are 2-3 mm diameter, kind of loose,												
YK-62	2-Oct-17	3.27	12.50	1.94	Table Saw	10YR	2	2	7	F	moss and leaf liter on top, decomposing organics, 2.5 cm wide piece of wood,	10YR	4	4	6	Ah	silty, thin matted roots, pebbles, leaf liter, some woody structures,												
YK-63	2-Oct-17	4.20	15.00	3.16	Table Saw	10YR	1	2	5	H	organic rich clay, some roots, mostly decomposing organics	7.5YR	6	4	11	Ah	silty sand, some organics, one root (1.7 cm diameter), very loose												

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-64	2-Oct-17	4.44	15.00	3.19	Table Saw	10YR	1	2	5	F	leaf liter, decomposing organics, with some clay, and thin wispy roots	10YR	2	5	5	Ahe	organic rich silt that has been leached at the top of the layer, bottom of layer is organic clay (10YR-1-2), a few roots (2mm diameter),	10YR	2	4	6	Bh	clayey silt, damp, thin wispy roots, coarse silt/ fine sand, roots that are 1 mm diameter, looks like layer has been illuviated						
YK-65	2-Oct-17	3.20	7.50	1.77	Table Saw	10YR	2	2	5	F	Moss and leaf liter on top, decomposing organics, and silty-clay, and woody debris throughout rest of horizon,	10YR	3	3	8	Ahe	organic rich silty-clay, roots 2-3mm diameter thick, thin wispy roots, eluviation at bottom of horizon (grey color and more silt and a little sand and there are still roots and organics)												
YK-66	2-Oct-17	3.19	10.00	2.98	Table Saw	10YR	1	2	5.5	F	top 3.5 cm is caribou moss and leaf liter, below that is decomposing organics and clay, with a some roots	7.5YR	4	3	12	Ah	Very peat like material, thick matted roots, several roots that 2-3mm in diameter, clay, horizontal streaks of dark brown and black (clay or organic?)	10YR	1	2	6	Bh	organic rich clay, bottom 2cm is browner in color (7.5YR- 3-3) and more peat like and lot more compact. overall clay rich						
YK-67	2-Oct-17	4.09	10.00	1.80	Table Saw	10YR	2	2	3	L	leaf liter, pine needles, very little clay, tiny bit of decomposing organics	10YR	3	4	8.5	Ahe	clayey-silt, with a little sand, several roots (2-3 mm diameter), many thin roots, other indiscernible organics, graying suggesting that eluviation is happening												
YK-68	2-Oct-17	2.08	10.00	2.45	Table Saw	10YR	2	2	2	L	Leaf litter and bark, little soil	7.5 YR	3	3	9	Ah	very organic rich, fibrous material including light coloured (almost white) moss and brown roots, little soil, some woody structures	10YR	2	2	4	Bh	organic rich clay, darker brown at bottom						
YK-69	2-Oct-17	3.95	15.00	1.82	Table Saw	10YR	1	2	7	Om	fibric moss on top, decomposing organics and fibric material lower in layer with clay, discernable leaf liter throughout horizon.	10YR	6	5	4.5	Ae	sandy silt and some pebbles, a few roots, high in iron												
YK-70	2-Oct-17	4.78	5.00	3.74	Table Saw	10YR	2	2	1.5	L	Leaf litter, twigs and moss, a little clay	10YR	2	6	27	Aeh	silty with a little sand, compact near bottom, some lenses of dark brown/black clay,												
YK-70-Dup	2-Oct-17	4.59	10.00	5.17	Table Saw	10YR	2	2	2	F	moss, leaf liter and bark, a little clay,	10YR	2	6	22.5	Aeh	very silty, compact, hard, little organics(thin roots), lenses of dark brown and black												

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-71	2-Oct-17	3.68	15.00	2.91	Table Saw	10YR	2	2	4	F	thin layer of leaf liter and twigs on top, mostly decomposing organics, with some clay. There is a thin layer of black organic rich clay separating O and A, is at an angle (assume it was pushed down when core was driven into the ground), at 4 cm there is the upper boundary of A-O, the lower boundary is at 8 cm	10YR	2	5	5	Ahe	A horizon has been leached, fine snad or coarse silt, with some thin roots and a couple roots up to 5 mm in diameter,	10YR	3	6	3.5	Bg	very silty, couple of thin roots, a couple roots that are 1mm diameter some motteling, a little sand						
YK-72	2-Oct-17	3.71	15.00	2.75	Table Saw	10YR	2	2	4	F	leaf liter, woddy structures, thin wispy roots, decomposing organics with some clay,	10YR	2	4	4	Ah	top of layer is loose clay with thin matted roots and some thicker roots (1-2mm diameter) that extend from the O, the bottom is more compact clay with root (1cm diameter), small lenses of black clay, and one root that is 8mm in diameter separates the A form the B	10 YR	2	7	12	Bg	very silty, couple of thin roots, horizontal streaks of brown (clay, organics?),						
YK-73	2-Oct-17	3.71	10.00	2.47	Table Saw	10YR	2	2	5	F	leaf liter, matted roots, clay, decomposing organics,	10YR	1	2	7	Ah	organic rich clay, some roots, woody structures, a little loose,	10YR	4	4	9	Bm	compact clay, little organics, lenses of various colors of clay (light brown, dark brown, black)						
YK-74	2-Oct-17	3.28	10.00	2.53	Table Saw	10YR	3	3	4	F	very top is some leaf liter and bark, below that is decomposing organics with matted roots and a little soil, below that is a black layer of organic rich clay.	10YR	2	5	4.5	Aeg	clayey, some roots, at O-A boundary is thin layer of lighter brown clay	10YR	2	4	7	Bg	a couple roots (2-3 mm diameter), hard silt (becomes dust when grinded between fingers), appears that there has been leaching from A to B						
YK-75	2-Oct-17	5.19	12.50	3.11	Table Saw	10YR	1	2	5	F	moss and leaf liter on top, organic rich clay with thick matted roots, some grasses	10YR	1	2	5	Ah	organic rich clay, thick matted roots, few integral layers (alternating light and dark brown), a couple of sand particles												
YK-76	2-Oct-17	4.31	10.00	2.16	Table Saw	10YR	2	2	6.5	F	Leaf liter on top, decomposing organics below, some clay, lose material	10YR	2	7	9.5	Aeg	very silty, matted roots, some roots 2mm in diameter, kind of loose,	2.5Y	3	7	10		compact, several 5mm diameter roots, very silty, similar to A but is more compact and yellow in color						
YK-77	2-Oct-17	4.06	10.00	2.58	Table Saw	10YR	3	3	3.5	F	leaf liter and bark, decomposing organics, some clay,	10YR	4	4	4	Ah	organic rich silt, some black decomposing organics, one large root separating the B and the A	10YR	4	5	7	Bm	very silty, little organics, pebble approximately 5 cm in length, a little sand						
YK-78	2-Oct-17	3.79	10.00	2.73	Table Saw	10YR	1	2	3.5	L	mostly leaf liter, twigs, very little clay,	10YR	1	2	3.5	Ah	organic rich clay, some leaf liter, thin wispy roots, loose	10YR	2	5	5.5	Bh	silty, thin roots (lees than 1 mm), pebbles (up to 3 cm), eluviation						

Site ID	Submitted for analysis					Organic Horizon						A Horizon						B Horizon						C Horizon					
	Date	Extract from core (cm)	Volume (mL)	Weight (grams)	Cutting Method	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description	Colour			Depth (cm)	Class	Description
						Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value				Hue	Chroma	Value			
YK-79	2-Oct-17	3.53	11.25	1.48	Table Saw	10YR	1	2	6	F	leaf liter, lots of decomposing organics, little clay, pine needles, some woody structures.	10YR	2	4	5	Ah	very loose ,material, thin wispy roots, with silt, some woody structures, one root 7 mm diameter	10YR 7.5YR	2 4	5 5	5 1.5	Bm Bf	very silty, one pebble, reddish orange is silty clay, organics throughout horizon.						
YK-79-Dup	2-Oct-17	2.03	7.50	1.07	Table Saw	10YR	1	2	3	L	leaf liter, little soil,	10YR	1	2	3	Ah	organic rich clay, matted roots, one root 2 cm diameter, very loose												
YR-01	25-Jan-17	3.15	14.80	3.00	Table Saw	10YR	2	2	5.5	F	leaf litter, decomposed organics, clay	2.5Y	3	6	7	Ae	silty, thin roots, woody structures (roots or twigs)	10YR	2	4	5.5	Bf	hardpan, compact clay						
YR-02	25-Jan-17	3.84	5.00	3.38	Table Saw	10YR	2	2	4.5	F	leaf litter, decomposed organics	10YR	2	5	13	Ae	silty, some organics, 1 cobble												
YR-03	10-Jan-17	2.30	10.00	3.47	Table Saw	5YR	2	2.5	3.5	F	decomposing leaf litter, clay,	5YR	1	2.5	6.5	Ah	Silty-clay, organic rich. Thin roots holding everything ng together												
YR-03-Dup	10-Jan-17	4.86	5.00	4.54	Table Saw	10YR	1	2	3.5	L	leaf litter and some moss, appears to be some charred organics	10YR 10YR	1 2	2 2	17	Ah	Silty-clay, moist, alternating layers of black and brown, some organics (roots) and woody structures. Compact. 1.5cm layer of charred (?) material						no discernable b horizon from the a horizon						
YR-04	25-Jan-17	4.53	5.00	4.10	Table Saw							2.5Y	4	6	5.5	Aeg	silty, matted roots, orangey hue in parts	2.5Y	4	7	12	Bf	silty, pebbles, a few roots						
YR-05	10-Jan-17	3.90	7.50	1.81	Table Saw	7.5YR	0	2	7	L	leaf litter, twigs, some clay, roots	10YR	3	3	4	Ah	rooty, silty, leached at bottom of layer	2.5Y	6	6	13.5	Btj	Silty, no organics, one cobble						
YR-06	10-Jan-17	4.12	2.50	1.81	Table Saw	10YR	1	2	2	H	decomposed leaf litter and ground cover, some clay	10YR	3	6	16	Ae	silty, some organics, roots up to ~3mm, cobble clasts, some sand												
YR-07	25-Jan-17	4.65	5.00	6.51	Table Saw	10YR	2	3	3	F	moss on top, matted roots, decomposing organics and some clay	10YR	6	4	5	Ae	silty sand, little organics, a couple 1-2 mm diameter roots	2.5Y	4	7	3	Bf	very silty, one root (6 mm diameter)						
YR-08	10-Jan-17	3.60	10.00	2.04	Table Saw	10YR	1	2	2	L	leaf litter	10YR	2	2	4	Ah	Thin roots and woody structures. Silty-clay	10YR	4	3	6	Bf	silty-clay, minor amount of organics						

Appendix F

Aluminum and Lead Contamination

Contamination from the aluminum tubes were a concern because during the sample processing steps, visible pieces of aluminum were observed. Larger pieces were plucked out from the sample. However, it is likely smaller fragments remained in some of the samples. After receiving the bulk geochemistry results, it was clear aluminum values were elevated. Lead and antimony values were also elevated. It is likely small pieces of the lead weight broke off while driving the aluminum tube into the ground and contaminated the sample.

This brought up the question, what other elements were potentially comprised. Small fragments of aluminum tubing and small fragments of the lead weight were submitted for bulk geochemistry analysis at ASU, Table F-1. The potential influence of the aluminum and lead fragments on the samples were calculated as follows:

$$Contamination = \frac{average\ weight\ of\ aluminum\ or\ lead\ fragments}{weight\ of\ soil\ sample\ analyzed} \times Elemental\ Concentration$$

Where the elemental concentration is the average concentration of the aluminum tube or lead weight. As shown in Table F-1, aluminum appears to be the only element potentially affected by aluminum tube fragments. Antimony, lead, and tin appear the only elements potentially affected by lead weight fragments. Caution is used here because the probability that aluminum and lead fragments made it into the portion of soil sample that was analyzed is low for several reasons. First, fragments were removed during the sample description procedure. Second, each sample submitted for analysis was weighed in a small plastic dish and inspected for aluminum and lead fragments. Thirdly, the amount of soil sample submitted for analysis ranged from 1.24 to 8.93 grams; only 0.5 grams was used for analysis, thus reducing the likelihood aluminum or lead fragments were analyzed. However, to avoid use of potentially contaminated values, aluminum, antimony, lead, and tin have been flagged with an X and have not been used in any data analysis.

Table F-1: Aqua regia results of aluminum and leads fragments.

Parameter	Units	Aluminum					Lead	
		Sample 1	Sample 2	Sample 3	Average	Contamination	Sample 1	Contamination
Aluminum	mg/kg	850000	810000	850000	836667	**446**	160	2.49
Antimony	mg/kg	<15	<15	<15	NA	NA	14000	**217**
Arsenic	mg/kg	<1	<1	<1	NA	NA	560	8.70
Barium	mg/kg	1.1	0.78	0.86	0.9133	0.0005	0.87	0.014
Beryllium	mg/kg	0.044	0.037	0.039	0.04	0.00002	<0.01	NA
Boron	mg/kg	16	13	14	14.3	0.008	<5	NA
Cadmium	mg/kg	<10	<10	<10	NA	NA	7.9	0.123
Calcium	mg/kg	<100	<100	<100	NA	NA	<100	NA
Chromium	mg/kg	680	650	680	670	0.357	<2	NA
Cobalt	mg/kg	1.1	0.96	1	1.02	0.0005	<0.5	NA
Copper	mg/kg	2100	1600	2100	1933	1.03	110	1.71
Iron	mg/kg	2300	2100	2200	2200	1.17	76	1.18
Lead	mg/kg	<10	<10	<10	NA	NA	41000	**637**
Magnesium	mg/kg	9400	8900	9400	9233	4.92	20	0.311
Manganese	mg/kg	260	220	230	237	0.126	0.8	0.012
Molybdenum	mg/kg	2.8	2.7	2.9	2.8	0.001	<0.5	NA
Nickel	mg/kg	49	41	49	46.3	0.025	<1	NA
Phosphorus	mg/kg	<150	<150	<150	NA	NA	21	0.326
Potassium	mg/kg	<20	<20	<20	NA	NA	<20	NA
Selenium	mg/kg	<10	<10	<10	NA	NA	1.1	0.017
Silver	mg/kg	<0.25	<0.25	<0.25	NA	NA	19	0.295
Sodium	mg/kg	<75	<75	<75	NA	NA	<75	NA
Strontium	mg/kg	<1	<1	<1	NA	NA	<1	NA
Sulphur	mg/kg	36	25	30	30.3	0.016	<25	NA
Thallium	mg/kg	<1	<1	<1	NA	NA	2.7	0.042
Tin	mg/kg	<5	<5	3.6	3.6	0.002	3400	**52.81**
Titanium	mg/kg	120	110	120	117	0.062	<5	NA
Uranium	mg/kg	<5	<5	<5	NA	NA	<5	NA
Vanadium	mg/kg	110	110	110	110	0.059	<1	NA
Zinc	mg/kg	89	75	80	81.3	0.043	<5	NA
Parameter	**Units**	**Average**				**Ratio fragments to soil**		
Aluminum fragments	mg	0.00027				0.00053		
Lead fragments	mg	0.0005				0.001		

Notes: Bolded and underline values have been identified as potentially significantly effecting results.

Appendix G

Preparation of samples for the Scanning Electron Microscope

Samples can be analyzed on the scanning electron microscope (SEM) either as thin sections or pucks; this Appendix describes how to make pucks for SEM and eventually automated mineralogy (AM) analysis. Pucks were made by first selecting a small portion of soil material, approximately 1 gram. The sample was air-dried in a plastic dish and after approximately 24 hours, the sample was lightly ground in a mortar and pestle (Figure H-1). The sample was lightly ground because the goal was not to pulverize mineral grains but rather break apart clusters of mineral grains. Next, the sample was combined with graphite in a 2:3 ratio, respectively. This mixture was added to 4 mL of epoxy and 1 mL of hardener. After thoroughly mixing the sample, it was placed in a sealed chamber and excess oxygen was removed from the sample (Figure H-2). The sample was then left to sit for 24 hours; after this time the sample was removed from the holder and labelled. The pucks made are 2.5 cm diameter. The thickness depends on the accuracy of epoxy and hardener added.

The pucks were taken to Nicol Hall at Queen's University for polishing. The first step in polishing was using 200-grit sandpaper on a spinning wheel with running water. Next, the puck is polished on sandpaper of 220, 320, 400, and 600 grit (Figure H-3). The puck is then polished on a spinning disk with Buehler Ltd. polishing cloth, using 6-micron lubricant Aveda pure abundance™ style prep™ and diamond lubricant comprised of 50% glycerin, 25% ethanol, and 25% water. The last step, also using the Buehler Ltd. polishing cloth, uses 1-micron lubricant and diamond lubricant (Figure H-4). After each step of polishing, the puck is wiped clean with a cotton ball and soap and dried with pressurized air.

After polishing, the last step prior analysis on the SEM is carbon coating the pucks. Carbon coating uses Denton Vacuum to apply a thin layer of carbon over the pucks. The machine heats graphite rods so that it is evenly applied over each sample. The carbon coating allows the electrons to be conducted to the ground from the beam; most grains are not conductive and thus the carbon coat is required. Sulphides, however, are conductive but still require carbon coating because the standards likely to be used will have been carbon coated. The approximate thickness of carbon coating used was 250 Ångström (Å).

An important tip is to wait approximately 1 week between polishing and carbon coating; despite drying the puck after the last step of polishing, some glycerin will remain. The extra time will allow the glycerin to evaporate prior to carbon coating. If this time is not allocated, the glycerin will still evaporate, leaving "holes" in the carbon coating. Polishing, SEM, and AM will all have to be redone.

Figure H-1: Lightly ground sample in preparation for SEM-AM analysis.

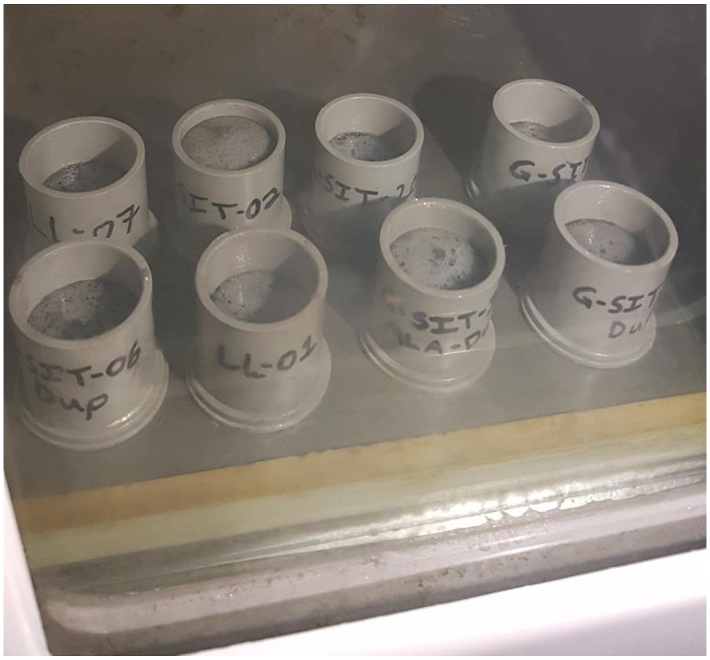


Figure H-2: Oxygen being removed from the samples causing bubbling.

Figure H-3: Polishing on grit 220, 320, 400, and 600 sandpapers.

Figure H-4: Final two steps of polishing; on the right, 6-micron diamond polish is done first and then, on the left, 1-micron diamond polish.

Appendix H

Bulk Geochemistry and

Total Carbon Results

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
CM-01	P	-	-	-	-	8500 X	200 X	190	660	0.58	<2.0	<0.60	4700	12	17	18	37000	6600	1400	1600
CM-02	LD	-	-	-	-	11000 X	8.2 X	230	220	0.77	<2.0	<0.60	5800	15	26	34	13000	64	1800	1000
CM-02	P	-	-	-	-	11000 X	7.3 X	210	210	0.76	<2.0	<0.60	5500	14	25	33	12000	54	1700	1000
CM-03	P	-	-	-	-	15000 X	8.6 X	90	55	0.19	<2.0	<0.60	2100	50	11	15	23000	250	6300	290
CM-03	SS	-	-	-	-	15000 X	4.7 X	51	41	0.17	<10	<0.60	1700	48	9.9	15	22000	120	6600	240
CM-04	P	-	-	-	-	32000 X	160 X	190	170	0.2	<2.0	2	11000	33	18	98	16000	5700	3500	2000
CM-05	P	43	0.121	42.9	-	6000 X	400 X	64	44	0.1	<2.0	<0.60	3300	5.5	2	20	2700	12000	690	110
CM-06	P	10.5	0.059	10.4	-	11000 X	41 X	370	140	0.18	<2.0	0.8	5000	22	12	46	13000	1200	1800	170
CM-07	P	-	-	-	-	12000 X	98 X	110	170	0.23	<2.0	<0.60	7900	26	6.6	27	13000	3200	3400	180
CM-08	P	26.4	0.155	26.3	-	14000 X	38 X	540	330	0.65	<2.0	1.7	7800	15	44	88	16000	980	1700	1100
CM-09	P	46.8	0.208	46.6	-	3500 X	73 X	95	83	0.012	3.8	<0.60	9600	4.4	1.5	15	1600	2500	990	460
CM-10	FD	-	-	-	-	16000 X	33 X	53	110	0.26	<2.0	0.67	3800	14	3.3	48	6400	1200	810	53
CM-10	P	-	-	-	-	6500 X	120 X	34	100	0.14	<2.0	<0.60	4200	4.1	2.2	13	4800	4300	500	39
CM-11	P	45.9	0.104	45.8	-	6300 X	120 X	340	160	0.2	<2.0	<0.60	6000	12	6.1	26	10000	3100	1800	140
CM-12	P	-	-	-	-	26000 X	13 X	140	410	0.97	9.5	1.3	21000	45	14	76	26000	270	6200	1400
CM-13	P	-	-	-	-	25000 X	3500 X	170	76	0.38	<2.0	3.9	8600	68	22	180	40000	59000	11000	650
CM-13	SS	-	-	-	-	25000 X	45 X	57	75	0.34	<10	1.8	9600	71	24	120	41000	1500	13000	870
CM-14	P	-	-	-	-	20000 X	16 X	210	140	0.35	<2.0	<0.60	3100	54	11	83	34000	350	4500	220
CM-15	P	16.5	0.126	16.4	-	18000 X	3.3 X	120	110	0.29	2.3	<0.60	7900	46	16	22	29000	28	9100	380
CM-15	SS	11.1	0.128	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CM-16	LD	-	-	-	-	23000 X	3.5 X	180	72	0.36	<2.0	<0.60	2800	80	21	26	33000	23	8900	260
CM-16	P	-	-	-	-	22000 X	4.3 X	180	73	0.36	<2.0	<0.60	2700	69	21	27	30000	43	7700	230
CM-17	FD	34.6	0.1	34.5	-	14000 X	89 X	450	180	0.3	<2.0	1.5	6300	17	18	73	21000	2300	2400	450
CM-17	P	-	-	-	-	15000 X	40 X	390	140	0.28	<2.0	1.2	5300	18	16	71	22000	720	2600	360
CM-18	P	-	-	-	-	9200 X	52 X	270	57	0.12	<2.0	0.63	5800	21	7.3	17	13000	1400	2700	260
CM-19	P	29.2	0.12	29.1	-	9500 X	21 X	180	150	0.21	13	0.7	7900	23	8.7	31	12000	40	4000	620
CM-20	LD	-	-	-	-	8600 X	23 X	83	58	0.014	14	0.62	12000	8.6	2.6	33	4000	180	1200	99
CM-20	P	44.9	0.317	44.6	-	7600 X	18 X	73	55	0.013	14	<0.60	12000	7.6	2.4	29	3500	46	1100	100
CM-21	P	39.8	1.26	38.5	-	4500 X	35 X	180	79	0.04	15	1.4	36000	7.3	6.3	41	6100	860	3500	1100
CM-22	P	-	-	-	-	11000 X	45 X	590	230	0.18	11	1.6	27000	16	20	83	17000	130	3600	2000
CM-23	P	25.5	0.094	25.4	-	13000 X	25 X	330	110	0.21	<10	<0.60	4300	44	8.5	41	19000	270	5000	170
CM-24	P	11.2	0.049	11.1	-	18000 X	23 X	710	74	0.15	18	<0.60	8500	44	22	65	39000	160	6600	410
CM-25	LD	-	-	-	-	21000 X	14 X	580	140	0.48	<10	1.3	7000	18	45	130	41000	330	4200	2200
CM-25	P	9.83	0.074	9.76	-	22000 X	180 X	570	140	0.51	<10	1.1	6200	18	46	140	42000	5700	4300	2100
CM-25	SS	-	-	-	-	23000 X	28 X	560	140	0.48	<10	1.3	6700	19	44	120	41000	780	4500	2200
CM-26	P	-	-	-	-	30000 X	110 X	430	250	0.88	10	<0.60	8900	56	39	51	26000	3800	5800	1800
Grace-01	LD	-	-	-	-	5000 X	8.4 X	85	120	0.21	<15	<0.60	3400	7.8	4.4	6.7	5500	56	1300	120
Grace-01	P	-	-	-	-	4500 X	11 X	81	150	0.23	<15	<0.60	4200	5.2	4.6	8	3900	13	940	130
Grace-02	P	-	-	-	-	15000 X	<5.0 X	16	130	0.59	11	<0.60	4000	31	9.7	11	19000	750	6300	530
Grace-03	P	-	-	-	-	10000 X	6.2 X	85	100	0.3	<5.0	<0.60	1800	25	7.5	9.9	15000	15	4000	180
Grace-03	SS	-	-	-	-	11000 X	6.4 X	90	110	0.31	<5.0	<0.60	1800	27	6.7	12	12000	8.7	3600	150
Grace-04	P	-	-	-	-	13000 X	<5.0 X	91	140	0.3	11	<0.60	8700	28	8.7	12	16000	33	5200	340
Grace-05	P	-	-	-	-	15000 X	8.6 X	440	150	0.82	5.2	<0.60	3400	17	7.1	27	16000	36	2000	150

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Grace-06	FD	-	-	-	-	5000 X	5 X	47	79	0.067	6.9	<0.60	5800	4.4	4.2	15	1700	200	920	950
Grace-06	P	-	-	-	-	8200 X	<5.0 X	83	130	0.26	11	<0.60	7400	13	8.2	10	8300	8.1	2500	1200
G-SIT-01	P	44.3	0.275	44	-	2500 X	14 X	42	27	<4.0	<75	<1.0	11000	<20	5	15	2300	120	1500	67
G-SIT-02	P	24.8	0.053	24.7	-	9000 X	33 X	560	92	<4.0	<20	<1.0	2300	22	5	91	25000	77	1400	130
G-SIT-03	P	44.4	0.086	44.3	-	3700 X	62 X	390	120	<4.0	<20	<1.0	6300	<20	<5.0	19	6800	260	1600	110
G-SIT-04	LD	24.3	0.075	24.2	-	12000 X	19 X	300	97	<4	<75	<1	2900	32	7.7	23	17000	38	3400	210
G-SIT-04	P	-	-	-	-	12000 X	20 X	260	93	<4	<75	<1	3300	31	7.3	22	17000	78	4000	210
G-SIT-05	P	-	-	-	-	4500 X	89 X	440	65	<4.0	<75	<1.0	7400	<20	<5.0	24	5500	1300	1600	360
G-SIT-06	P	41.7	0.104	41.6	-	5800 X	68 X	350	97	<4.0	<75	<1.0	8000	<20	7.3	30	8600	170	2000	620
G-SIT-07	P	44.9	0.05	44.9	-	4200 X	33 X	160	93	<4.0	<20	<1.0	3900	<20	6.1	32	8700	50	1200	65
G-SIT-08	LD	-	-	-	-	13000 X	13 X	350	84	<4	<20	1	3600	41	15	210	22000	29	2400	340
G-SIT-08	P	-	-	-	-	11000 X	11 X	330	59	<4	<20	<1	5000	44	19	150	24000	22	3700	500
G-SIT-08	SS	-	-	-	-	12000 X	11 X	390	86	0.25	<10	1.3	4200	46	21	210	24000	43	2700	480
G-SIT-09	P	-	-	-	-	10000 X	72 X	360	140	<4.0	<75	<1.0	2900	<20	5.6	77	11000	71	1700	95
G-SIT-10	FD	-	-	-	-	6100 X	2900 X	130	54	<4.0	<20	1.8	4200	<20	<5.0	47	6000	47000	710	140
G-SIT-10	P	13.6	0.071	13.6	-	20000 X	20 X	560	81	<4.0	<20	<1.0	5000	50	13	340	34000	160	4500	270
G-SIT-11	P	-	-	-	-	9600 X	47 X	150	130	<4.0	<20	<1.0	4200	<20	5.3	57	8600	190	1400	71
G-SIT-12	P	39.5	0.106	39.4	-	8200 X	11 X	37	63	<4.0	<20	<1.0	4800	<20	<5.0	32	5400	79	1800	130
G-SIT-13	P	-	-	-	-	16000 X	28 X	220	52	<4.0	<75	<1.0	3200	20	5.4	69	18000	230	3500	150
G-SIT-13	SS	-	-	-	-	14000 X	31 X	220	48	0.17	<10	<0.60	3200	18	5.3	60	18000	620	3700	150
G-SIT-14	P	31.8	0.073	31.7	-	11000 X	79 X	600	200	<4.0	<20	<1.0	4600	<20	15	71	23000	180	2400	130
G-SIT-15	P	30.5	0.164	30.4	-	5900 X	61 X	550	84	<4.0	<75	<1.0	8400	<20	5.8	18	8800	42	2500	760
G-SIT-16	P	41.7	0.069	41.7	-	8500 X	43 X	140	100	<4.0	<75	<1.0	2600	<20	<5.0	31	5100	56	820	47
G-SIT-17	P	42.4	0.1	42.3	-	5600 X	44 X	120	160	<4.0	<75	<1.0	7500	<20	12	28	8000	410	1900	490
G-SIT-18	P	8.64	0.057	8.58	-	36000 X	11 X	110	180	<4.0	<75	<1.0	3300	77	55	510	37000	29	2300	620
G-SIT-18	SS	7.99	0.062	7.93	-	34000 X	6.4 X	110	170	1.8	<10	<0.60	3400	74	54	490	37000	26	2500	630
G-SIT-19	P	-	-	-	-	1600 X	25 X	100	37	<4.0	<75	<1.0	4700	<20	<5.0	19	2600	540	860	180
G-SIT-20	FD	41.1	0.1	41	-	7000 X	41 X	160	87	<4.0	<75	<1.0	4200	<20	5.4	35	5300	210	920	56
G-SIT-20	P	45.3	0.09	45.2	-	8000 X	97 X	390	85	<4.0	<20	<1.0	5400	<20	5.8	34	9300	2400	1600	150
G-SIT-21	P	-	-	-	-	9100 X	23 X	240	82	<4.0	<75	<1.0	3700	27	6.1	54	17000	110	2100	190
G-SIT-22	LD	-	-	-	-	3100 X	50 X	380	58	<4	<75	<1	4000	<20	<5	25	5900	230	1100	130
G-SIT-22	P	-	-	-	-	4500 X	60 X	380	82	<4	<75	<1	5600	<20	5.7	36	8600	82	1700	190
G-SIT-23	P	46.7	0.072	46.6	-	3700 X	68 X	200	50	<4.0	<20	<1.0	3700	<20	<5.0	30	5200	70	1000	110
G-SIT-24	P	9.35	0.062	9.29	-	34000 X	14 X	360	62	<4.0	<75	<1.0	2100	56	5.8	220	13000	23	1100	58
G-SIT-25	P	-	-	-	-	5100 X	130 X	400	75	<4.0	<75	<1.0	3500	<20	<5.0	30	9200	91	1400	110
G-SIT-26	P	22	0.098	21.9	-	10000 X	40 X	990	100	<4.0	<20	<1.0	2100	33	<5.0	75	16000	420	910	76
G-SIT-26	SS	21.7	0.095	21.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G-SIT-27	P	25.7	0.148	25.5	-	15000 X	89 X	3000	130	<4.0	<75	<1.0	5600	55	360	200	64000	1400	2000	5100
G-SIT-28	P	-	-	-	-	5300 X	32 X	140	75	<4.0	<75	<1.0	4600	<20	10	41	7800	36	1800	350
G-SIT-29	P	39.8	0.141	39.6	-	6000 X	140 X	320	100	<4.0	<75	<1.0	5400	<20	25	51	7100	4100	1700	860
G-SIT-30	P	41.6	0.281	41.3	-	4900 X	15 X	71	160	<4.0	<75	1.2	9500	<20	10	44	4400	130	1900	2300
G-SIT-31	FD	45.9	0.174	45.7	-	6800 X	60 X	130	91	<4.0	<75	<1.0	8100	<20	<5.0	32	2900	1600	1800	840
G-SIT-31	P	-	-	-	-	3200 X	38 X	170	71	<4.0	<20	<1.0	6200	<20	<5.0	23	5900	550	2000	330
G-SIT-32	P	-	-	-	-	13000 X	44 X	130	68	<4.0	<75	<1.0	4400	<20	6.8	54	16000	810	2600	170
G-SIT-33	P	-	-	-	-	11000 X	14 X	260	96	<4.0	<75	<1.0	4800	27	12	42	21000	46	3600	330
G-SIT-35	LD	33.7	0.094	33.6	-	14000 X	59 X	210	110	<4	<20	<1	3000	<20	5.1	180	15000	1100	1500	110
G-SIT-35	P	-	-	-	-	13000 X	39 X	230	120	<4	<20	<1	2800	<20	<5	200	13000	400	1000	92

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
G-SIT-36	P	23.9	0.073	23.8	-	22000 X	50 X	1100	110	<4.0	<20	<1.0	4500	22	48	250	47000	100	5100	590
G-SIT-36	SS	-	-	-	-	22000 X	51 X	1200	120	0.68	<10	<0.60	4000	22	54	300	50000	100	4200	610
G-SIT-37	P	12.6	0.042	12.5	-	12000 X	18 X	390	73	<4.0	<75	<1.0	5800	<20	16	24	28000	210	5700	440
G-SIT-38	P	44	0.178	43.8	-	10000 X	96 X	210	83	<4.0	<75	1.4	8600	<20	<5.0	48	5200	140	1700	280
G-SIT-39	P	39.1	0.254	38.8	-	4900 X	43 X	110	62	<4.0	<20	<1.0	17000	<20	11	34	9100	220	2100	160
G-SIT-40	P	-	-	-	-	8300 X	25 X	220	59	<4.0	<75	<1.0	3600	20	8	76	16000	360	2000	300
G-SIT-41	P	40.6	0.115	40.5	-	3100 X	35 X	240	100	<4.0	<75	<1.0	3800	<20	6.1	35	4600	40	960	270
G-SIT-42	P	43.6	0.124	43.5	-	5900 X	13 X	81	72	<4.0	<20	<1.0	8200	<20	5	26	6300	150	1800	770
G-SIT-43	P	37.9	0.113	37.8	-	11000 X	83 X	420	230	<4.0	<20	1.7	8100	<20	12	47	11000	1200	2700	3600
G-SIT-43	SS	36.3	0.113	36.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G-SIT-44	P	12.6	0.057	12.6	-	9200 X	29 X	400	120	<4.0	<20	1.2	3500	30	20	69	19000	360	1800	1400
G-SIT-45	LD	-	-	-	-	13000 X	18 X	530	280	<4	<75	2	4900	37	31	120	23000	52	3000	4900
G-SIT-45	P	15.9	0.095	15.8	-	12000 X	18 X	510	280	<4	<75	2	5000	34	31	120	22000	42	2400	5000
G-SIT-46	FD	21.7	0.103	21.6	-	7600 X	61 X	310	230	<4.0	<75	<1.0	4700	<20	12	27	10000	1200	2000	1100
G-SIT-46	P	43.4	0.167	43.3	-	1400 X	35 X	37	57	<4.0	<75	<1.0	6000	<20	<5.0	11	2000	1100	780	330
G-SIT-47	P	11.6	0.057	11.5	-	25000 X	15 X	1100	110	<4.0	<75	<1.0	1400	31	6.7	210	32000	23	3100	97
G-SIT-47	SS	-	-	-	-	26000 X	19 X	1300	100	0.4	<10	<0.60	1600	29	7.9	190	38000	64	3400	98
G-SIT-48	P	-	-	-	-	7200 X	81 X	250	91	<4.0	<75	<1.0	3000	<20	7	81	12000	470	2500	120
G-SIT-49	P	-	-	-	-	8000 X	120 X	200	67	<4.0	<75	<1.0	2700	<20	6	100	5900	2900	1000	60
G-SIT-50	P	-	-	-	-	8600 X	190 X	81	40	<4.0	<75	<1.0	2300	<20	<5.0	160	3400	5700	700	51
G-SIT-51	P	38.7	0.098	38.6	-	4000 X	44 X	220	45	<4.0	<75	<1.0	4100	<20	<5.0	30	5500	1000	800	32
G-SIT-52	FD	-	-	-	-	4500 X	580 X	66	55	<4.0	<20	<1.0	10000	<20	8.8	30	5200	20000	1500	340
G-SIT-52	P	45	0.171	44.8	-	2700 X	10 X	32	43	<4.0	<75	<1.0	7000	<20	7.6	25	3600	130	1200	330
G-SIT-53	P	33.2	0.142	33.1	-	9200 X	33 X	450	80	<4.0	<20	1	7900	<20	16	63	14000	90	2100	410
G-SIT-54	P	-	-	-	-	9400 X	260 X	150	91	<4.0	<20	<1.0	2900	<20	6	47	6700	7100	980	79
G-SIT-55	P	-	-	-	-	2400 X	63 X	250	38	<4.0	<75	1.2	5500	<20	<5.0	36	5500	1300	1000	72
G-WGM-01	P	-	-	-	-	12000 X	320 X	1300	87	0.17	<10	<0.60	2600	12	4.5	44	10000	500	1500	93
G-WGM-02	P	-	-	-	-	8900 X	97 X	1300	62	0.19	<10	<0.60	790	8.3	2.6	20	11000	140	1200	51
G-WGM-03	FD	28.9	0.076	28.8	-	9900 X	240 X	2200	150	0.26	<10	<0.60	3900	25	8.4	35	16000	110	2800	230
G-WGM-03	P	-	-	-	-	14000 X	97 X	1900	120	0.35	<10	<0.60	1400	39	11	19	26000	1500	5300	200
G-WGM-04	LD	-	-	-	-	12000 X	100 X	1000	62	0.14	<10	<0.60	2100	38	8.1	18	22000	250	5000	170
G-WGM-04	P	-	-	-	-	11000 X	100 X	1000	56	0.14	<10	<0.60	1500	35	7.4	15	20000	520	4400	140
G-WGM-05	P	-	-	-	-	13000 X	180 X	1800	97	0.32	<10	<0.60	1900	37	8.2	24	23000	390	4800	180
G-WGM-06	P	-	-	-	-	3100 X	880 X	280	31	0.031	<10	<0.60	1600	4.4	1.3	19	2400	11000	420	69
G-WGM-07	P	27.2	0.073	27.1	-	12000 X	550 X	2100	170	0.68	<10	<0.60	2200	34	8	70	18000	12000	3000	200
G-WGM-08	LD	-	-	-	-	6900 X	120 X	920	100	0.19	<10	<0.60	3000	17	5.8	17	10000	1600	1800	180
G-WGM-08	P	-	-	-	-	6300 X	390 X	990	110	0.2	<10	<0.60	3100	17	5.5	22	9700	10000	1800	190
G-WGM-08	SS	-	-	-	-	9300 X	350 X	970	100	0.2	<10	<0.60	2900	19	6.6	27	11000	10000	1800	190
G-WGM-09	P	-	-	-	-	12000 X	65 X	540	160	0.55	<10	<0.60	4300	25	12	31	16000	150	3300	150
G-WGM-10	P	-	-	-	-	10000 X	110 X	270	99	0.2	<10	<0.60	1400	21	6	14	13000	2300	3500	110
G-WGM-11	P	-	-	-	-	9500 X	130 X	680	100	0.15	<10	<0.60	1100	22	3.1	25	8100	3100	1500	69
G-WGM-12	FD	-	-	-	-	5000 X	910 X	1700	130	0.077	<10	0.66	4700	7.7	5.5	34	6400	26000	1200	150
G-WGM-12	P	-	-	-	-	6900 X	200 X	990	70	0.084	<10	<0.60	2800	23	5.3	12	14000	3700	3400	210
G-WGM-12	SS	-	-	-	-	5900 X	86 X	740	76	0.069	<10	<0.60	3100	19	5.2	10	11000	560	2500	220
G-WGM-13	P	-	-	-	-	6700 X	190 X	300	71	0.12	<10	<0.60	1800	8.3	2.3	20	6300	1900	1000	64
G-WGM-14	P	21.3	0.061	21.2	-	13000 X	1100 X	2100	110	0.55	<10	<0.60	2000	11	5.7	45	8800	27000	1300	83
G-WGM-15	P	45.4	0.071	45.3	-	7800 X	700 X	670	220	0.3	<10	<0.60	3600	11	5.1	37	6500	22000	1500	120

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
G-WGM-16	P	-	-	-	-	3200 X	1900 X	150	47	0.06	<10	1.3	5700	5.1	4	35	2600	50000	1000	220
G-WGM-17	P	-	-	-	-	7200 X	210 X	1600	100	0.11	<10	<0.60	7000	13	5.7	37	8600	2000	2100	340
G-WGM-18	P	40.3	0.087	40.2	-	9100 X	540 X	3600	160	0.45	<10	<0.60	4000	15	9.2	56	14000	7000	1600	200
G-WGM-19	LD	-	-	-	-	7500 X	510 X	630	170	0.4	<10	<0.60	4000	11	8.1	31	9500	10000	1800	120
G-WGM-19	P	-	-	-	-	6800 X	520 X	580	180	0.41	<10	<0.60	4100	11	8	28	9100	11000	1800	120
G-WGM-20	P	-	-	-	-	20000 X	3500 X	2000	180	0.79	<10	2	2200	34	9.6	69	25000	48000	3000	110
G-WGM-20	SS	-	-	-	-	20000 X	1300 X	1900	200	0.87	<10	1	2200	33	9.5	48	25000	42000	3100	120
G-WGM-21	FD	39.2	0.059	39.2	-	9300 X	190 X	1900	73	0.33	<10	<0.60	2000	9.9	6.1	20	12000	2300	1200	92
G-WGM-21	P	36.7	0.077	36.6	-	27000 X	610 X	4700	120	0.84	10	<0.60	2000	27	11	67	29000	18000	1800	110
G-WGM-22	LD	-	-	-	-	18000 X	1000 X	1000	320	0.91	<10	1.1	2400	35	14	57	28000	32000	4900	210
G-WGM-22	P	-	-	-	-	15000 X	230 X	1100	350	1.1	<10	0.68	2200	24	11	54	23000	5500	2600	120
G-WGM-23	P	28	0.071	28	-	17000 X	2000 X	1800	180	0.46	<10	1.2	2700	35	14	47	33000	51000	3500	270
G-WGM-24	P	-	-	-	-	16000 X	270 X	1300	110	0.41	<10	<0.60	1700	40	16	16	26000	7800	5500	210
G-WGM-25	P	-	-	-	-	18000 X	59 X	500	68	0.43	<10	<0.60	700	51	11	19	28000	1500	6800	180
G-WGM-26	P	-	-	-	-	16000 X	45 X	1000	130	0.42	<10	<0.60	3000	51	15	19	22000	67	6000	490
G-WGM-27	P	-	-	-	-	20000 X	53 X	1200	110	0.47	<10	<0.60	1400	55	16	25	27000	110	6200	550
G-WGM-28	P	4.76	0.035	4.72	-	15000 X	16 X	580	64	0.34	<10	<0.60	1400	42	9.6	22	19000	90	5100	220
G-WGM-28	SS	2.78	0.04	2.74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G-WGM-29	P	-	-	-	-	12000 X	97 X	640	220	0.27	<10	<0.60	4100	34	10	34	18000	210	4400	520
G-WGM-30	P	21.4	0.063	21.4	-	12000 X	130 X	1200	190	0.43	<10	<0.60	3400	30	15	38	19000	990	3800	510
G-WGM-31	FD	15.4	0.143	15.3	-	15000 X	100 X	690	160	0.37	<10	<0.60	4600	49	14	25	25000	1600	6600	720
G-WGM-31	P	15	0.102	14.9	-	13000 X	37 X	540	69	0.25	<10	<0.60	3300	38	9.7	21	21000	750	5100	300
G-WGM-31	SS	14.4	0.11	14.3	-	15000 X	1600 X	690	160	0.34	<10	0.98	5200	45	14	36	24000	53000	5800	650
G-WGM-32	P	-	-	-	-	13000 X	120 X	1200	140	0.24	<10	<0.60	2300	35	18	15	26000	2700	4900	1400
G-WGM-33	P	27.3	0.085	27.2	-	9500 X	950 X	670	88	0.21	<10	1.1	2800	10	3.7	42	12000	26000	1600	130
G-WGM-34	LD	-	-	-	-	19000 X	53 X	1200	58	0.42	<10	<0.60	1100	58	10	19	34000	720	7700	230
G-WGM-34	P	-	-	-	-	19000 X	39 X	1200	57	0.42	<10	<0.60	1100	59	10	20	34000	300	7400	220
G-WGM-35	P	-	-	-	-	11000 X	220 X	970	210	0.32	<10	<0.60	2000	9.3	4.7	23	16000	4600	1500	170
G-WGM-36	P	-	-	-	-	17000 X	37 X	790	200	0.97	<10	<0.60	1200	47	8.1	71	20000	280	2400	71
G-WGM-37	P	-	-	-	-	3600 X	38 X	99	200	0.18	<10	<0.60	1600	3.4	1.6	3.4	4000	440	550	170
G-WGM-38	P	34.7	0.06	34.6	-	9300 X	1800 X	2200	150	0.32	<10	1.6	1900	12	5.1	52	11000	48000	1400	87
G-WGM-39	P	-	-	-	-	12000 X	190 X	1200	360	0.49	<10	<0.60	8300	25	9.1	29	21000	2300	2600	230
G-WGM-40	P	-	-	-	-	19000 X	14 X	140	65	0.45	<10	<0.60	960	52	11	32	26000	100	7500	160
G-WGM-40	SS	-	-	-	-	18000 X	29 X	250	88	0.45	<10	<0.60	1500	47	11	31	24000	280	6400	160
G-WGM-41	FD	11	0.052	10.9	-	14000 X	61 X	1100	70	0.3	<10	<0.60	1100	37	7.5	11	24000	47	4400	130
G-WGM-41	P	6.91	0.035	6.87	-	15000 X	43 X	1200	63	0.26	<10	<0.60	1100	35	7.2	11	22000	43	3900	140
G-WGM-42	P	-	-	-	-	12000 X	7.9 X	250	81	0.34	<10	<0.60	3300	39	12	28	20000	36	6000	380
G-WGM-43	P	9.32	0.049	9.27	-	8200 X	83 X	1000	51	0.15	<10	<0.60	670	7.6	1.4	14	10000	110	730	41
G-WGM-44	LD	-	-	-	-	20000 X	96 X	1800	61	0.41	<10	<0.60	1200	41	7.8	26	26000	100	6400	210
G-WGM-44	P	11.9	0.049	11.8	-	20000 X	100 X	1900	62	0.41	<10	<0.60	1200	38	7.2	25	24000	130	5300	190
G-WGM-45	P	-	-	-	-	5500 X	30 X	380	26	0.072	<10	<0.60	610	5.9	1.6	9	8800	44	980	51
G-WGM-46	P	-	-	-	-	5100 X	120 X	560	140	0.079	11	<0.60	8500	13	4.4	26	8600	760	2500	470
G-WGM-47	P	23.8	0.081	23.8	-	13000 X	200 X	1500	120	0.27	<10	<0.60	2200	34	7.2	22	22000	2800	4100	220
G-WGM-48	P	-	-	-	-	11000 X	130 X	520	160	0.3	<10	<0.60	1600	31	6.1	20	18000	1500	4000	140
G-WGM-49	LD	-	-	-	-	6600 X	180 X	740	100	0.16	<10	<0.60	850	8.1	3.1	32	10000	1800	1100	56
G-WGM-49	P	-	-	-	-	11000 X	270 X	1300	160	0.27	<10	0.65	1600	13	5.3	54	16000	1100	1800	94
G-WGM-50	P	-	-	-	-	8600 X	330 X	910	160	0.18	<10	<0.60	3600	16	5.9	33	12000	740	2000	110

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
G-WGM-51	FD	10.9	0.056	10.8	-	21000 X	79 X	1700	160	0.59	<10	<0.60	1300	52	13	22	30000	70	7000	210
G-WGM-51	P	-	-	-	-	23000 X	31 X	710	67	0.54	<10	<0.60	1300	59	12	16	35000	62	8600	190
G-WGM-52	P	-	-	-	-	14000 X	91 X	1000	110	0.23	<10	<0.60	3600	33	10	20	19000	1000	5200	460
G-WGM-53	P	37	0.063	36.9	-	9100 X	110 X	360	78	0.077	<10	<0.60	3800	21	4.8	25	12000	340	3000	230
IL-01	P	-	-	-	-	14000 X	3.6 X	120	180	0.54	<10	<0.60	1500	47	8.5	12	17000	34	3000	130
IL-02	P	22	0.069	22	-	15000 X	160 X	48	89	0.54	<10	<0.60	590	26	2.5	14	8600	6100	1900	46
IL-02	SS	13	0.062	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IL-03	P	45.4	0.06	45.3	-	7700 X	10 X	68	87	0.36	<10	<0.60	2400	6.1	2.8	14	3700	200	760	83
IL-04	LD	-	-	-	-	10000 X	110 X	46	140	0.34	<10	0.68	2200	24	3.4	15	11000	4100	2800	130
IL-04	P	-	-	-	-	10000 X	55 X	41	140	0.31	<10	0.62	2200	25	3.4	14	11000	2100	2800	130
IL-05	P	-	-	-	-	11000 X	10 X	100	170	0.54	<10	<0.60	1900	39	3.5	18	14000	220	2800	120
IL-06	P	-	-	-	-	5200 X	3.7 X	48	140	0.32	<10	<0.60	4000	2.6	2.1	13	2300	43	530	130
IL-07	P	-	-	-	-	6200 X	11 X	39	27	0.31	<10	<0.60	880	3.8	0.66	64	4200	49000	290	20
IL-08	P	37.9	0.059	37.8	-	6200 X	11 X	45	44	0.23	<10	<0.60	1000	4	0.61	7.9	2600	300	390	33
IL-09	P	28.4	0.036	28.4	-	3000 X	3.7 X	27	39	0.089	<10	<0.60	1200	3.3	<0.50	4.4	2800	13	260	55
IL-10	FD	21.5	0.04	21.4	-	5700 X	90 X	25	63	0.12	<10	<0.60	1400	21	4	4	11000	3300	3000	150
IL-10	P	-	-	-	-	5900 X	1 X	10	55	0.12	<10	<0.60	1400	18	3.6	3.9	9800	25	2700	250
IL-11	P	6.03	0.059	5.97	-	23000 X	98 X	13	120	0.84	<10	<0.60	870	29	5.3	11	26000	3400	2600	90
IL-11	SS	-	-	-	-	25000 X	11 X	12	130	0.96	<10	<0.60	800	31	5.8	11	29000	210	2800	91
IL-12	P	-	-	-	-	6200 X	4.9 X	36	190	0.62	<10	<0.60	3400	18	3.2	23	7500	79	850	110
IL-13	P	43.5	0.05	43.4	-	3400 X	3.7 X	56	77	0.15	<10	<0.60	1700	2.7	0.73	6.6	2200	15	320	25
LL-01	P	11.6	0.041	11.6	-	8600 X	17 X	380	56	<4.0	<20	<1.0	1100	<20	<5.0	15	15000	43	3000	110
LL-02	P	-	-	-	-	10000 X	20 X	230	130	<4.0	<20	<1.0	870	<20	<5.0	18	8200	71	380	22
LL-03	P	-	-	-	-	15000 X	5.9 X	110	150	<4.0	<20	<1.0	980	<20	<5.0	22	20000	20	1400	130
LL-04	P	7.41	0.042	7.37	-	14000 X	9.1 X	450	57	<4.0	<20	<1.0	1100	<20	<5.0	22	22000	18	1800	77
LL-05	LD	-	-	-	-	17000 X	10 X	160	99	<4	<20	<1	2300	35	9.6	72	28000	31	4500	160
LL-05	P	-	-	-	-	20000 X	11 X	190	110	<4	<20	<1	3200	43	12	83	32000	35	5500	190
LL-05	SS	-	-	-	-	19000 X	14 X	190	120	0.36	<10	<0.60	3200	45	13	85	31000	38	5800	210
LL-06	P	38.4	0.137	38.2	-	16000 X	32 X	290	160	<4.0	<20	<1.0	5000	37	16	20	25000	49	5400	260
LL-07	P	43	0.085	43	-	4200 X	49 X	320	62	<4.0	<20	<1.0	5800	<20	<5.0	21	5700	31	1800	290
LL-08	P	34.1	0.213	33.9	-	6000 X	26 X	200	70	<4.0	<20	<1.0	11000	22	<5.0	18	11000	55	3900	220
TX-01	P	-	-	-	0.012	7300 X	2.7 X	37	81	0.12	20	1.9	5900	7.5	9.1	32	4700	30	700	97
TX-02	P	-	-	-	<0.01	21000 X	3 X	200	100	1.2	12	<0.60	20000	33	37	61	24000	13	3400	810
TX-03	P	-	-	-	0.016	5400 X	4 X	46	200	0.12	<10	1.1	7600	5.3	9.3	19	5900	16	810	1700
TX-04	P	-	-	-	0.023	9900 X	5.1 X	55	180	0.37	<10	0.98	4800	9.5	1.9	33	4100	27	760	82
TX-05	LD	-	-	-	<0.01	2600 X	<1.0 X	8.3	34	0.022	<10	<0.60	3700	2.4	1	15	490	<5.0	1000	140
TX-05	P	-	-	-	<0.01	2700 X	<1.0 X	8	34	0.023	<10	<0.60	3800	2.8	1	16	490	<5.0	1100	150
TX-06	P	-	-	-	0.023	12000 X	11 X	120	130	0.26	<10	<0.60	8100	14	4.7	32	2900	5.6	1200	21
TX-07	P	-	-	-	0.026	12000 X	8.6 X	140	270	0.43	<10	<0.60	6500	19	22	89	26000	8.7	4300	230
TX-08	P	-	-	-	<0.01	11000 X	29 X	21	74	0.18	<10	<0.60	2500	14	5.4	98	3000	1100	470	41
TX-08	SS	-	-	-	0.13	12000 X	2.5 X	48	65	0.18	<10	<0.60	2200	16	5.5	100	3400	43	580	46
TX-09	P	-	-	-	0.016	26000 X	17 X	100	91	0.31	<10	0.84	14000	56	28	83	45000	310	12000	1600
TX-10	FD	18.5	0.465	18	0.017	19000 X	4.3 X	170	88	0.3	11	0.85	19000	73	23	85	53000	15	9900	3500
TX-10	P	16.7	0.37	16.4	<0.01	21000 X	12 X	170	50	0.26	<10	<0.60	11000	76	21	53	56000	130	11000	1600
TX-11	P	29.2	0.808	28.4	0.023	26000 X	22 X	310	180	0.26	13	0.8	35000	92	29	140	59000	250	7300	7000
TX-11	SS	25.9	0.709	25.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-12	P	-	-	-	<0.01	21000 X	2.6 X	83	100	0.44	<10	<0.60	3500	65	19	23	27000	22	10000	460

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
TX-12	SS	-	-	-	0.015	16000 X	2.3 X	71	110	0.29	<10	<0.60	5900	47	14	17	22000	14	8500	460
TX-13	P	24.2	0.14	24	<0.01	11000 X	100 X	40	130	0.18	<10	<0.60	11000	11	6.3	40	9800	3400	3400	230
TX-13	SS	30.1	0.115	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-14	P	49.2	0.188	49	<0.01	1600 X	1.5 X	10	29	0.027	<10	<0.60	3900	1.6	<0.50	6.1	300	46	390	99
TX-15	P	-	-	-	0.02	17000 X	2.8 X	68	120	0.48	<10	<0.60	5200	32	7.8	27	19000	53	4500	200
TX-16	LD	-	-	-	0.027	8100 X	10 X	49	100	0.077	32	0.91	80000	18	6.6	130	6600	260	4000	540
TX-16	P	35.2	2.33	32.8	0.021	5700 X	3.7 X	41	93	0.066	31	0.83	73000	13	4	91	3300	67	2200	430
TX-17	P	-	-	-	0.054	5800 X	56 X	57	140	0.11	<10	0.72	12000	5.2	3.8	22	2800	1700	930	86
TX-18	P	-	-	-	0.05	30000 X	37 X	160	300	0.1	19	1.8	23000	36	15	80	22000	1100	10000	1400
TX-19	P	47.8	0.394	47.4	0.019	3500 X	410 X	58	300	0.057	11	0.6	16000	4.2	4.8	28	1300	13000	1500	1100
TX-20	FD	37.4	0.818	36.6	0.02	21000 X	150 X	1200	130	0.43	12	1.8	30000	32	18	79	38000	5500	14000	1800
TX-20	P	19.7	0.504	19.2	0.011	25000 X	10 X	650	270	0.81	12	1.8	23000	31	33	130	31000	160	8700	1900
TX-21	LD	-	-	-	<0.01	23000 X	1.5 X	32	73	0.42	11	<0.60	4700	52	18	34	38000	31	14000	370
TX-21	P	-	-	-	<0.01	23000 X	1.1 X	33	72	0.43	12	<0.60	4400	54	17	34	37000	24	13000	350
TX-22	P	45.2	0.73	44.5	0.027	10000 X	2.2 X	98	120	0.24	11	3.6	25000	15	16	130	9700	27	2700	2300
TX-22	SS	44.8	0.683	44.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-23	LD	-	-	-	0.011	35000 X	55 X	94	360	0.88	<10	1.5	6400	45	17	120	27000	1900	5400	1000
TX-23	P	-	-	-	<0.01	33000 X	3.2 X	86	340	0.87	<10	1.5	6500	41	17	120	26000	92	5000	970
TX-23	SS	-	-	-	0.01	34000 X	2.4 X	87	340	0.84	<10	1.4	6200	44	17	110	26000	67	5500	930
TX-24	P	-	-	-	0.031	8800 X	38 X	37	160	0.11	17	1.2	37000	13	6.1	48	6900	1300	4100	700
TX-25	P	-	-	-	0.023	4000 X	2.9 X	31	160	0.097	12	0.74	11000	3.7	13	35	1300	37	670	810
TX-26	P	-	-	-	<0.01	8000 X	11 X	52	62	0.14	15	0.69	37000	9.1	7.4	90	10000	300	3800	330
TX-27	P	42.7	0.627	42	0.015	3000 X	20 X	24	68	0.034	12	1.1	17000	3.1	1.3	17	1400	650	720	230
TX-28	P	-	-	-	0.028	4800 X	110 X	28	50	0.032	<10	0.79	3300	5.3	2.9	32	5200	4800	650	88
TX-29	P	24.8	0.094	24.7	0.026	9000 X	21 X	84	270	0.76	<10	<0.60	3700	18	11	9.7	31000	600	2000	410
TX-30	FD	-	-	-	0.016	9300 X	26 X	34	44	0.26	<10	1.5	2200	7.5	1.5	16	2800	1100	460	33
TX-30	P	-	-	-	<0.01	10000 X	28 X	24	51	0.33	<10	1.6	3300	7.9	1.7	17	2800	960	520	37
TX-30	SS	-	-	-	0.018	11000 X	12 X	40	47	0.29	<10	1.7	2500	9	1.8	18	3200	270	560	43
TX-31	P	-	-	-	0.021	9000 X	5.6 X	68	170	0.37	<10	2.4	14000	6.4	34	78	10000	69	1400	1000
TX-32	P	-	-	-	0.014	22000 X	13 X	160	430	0.46	<10	<0.60	11000	56	16	17	27000	240	9100	2200
TX-33	LD	-	-	-	0.019	3200 X	4.8 X	94	74	0.063	<10	<0.60	14000	4	8.5	12	3400	69	1700	1200
TX-33	P	-	-	-	0.027	4100 X	4.9 X	140	110	0.1	<10	<0.60	21000	5.2	13	16	5100	50	2500	1800
TX-34	P	-	-	-	<0.01	15000 X	27 X	100	470	0.33	<10	<0.60	19000	52	18	38	19000	820	8800	2200
TX-35	P	-	-	-	<0.01	6500 X	56 X	17	88	0.12	<10	<0.60	5300	12	5.6	34	5300	2600	2300	590
YK-01	P	32.6	0.204	32.4	-	3000 X	18 X	18	210	0.096	<10	0.95	9300	5.1	3.8	12	3700	610	1900	910
YK-02	FD	-	-	-	-	14000 X	2.4 X	65	90	0.39	<10	<0.60	2500	20	6.5	9.7	16000	22	3600	140
YK-02	P	-	-	-	-	17000 X	21 X	35	50	0.39	<10	<0.60	1900	29	8.4	12	23000	550	5300	190
YK-03	P	5.58	0.108	5.48	-	14000 X	2.6 X	57	92	0.41	<10	<0.60	3800	23	5.5	7	17000	12	3500	150
YK-03	SS	6.03	0.105	5.92	-	14000 X	3.3 X	57	98	0.41	13	<0.60	4900	22	5.2	7.6	16000	18	3200	150
YK-04	P	12.6	0.061	12.5	-	8300 X	7.1 X	90	120	0.28	<10	<0.60	2100	9.1	5	7	10000	58	2700	340
YK-05	P	-	-	-	-	25000 X	8 X	370	210	1.7	<50	<0.60	1300	27	7.7	62	26000	63	2800	78
YK-06	P	39.2	0.087	39.1	-	7100 X	6 X	110	150	0.19	<10	<0.60	880	3.9	0.82	10	2000	15	280	13
YK-07	P	20.2	0.143	20.1	-	11000 X	26 X	260	210	0.27	<10	0.66	11000	23	17	49	23000	60	5100	1100
YK-08	LD	-	-	-	-	14000 X	5.5 X	240	50	0.18	<10	<0.60	2000	34	8.5	23	23000	16	5800	150
YK-08	P	-	-	-	-	16000 X	5.9 X	260	55	0.19	<10	<0.60	1900	37	8.8	23	24000	31	5800	160
YK-09	P	8.35	0.087	8.27	-	12000 X	12 X	160	74	0.27	<10	<0.60	3900	31	9.5	21	16000	140	4300	310
YK-10	P	-	-	-	-	12000 X	3 X	150	89	0.19	<10	<0.60	5400	43	10	13	20000	40	5500	540

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
YK-11	P	13.7	0.054	13.6	-	23000 X	16 X	240	120	0.63	<10	<0.60	2000	52	12	33	29000	17	8100	260
YK-12	FD	-	-	-	-	12000 X	100 X	660	61	0.21	<10	<0.60	660	7.5	1.8	18	13000	120	600	30
YK-12	P	34.7	0.051	34.7	-	6600 X	140 X	220	69	0.062	<10	<0.60	1500	6.9	2.5	22	8300	400	840	49
YK-13	P	-	-	-	-	7200 X	160 X	670	55	0.086	<10	<0.60	6500	16	8.6	50	12000	310	2200	280
YK-14	P	-	-	-	-	5400 X	40 X	100	23	0.019	<10	<0.60	3900	8	3	29	4100	50	1200	120
YK-15	P	21.4	0.073	21.3	-	12000 X	640 X	470	110	0.31	<10	<0.60	3800	27	10	23	13000	21000	3300	170
YK-16	LD	-	-	-	-	6400 X	39 X	490	110	0.093	10	<0.60	6500	11	3.4	22	5100	410	1700	290
YK-16	P	-	-	-	-	3700 X	29 X	320	75	0.061	<10	<0.60	4300	6.9	2.3	14	3400	490	1200	200
YK-17	P	42.4	0.135	42.2	-	9700 X	190 X	410	160	0.43	12	<0.60	8500	11	6.8	29	8100	5800	2200	170
YK-18	P	-	-	-	-	4000 X	27 X	180	49	0.15	<10	<0.60	980	10	1.9	7.6	6000	160	1200	59
YK-19	P	-	-	-	-	13000 X	19 X	500	96	0.41	<10	<0.60	1600	46	7	14	18000	21	4400	220
YK-20	FD	31.1	0.064	31	-	7700 X	67 X	800	150	1	<10	<0.60	2600	12	4.8	28	7500	64	1100	140
YK-20	LD	-	-	-	-	5400 X	93 X	600	110	0.33	<10	<0.60	3600	5.7	3.3	17	4500	240	930	110
YK-20	P	-	-	-	-	6400 X	120 X	760	130	0.41	<10	<0.60	4400	6.6	4	21	5500	390	1100	130
YK-21	P	45	0.13	44.9	-	7800 X	57 X	430	71	0.15	<10	<0.60	5500	8.7	3.8	33	3800	590	1300	230
YK-22	P	-	-	-	-	3200 X	180 X	470	130	0.036	<10	0.67	13000	7	4.1	18	6300	2800	2000	240
YK-23	P	-	-	-	-	19000 X	31 X	1600	230	1.1	<10	<0.60	8200	72	31	94	24000	18	6400	1100
YK-23	SS	-	-	-	-	20000 X	44 X	1600	220	1	<10	<0.60	8000	66	31	87	24000	390	5700	1100
YK-24	P	16	0.16	15.8	-	28000 X	13 X	180	170	0.52	<10	2.3	11000	110	38	320	32000	52	5400	3000
YK-25	P	-	-	-	-	17000 X	48 X	1100	140	0.33	<10	<0.60	6000	31	13	53	25000	140	3000	420
YK-26	P	-	-	-	-	49000 X	18 X	22	360	1.6	15	<0.60	2600	68	16	29	41000	440	9200	310
YK-26	SS	-	-	-	-	44000 X	1.4 X	15	320	1.5	11	<0.60	2500	65	16	30	39000	5000	8400	310
YK-27	P	-	-	-	-	32000 X	25 X	7.7	250	1	29	<0.60	28000	49	13	41	29000	770	22000	330
YK-28	P	-	-	-	-	7200 X	37 X	23	130	0.13	<10	<0.60	9600	8.8	1.5	19	2100	1400	1200	720
YK-29	P	-	-	-	-	8800 X	73 X	38	110	0.24	<10	<0.60	8000	15	5.9	11	9700	2700	4200	930
YK-30	FD	-	-	-	-	25000 X	4.1 X	19	110	0.66	<10	<0.60	1500	39	8.5	10	23000	130	5300	160
YK-30	P	-	-	-	-	24000 X	16 X	49	160	0.66	<10	<0.60	1700	37	8.7	8.6	22000	390	4700	190
YK-31	P	-	-	-	-	4400 X	15 X	60	93	0.091	<10	0.67	5500	6.2	1.4	14	2500	310	2100	100
YK-32	P	-	-	-	-	7100 X	1700 X	95	65	0.16	<10	1.1	4500	10	2.7	24	7100	46000	2600	130
YK-33	FD	-	-	-	-	17000 X	2.2 X	55	110	0.76	<10	<0.60	1700	30	8.5	15	23000	19	4600	130
YK-33	P	20	0.096	19.9	-	9700 X	530 X	58	150	0.47	<10	<0.60	3000	15	5	18	12000	18000	3400	110
YK-34	LD	-	-	-	-	15000 X	25 X	100	130	0.41	<10	<0.60	1800	8.5	3	26	10000	32	780	39
YK-34	P	-	-	-	-	14000 X	100 X	100	120	0.36	<10	<0.60	1800	8.5	2.7	26	9500	3000	780	39
YK-35	P	-	-	-	-	8100 X	6.7 X	66	20	0.18	<10	<0.60	870	25	3.8	5.2	12000	140	3100	93
YK-36	P	-	-	-	-	10000 X	1000 X	53	150	0.5	<10	0.78	2400	18	6.3	32	9200	34000	1600	110
YK-37	LD	-	-	-	-	15000 X	12 X	11	66	0.52	<10	<0.60	2200	48	11	18	21000	250	6200	280
YK-37	P	1.41	0.06	1.35	-	15000 X	1100 X	55	64	0.52	<10	0.65	1900	46	11	26	20000	39000	5900	270
YK-37	SS	-	-	-	-	16000 X	14 X	12	65	0.58	<10	<0.60	1700	51	12	15	22000	350	6100	280
YK-38	P	-	-	-	-	2700 X	820 X	39	260	0.049	<10	0.84	7600	3.8	2.4	19	870	24000	1300	520
YK-39	P	19.6	0.048	19.6	-	13000 X	1500 X	63	160	0.33	<10	0.93	1300	55	7.9	50	16000	45000	4000	82
YK-40	FD	-	-	-	-	14000 X	25 X	43	230	0.38	<10	<0.60	4700	45	14	16	20000	790	6300	800
YK-40	P	-	-	-	-	8600 X	11 X	47	200	0.2	<50	<0.60	7300	27	6.7	13	12000	330	4000	490
YK-41	P	-	-	-	-	12000 X	1400 X	120	250	0.29	<50	1.2	2900	32	9	57	12000	41000	2600	130
YK-42	LD	-	-	-	-	19000 X	1 X	30	210	0.78	<50	<0.60	2900	50	28	22	25000	11	7100	800
YK-42	P	-	-	-	-	20000 X	1.2 X	30	200	0.74	<50	<0.60	3000	53	28	22	25000	17	7500	790
YK-42	SS	-	-	-	-	17000 X	1.3 X	32	230	0.74	<10	0.69	3100	50	28	20	23000	9.5	6500	860
YK-43	P	-	-	-	-	22000 X	20 X	160	350	1.1	<10	<0.60	3900	34	12	110	20000	500	1400	120

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
YK-44	P	-	-	-	-	2600 X	680 X	57	170	0.06	<10	1.1	6900	6.6	2.4	19	2500	22000	1500	730
YK-45	P	-	-	-	-	5400 X	23 X	130	110	0.18	<15	<0.60	16000	10	5.1	24	7700	21	4000	360
YK-45	SS	-	-	-	-	10000 X	21 X	160	150	0.33	11	0.82	23000	16	6.7	46	9600	80	6100	490
YK-46	P	-	-	-	-	860 X	11 X	34	52	0.054	<15	<0.60	18000	1.9	1.2	12	1400	25	2900	200
YK-47	P	-	-	-	-	1300 X	47 X	51	33	<0.010	<15	<0.60	5800	1.8	0.87	5.5	740	1300	690	980
YK-48	P	-	-	-	-	680 X	10 X	25	33	0.011	<15	<0.60	13000	1.3	0.8	4.4	730	200	2500	200
YK-49	LD	-	-	-	-	1700 X	2 X	6.5	30	<0.010	<15	0.87	8200	2	0.67	7.5	510	24	1400	1100
YK-49	P	-	-	-	-	690 X	1.9 X	6.6	35	<0.010	<15	0.78	9800	1.3	0.8	5.3	580	21	1800	1300
YK-50	FD	-	-	-	-	680 X	23 X	66	51	0.017	<15	<0.60	9100	1.2	1.9	5.4	650	45	1400	500
YK-50	P	-	-	-	-	1900 X	10 X	43	72	<0.010	<15	<0.60	15000	2.9	1.1	10	1400	18	2400	660
YK-51	P	-	-	-	-	5000 X	29 X	460	150	0.2	<15	<0.60	22000	10	6.7	19	8500	190	2900	1700
YK-52	P	-	-	-	-	4000 X	74 X	1300	140	0.12	<15	<0.60	8400	8.3	4.6	16	6300	46	1400	390
YK-53	P	-	-	-	-	1400 X	79 X	750	83	0.017	<15	<0.60	4100	3	1.9	8	2500	360	740	100
YK-54	P	-	-	-	-	1700 X	4.1 X	10	45	0.16	<15	0.67	1100	1.3	1.5	7	390	92	410	41
YK-55	P	-	-	-	-	2500 X	4.2 X	24	22	<0.010	<15	0.75	4000	2.2	<0.50	7.6	350	33	690	270
YK-56	P	-	-	-	-	4600 X	10 X	42	33	0.096	<15	<0.60	950	2.7	0.86	15	3500	210	330	32
YK-57	P	-	-	-	-	3000 X	2 X	6.4	130	0.039	<15	0.73	16000	3.8	2.4	9.9	1800	50	2000	750
YK-58	P	-	-	-	-	2500 X	94 X	26	32	0.039	<15	<0.60	1300	1.4	0.62	5.6	1300	3300	280	40
YK-59	P	-	-	-	-	3800 X	9.3 X	13	74	0.03	<15	<0.60	5500	2.4	1.4	12	550	360	1400	650
YK-60	P	-	-	-	-	1600 X	<1.0 X	3.5	9.5	0.052	<15	<0.60	1500	3.7	0.92	<2.0	3600	5.4	1200	79
YK-61	FD	-	-	-	-	2800 X	<1.0 X	1	47	0.06	<15	<0.60	6900	1.5	0.99	8.1	560	13	890	110
YK-61	LD	-	-	-	-	2700 X	<5.0 X	1.7	81	0.093	6	<0.60	11000	1.7	2	8.7	870	57	1500	280
YK-61	P	-	-	-	-	1900 X	<1.0 X	1.6	61	0.078	<15	<0.60	8800	1.2	1.6	5.6	760	16	1000	200
YK-61	SS	-	-	-	-	4900 X	<5.0 X	2	87	0.11	5.8	<0.60	12000	3.6	2	14	980	5.8	1600	270
YK-62	LD	-	-	-	-	4600 X	<1.0 X	4.3	53	0.066	<15	<0.60	4700	2.9	2	12	2500	<5.0	750	58
YK-62	P	-	-	-	-	4200 X	<1.0 X	5.6	54	0.075	<15	<0.60	5000	2.6	2.3	12	2500	6.4	820	40
YK-63	P	-	-	-	-	4000 X	2.3 X	40	310	0.14	<15	0.9	19000	4.3	8.5	14	6400	19	3000	2200
YK-64	P	-	-	-	-	4700 X	<1.0 X	8.3	73	0.18	17	<0.60	15000	11	7	16	9700	<5.0	4000	360
YK-65	P	-	-	-	-	2700 X	<1.0 X	4	33	0.051	<15	<0.60	1500	1.6	<0.50	5.7	800	<5.0	230	67
YK-66	P	-	-	-	-	580 X	<1.0 X	12	6.6	<0.010	<15	<0.60	900	<1.0	<0.50	3	260	5.8	450	22
YK-67	P	-	-	-	-	2000 X	<1.0 X	2.1	120	0.12	<15	<0.60	6000	1.9	3.6	7.1	1300	<5.0	820	300
YK-68	P	-	-	-	-	1200 X	<1.0 X	6.2	28	<0.010	<15	<0.60	2900	<1.0	<0.50	6.3	190	<5.0	560	180
YK-69	P	-	-	-	-	1900 X	<1.0 X	8.9	140	0.13	<15	<0.60	3600	1.3	2.6	6.4	1100	<5.0	560	320
YK-70	FD	-	-	-	-	11000 X	1.3 X	16	87	0.44	<15	<0.60	3000	27	11	9.9	18000	8.5	4900	380
YK-70	P	-	-	-	-	13000 X	<1.0 X	16	98	0.52	<15	<0.60	3600	30	11	12	20000	140	5300	480
YK-71	LD	-	-	-	-	980 X	5.2 X	65	61	0.026	<15	<0.60	6800	2	2.3	8.7	1100	15	820	610
YK-71	P	-	-	-	-	1800 X	7.6 X	90	79	0.036	<15	<0.60	8800	2.7	2.9	11	1400	13	940	800
YK-72	P	-	-	-	-	2100 X	5.6 X	41	52	0.025	<15	0.74	4600	2.9	0.96	8.6	1000	100	770	250
YK-73	P	-	-	-	-	8500 X	1.3 X	130	320	0.38	22	<0.60	16000	17	22	25	21000	9.3	5700	7600
YK-73	SS	-	-	-	-	8200 X	<5.0 X	180	300	0.38	24	<0.60	16000	16	21	22	23000	8.5	6100	6400
YK-74	P	-	-	-	-	6900 X	21 X	230	99	0.28	<15	1.1	7600	17	11	45	16000	19	3100	610
YK-74	SS	-	-	-	-	10000 X	28 X	290	140	0.39	13	1	7900	24	13	54	19000	100	4400	660
YK-75	P	-	-	-	-	4700 X	57 X	370	85	0.048	<15	1.3	20000	8.1	8.2	35	8900	410	3900	520
YK-76	P	-	-	-	-	2800 X	25 X	250	120	0.03	<15	<0.60	13000	4.8	3.6	17	4800	35	2500	880
YK-77	P	-	-	-	-	6100 X	5.5 X	160	170	0.17	<15	<0.60	4500	14	6.8	20	6200	10	1500	760
YK-78	P	-	-	-	-	1200 X	1.5 X	11	90	0.014	<15	<0.60	5100	1.4	1	5.2	380	8.9	920	140
YK-79	FD	-	-	-	-	1300 X	<1.0 X	5.9	48	<0.010	<15	<0.60	6300	1.9	0.69	6.3	510	5.5	1300	490

Sample ID	QAQC	Total Carbon	Inorganic Carbon	Organic Carbon	Gold	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
		% dry	% dry	% dry	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
YK-79	P	-	-	-	-	3900 X	<1.0 X	12	51	0.023	<15	<0.60	4500	4.9	1.1	11	1100	5.2	800	230
YR-01	P	46.2	0.426	45.8	-	4200 X	24 X	10	180	0.021	<50	0.96	16000	4.4	1.2	15	910	990	2900	700
YR-02	P	27.9	0.113	27.7	-	6500 X	10 X	46	180	0.27	<50	<0.60	4800	15	14	45	7600	210	2200	240
YR-03	FD	-	-	-	-	16000 X	41 X	82	91	0.5	<10	0.62	1500	61	5.4	89	19000	1200	3300	120
YR-03	P	-	-	-	-	3500 X	15 X	16	49	0.039	<10	0.86	7700	3.3	1.5	12	830	590	1100	320
YR-04	P	9.42	0.068	9.35	-	11000 X	110 X	43	57	0.24	<50	<0.60	1400	36	7	21	20000	3600	5700	160
YR-04	SS	9.48	0.066	9.41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
YR-05	LD	-	-	-	-	4400 X	74 X	97	270	0.19	<10	<0.60	9400	8.5	14	27	3800	2500	1600	1900
YR-05	P	-	-	-	-	3700 X	9.7 X	73	200	0.15	<10	<0.60	7400	7.2	11	22	3200	150	1400	1500
YR-06	P	-	-	-	-	16000 X	4.4 X	120	99	0.24	<10	<0.60	3600	57	11	9.5	25000	99	9500	650
YR-06	SS	-	-	-	-	14000 X	110 X	130	140	0.23	<10	<0.60	4700	53	12	12	22000	4000	7200	1100
YR-07	LD	-	-	-	-	8800 X	1.5 X	48	43	0.25	<10	<0.60	1200	21	7.2	9.1	12000	8.6	3100	120
YR-07	LD	-	-	-	-	8200 X	1.4 X	45	38	0.23	<50	<0.60	1200	17	5.9	8.7	11000	20	2800	110
YR-07	P	-	-	-	-	8800 X	1.6 X	47	41	0.24	<50	<0.60	1200	18	6.4	9.7	11000	15	3000	110
YR-07	SS	-	-	-	-	9600 X	1.7 X	47	43	0.24	<10	<0.60	1200	23	6.9	10	13000	13	3300	130
YR-08	P	-	-	-	-	4000 X	15 X	60	150	0.042	<10	0.67	9400	5.5	4.9	14	2500	130	2000	720

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
CM-01	P	<0.50	29	440	1300	<1.0	0.3	150	26	380	<1.0	49 X	110	<5.0	17	67
CM-02	LD	<0.50	17	670	710	<1.0	<0.25	140	31	610	<1.0	<2.0 X	310	<5.0	19	97
CM-02	P	<0.50	16	640	690	<1.0	<0.25	140	30	580	<1.0	<2.0 X	270	<5.0	17	93
CM-03	P	<0.50	24	260	540	<1.0	<0.25	140	11	190	<1.0	2 X	670	<5.0	44	46
CM-03	SS	<0.50	22	180	550	<1.0	<0.25	140	8.8	120	<1.0	<2.0 X	630	<5.0	43	42
CM-04	P	<0.50	22	620	660	<1.0	0.35	110	20	770	<1.0	44 X	280	<5.0	23	140
CM-05	P	<0.50	7.5	760	390	<1.0	0.66	81	9.9	790	<1.0	120 X	30	<5.0	4.5	34
CM-06	P	<0.50	32	550	370	<1.0	0.47	140	17	710	<1.0	9.3 X	460	<5.0	24	57
CM-07	P	0.55	17	500	580	<1.0	<0.25	180	28	1000	<1.0	25 X	420	<5.0	26	44
CM-08	P	<0.50	50	900	440	<1.0	<0.25	180	27	750	<1.0	7.4 X	340	<5.0	31	190
CM-09	P	<0.50	3	780	1000	<1.0	<0.25	<75	19	1300	<1.0	19 X	30	<5.0	2.8	99
CM-10	FD	<0.50	21	3100	500	<1.0	<0.25	120	14	2500	<1.0	8.6 X	62	<5.0	13	29
CM-10	P	<0.50	11	2800	610	<1.0	0.26	82	18	2500	<1.0	34 X	39	<5.0	4.5	30
CM-11	P	<0.50	18	750	340	<1.0	0.29	110	20	1400	<1.0	24 X	240	<5.0	14	45
CM-12	P	0.77	35	640	1400	<1.0	<0.25	230	42	940	<1.0	3.3 X	570	<5.0	49	180
CM-13	P	<0.50	41	510	380	<1.0	4.4	160	12	300	<1.0	1000 X	1200	<5.0	86	270
CM-13	SS	<0.50	44	540	540	<1.0	<0.25	210	15	320	<1.0	12 X	1400	<5.0	94	240
CM-14	P	<0.50	27	730	390	<1.0	<0.25	150	9.9	560	<1.0	3.1 X	900	<5.0	76	110
CM-15	P	<0.50	29	310	800	<1.0	<0.25	180	31	300	<1.0	<2.0 X	1100	<5.0	68	92
CM-15	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CM-16	LD	<0.50	50	320	540	<1.0	<0.25	160	9.6	350	<1.0	<2.0 X	1100	<5.0	71	160
CM-16	P	<0.50	48	340	550	<1.0	<0.25	150	9.5	380	<1.0	<2.0 X	980	<5.0	64	160
CM-17	FD	<0.50	24	1200	390	<1.0	0.51	120	21	1600	<1.0	18 X	200	<5.0	31	150
CM-17	P	<0.50	23	1300	440	<1.0	0.41	110	19	1500	<1.0	5 X	210	<5.0	32	130

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
CM-18	P	<0.50	11	610	550	<1.0	0.36	110	14	820	<1.0	11 X	280	<5.0	21	40
CM-19	P	<0.50	17	760	690	<1.0	0.35	150	30	1000	<1.0	<2.0 X	220	<5.0	22	190
CM-20	LD	<0.50	5.1	540	520	<1.0	0.34	<75	33	1500	<1.0	<2.0 X	26	<5.0	4.3	110
CM-20	P	<0.50	4.6	490	490	<1.0	0.29	<75	31	1300	<1.0	<2.0 X	24	<5.0	3.8	100
CM-21	P	<0.50	11	810	610	<1.0	0.37	<75	21	1500	<1.0	6 X	36	<5.0	12	110
CM-22	P	0.85	26	940	490	1.2	0.72	130	34	1700	<1.0	<2.0 X	200	<5.0	37	250
CM-23	P	0.65	16	630	520	<1.0	<0.25	190	14	760	<1.0	2.9 X	230	<5.0	47	97
CM-24	P	0.92	28	490	740	<1.0	0.28	520	29	400	<1.0	<2.0 X	2000	<5.0	110	87
CM-25	LD	<0.50	33	870	530	<1.0	0.58	190	19	530	<1.0	2.6 X	780	<5.0	67	330
CM-25	P	<0.50	33	820	460	<1.0	0.73	170	15	510	<1.0	46 X	680	<5.0	66	290
CM-25	SS	<0.50	33	840	530	<1.0	0.58	190	18	520	<1.0	7 X	730	<5.0	67	320
CM-26	P	0.72	33	530	890	<1.0	<0.25	220	28	590	<1.0	29 X	620	<5.0	55	79
Grace-01	LD	<0.50	7.6	350	370	<1.0	<0.25	100	24	520	<1.0	<2.0 X	140	<5.0	11	37
Grace-01	P	<0.50	7.6	360	340	<1.0	<0.25	89	31	540	<1.0	<2.0 X	91	<5.0	7.3	39
Grace-02	P	<0.50	16	500	2500	<1.0	<0.25	220	41	240	<1.0	<2.0 X	870	<5.0	37	60
Grace-03	P	<0.50	14	280	430	<1.0	<0.25	140	12	250	<1.0	<2.0 X	610	<5.0	26	33
Grace-03	SS	<0.50	13	290	440	<1.0	<0.25	140	12	280	<1.0	<2.0 X	580	<5.0	24	29
Grace-04	P	<0.50	16	280	1300	<1.0	<0.25	200	34	470	<1.0	<2.0 X	650	<5.0	31	43
Grace-05	P	<0.50	11	860	960	<1.0	<0.25	120	16	560	<1.0	<2.0 X	440	<5.0	24	67
Grace-06	FD	<0.50	3.7	660	1100	<1.0	<0.25	93	27	640	<1.0	<2.0 X	43	<5.0	3.4	60
Grace-06	P	<0.50	8.2	650	1600	<1.0	<0.25	140	36	700	<1.0	<2.0 X	240	<5.0	15	71
G-SIT-01	P	<2.0	8.3	630	900	<10	<2.0	200	32	1400	<1.0	<2.0 X	50	<10	<10	74
G-SIT-02	P	<2.0	19	2100	590	<10	<2.0	160	8	780	<1.0	<2.0 X	27	<10	32	67
G-SIT-03	P	<2.0	9.2	700	540	<10	<2.0	200	20	1400	<1.0	<2.0 X	150	<10	10	43
G-SIT-04	LD	<2	20	390	450	<10	<2	150	12	510	<1	<2 X	440	<10	36	100
G-SIT-04	P	<2	20	410	460	<10	<2	140	13	560	<1	<2 X	430	<10	32	98
G-SIT-05	P	<2.0	11	700	550	<10	<2.0	170	15	1500	<1.0	11 X	150	<10	11	110
G-SIT-06	P	<2.0	13	690	1100	<10	<2.0	220	23	1100	<1.0	<2.0 X	260	<10	12	120
G-SIT-07	P	<2.0	12	780	880	<10	<2.0	150	13	1300	<1.0	<2.0 X	100	<10	<10	39
G-SIT-08	LD	<2	27	840	790	<10	<2	250	8.8	670	<1	<2 X	1100	<10	64	59
G-SIT-08	P	<2	22	620	570	<10	<2	300	6.5	420	<1	<2 X	1900	<10	73	43
G-SIT-08	SS	1.8	29	750	780	<1.0	0.56	300	9.4	590	<1.0	<2.0 X	1300	<5.0	78	61
G-SIT-09	P	<2.0	18	1100	610	<10	<2.0	220	13	1000	<1.0	<2.0 X	130	<10	18	83
G-SIT-10	FD	<2.0	12	530	410	<10	3.4	140	9.8	860	<1.0	840 X	53	<10	<10	52
G-SIT-10	P	<2.0	26	750	650	<10	<2.0	250	12	680	<1.0	<2.0 X	1100	<10	57	130
G-SIT-11	P	<2.0	17	1800	660	<10	<2.0	170	300	3500	<1.0	3.2 X	130	<10	14	36
G-SIT-12	P	<2.0	7	650	1700	<10	<2.0	230	13	850	<1.0	<2.0 X	160	<10	10	59
G-SIT-13	P	<2.0	16	1100	540	<10	<2.0	390	5.9	820	<1.0	2.3 X	270	<10	66	37
G-SIT-13	SS	<0.50	15	930	670	<1.0	<0.25	430	6	690	<1.0	5.4 X	130	<5.0	63	37
G-SIT-14	P	<2.0	20	490	450	<10	<2.0	300	23	630	<1.0	<2.0 X	710	<10	31	63
G-SIT-15	P	<2.0	11	490	440	<10	<2.0	130	18	960	<1.0	<2.0 X	200	<10	16	240
G-SIT-16	P	<2.0	15	1700	400	<10	<2.0	140	12	2700	<1.0	<2.0 X	51	<10	<10	50
G-SIT-17	P	<2.0	16	640	650	<10	<2.0	220	28	1000	<1.0	3.6 X	220	<10	12	120
G-SIT-18	P	<2.0	73	1400	400	<10	<2.0	260	9.6	600	<1.0	<2.0 X	860	<10	79	520
G-SIT-18	SS	0.87	72	1200	460	<1.0	0.27	290	9.6	520	<1.0	<2.0 X	830	<5.0	77	480
G-SIT-19	P	<2.0	8	470	340	<10	<2.0	130	11	930	<1.0	4.2 X	83	<10	<10	66
G-SIT-20	FD	<2.0	17	2100	460	<10	<2.0	130	13	4000	<1.0	<2.0 X	23	<10	15	32

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
G-SIT-20	P	<2.0	15	1500	670	<10	<2.0	180	16	3700	<1.0	20 X	48	<10	14	70
G-SIT-21	P	<2.0	13	1000	880	<10	<2.0	190	12	970	<1.0	<2.0 X	490	<10	39	89
G-SIT-22	LD	<2	10	460	320	<10	<2	140	12	1000	<1	<2 X	150	<10	11	97
G-SIT-22	P	<2	14	640	450	<10	<2	190	17	1400	<1	<2 X	250	<10	16	130
G-SIT-23	P	<2.0	9.1	800	450	<10	<2.0	110	10	1300	<1.0	<2.0 X	110	<10	<10	60
G-SIT-24	P	<2.0	13	3400	230	<10	<2.0	190	6.4	610	<1.0	<2.0 X	1300	<10	60	78
G-SIT-25	P	<2.0	12	910	480	<10	<2.0	170	13	1500	<1.0	<2.0 X	75	<10	12	82
G-SIT-26	P	<2.0	12	1800	490	<10	<2.0	160	7.6	1100	<1.0	4 X	54	<10	33	35
G-SIT-26	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G-SIT-27	P	4.2	38	1400	580	<10	<2.0	190	16	1000	1.9	13 X	600	<10	220	320
G-SIT-28	P	<2.0	12	920	660	<10	<2.0	170	14	1200	<1.0	<2.0 X	59	<10	14	81
G-SIT-29	P	<2.0	14	540	420	<10	<2.0	190	16	740	<1.0	34 X	210	<10	13	87
G-SIT-30	P	<2.0	19	610	530	<10	<2.0	210	27	870	<1.0	<2.0 X	140	<10	<10	210
G-SIT-31	FD	<2.0	6.6	600	920	<10	<2.0	180	20	1100	<1.0	14 X	98	<10	<10	120
G-SIT-31	P	<2.0	8.4	810	1000	<10	<2.0	200	16	1400	<1.0	4.7 X	130	<10	<10	100
G-SIT-32	P	<2.0	12	510	570	<10	<2.0	360	10	700	<1.0	7 X	1100	<10	47	57
G-SIT-33	P	<2.0	19	500	610	<10	<2.0	330	11	500	<1.0	<2.0 X	1500	<10	56	100
G-SIT-35	LD	<2	21	3500	450	<10	<2	160	11	1100	<1	8.7 X	19	<10	15	120
G-SIT-35	P	<2	21	3700	430	<10	<2	140	11	1100	<1	2.7 X	15	<10	13	120
G-SIT-36	P	<2.0	29	1300	690	<10	<2.0	360	10	760	<1.0	<2.0 X	940	<10	62	240
G-SIT-36	SS	1.5	32	1400	630	<1.0	0.52	350	10	840	<1.0	<2.0 X	880	<5.0	65	270
G-SIT-37	P	<2.0	13	380	590	<10	<2.0	560	8.5	320	<1.0	2 X	2200	<10	85	290
G-SIT-38	P	<2.0	10	530	460	<10	<2.0	180	21	1100	<1.0	<2.0 X	110	<10	<10	220
G-SIT-39	P	<2.0	13	870	910	<10	<2.0	310	31	2300	<1.0	<2.0 X	120	<10	13	170
G-SIT-40	P	<2.0	11	750	660	<10	<2.0	230	7.9	730	<1.0	3.3 X	600	<10	32	72
G-SIT-41	P	<2.0	14	450	390	<10	<2.0	150	11	710	<1.0	<2.0 X	130	<10	<10	72
G-SIT-42	P	<2.0	9.3	700	650	<10	<2.0	230	16	1100	<1.0	<2.0 X	180	<10	11	110
G-SIT-43	P	<2.0	18	880	790	<10	<2.0	220	21	1100	<1.0	10 X	350	<10	21	350
G-SIT-43	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G-SIT-44	P	<2.0	19	740	470	<10	<2.0	150	9.4	470	<1.0	3.1 X	1300	<10	46	120
G-SIT-45	LD	<2	26	930	530	<10	<2	220	16	790	1.9	<2 X	560	<10	65	370
G-SIT-45	P	<2	25	970	560	<10	<2	230	16	800	1.8	<2 X	560	<10	62	370
G-SIT-46	FD	<2.0	14	520	600	<10	<2.0	200	21	720	<1.0	11 X	350	<10	24	140
G-SIT-46	P	<2.0	<5.0	340	370	<10	<2.0	130	14	580	<1.0	9.7 X	69	<10	<10	63
G-SIT-47	P	<2.0	13	1700	390	<10	<2.0	180	6.9	650	<1.0	<2.0 X	760	<10	130	41
G-SIT-47	SS	1.2	13	1800	370	<1.0	<0.25	170	6.9	680	<1.0	<2.0 X	650	<5.0	140	47
G-SIT-48	P	<2.0	18	590	600	<10	<2.0	300	11	1000	<1.0	4 X	230	<10	22	65
G-SIT-49	P	<2.0	18	1300	500	<10	<2.0	170	11	2100	<1.0	50 X	53	<10	15	52
G-SIT-50	P	<2.0	17	950	360	<10	<2.0	150	7.5	1600	<1.0	50 X	61	<10	14	66
G-SIT-51	P	<2.0	15	610	340	<10	<2.0	120	12	1600	<1.0	8.3 X	48	<10	<10	27
G-SIT-52	FD	<2.0	11	620	710	<10	<2.0	160	17	1200	<1.0	120 X	120	<10	<10	120
G-SIT-52	P	<2.0	9.8	610	630	<10	<2.0	150	14	1100	<1.0	<2.0 X	98	<10	<10	100
G-SIT-53	P	<2.0	22	790	1100	<10	<2.0	150	17	830	<1.0	<2.0 X	350	<10	21	210
G-SIT-54	P	<2.0	11	720	650	<10	<2.0	140	9.5	830	<1.0	66 X	100	<10	<10	64
G-SIT-55	P	<2.0	8.7	440	450	<10	<2.0	140	13	1100	<1.0	10 X	92	<10	<10	170
G-WGM-01	P	0.8	12	720	510	<1.0	4.6	130	8.9	1200	<1.0	3.7 X	120	<5.0	13	58
G-WGM-02	P	0.86	6.7	400	630	<1.0	0.39	<400	4.9	390	<1.0	<2.0 X	150	<5.0	19	37

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
G-WGM-03	FD	0.61	19	630	550	<1.0	0.74	140	14	970	<1.0	<2.0 X	230	<5.0	24	82
G-WGM-03	P	0.66	25	370	400	<1.0	<0.25	<400	8.9	420	<1.0	12 X	530	<5.0	54	78
G-WGM-04	LD	0.7	20	390	470	<1.0	0.4	<400	8.8	680	<1.0	2 X	400	<5.0	41	57
G-WGM-04	P	0.72	17	350	460	<1.0	0.36	<400	7.6	590	<1.0	4 X	360	<5.0	40	49
G-WGM-05	P	0.66	22	490	490	<1.0	0.46	<400	11	670	<1.0	3.2 X	460	<5.0	45	66
G-WGM-06	P	<0.50	3.8	250	250	<1.0	1.5	<400	5.8	570	<1.0	260 X	18	<5.0	3.8	27
G-WGM-07	P	0.56	28	1000	830	<1.0	1	<400	14	880	<1.0	100 X	140	<5.0	26	98
G-WGM-08	LD	<0.50	11	350	380	<1.0	0.28	130	14	490	<1.0	14 X	170	<5.0	16	39
G-WGM-08	P	<0.50	11	410	410	<1.0	0.65	<400	15	600	<1.0	88 X	180	<5.0	15	41
G-WGM-08	SS	<0.50	11	370	380	<1.0	0.64	130	14	500	<1.0	87 X	200	<5.0	18	41
G-WGM-09	P	0.62	24	390	450	<1.0	<0.25	150	24	520	<1.0	<2.0 X	380	<5.0	31	40
G-WGM-10	P	<0.50	15	270	360	<1.0	0.27	130	8.9	320	<1.0	17 X	180	<5.0	22	41
G-WGM-11	P	<0.50	9.7	370	300	<1.0	0.77	<400	9	430	<1.0	25 X	160	<5.0	14	24
G-WGM-12	FD	<0.50	11	500	400	<1.0	1.7	150	23	1000	<1.0	230 X	89	<5.0	9.3	79
G-WGM-12	P	<0.50	14	290	330	<1.0	0.33	<400	14	500	<1.0	30 X	320	<5.0	30	58
G-WGM-12	SS	<0.50	12	270	320	<1.0	<0.25	120	16	440	<1.0	4.7 X	280	<5.0	24	55
G-WGM-13	P	1.3	7.3	560	510	<1.0	0.41	<400	7.1	730	<1.0	17 X	83	<5.0	12	46
G-WGM-14	P	0.58	14	820	380	<1.0	1.9	140	10	1200	<1.0	260 X	130	<5.0	12	41
G-WGM-15	P	0.62	15	600	390	<1.0	1.3	150	20	1100	<1.0	200 X	100	<5.0	10	51
G-WGM-16	P	0.55	8.3	600	480	<1.0	2.8	<400	22	1200	<1.0	570 X	46	<5.0	5.1	62
G-WGM-17	P	0.64	14	680	530	<1.0	0.85	160	21	1500	<1.0	16 X	120	<5.0	13	100
G-WGM-18	P	1	26	1200	640	<1.0	1.5	180	19	1400	<1.0	55 X	60	<5.0	16	83
G-WGM-19	LD	1	17	1200	930	<1.0	0.89	250	23	1700	<1.0	84 X	53	<5.0	12	74
G-WGM-19	P	1	15	1200	930	<1.0	0.9	230	24	1700	<1.0	89 X	55	<5.0	12	63
G-WGM-20	P	1.4	24	1200	1600	<1.0	5.3	290	16	890	<1.0	990 X	65	<5.0	35	59
G-WGM-20	SS	1.3	24	1400	1600	<1.0	2.3	240	18	1000	<1.0	400 X	69	<5.0	34	60
G-WGM-21	FD	0.82	11	1300	640	<1.0	0.49	140	10	1300	<1.0	21 X	38	<5.0	10	49
G-WGM-21	P	1.7	24	2300	890	<1.0	1.1	160	13	1100	<1.0	160 X	93	11	25	63
G-WGM-22	LD	1.5	32	640	900	<1.0	1.8	180	20	730	<1.0	290 X	240	<5.0	46	70
G-WGM-22	P	1.6	27	720	890	<1.0	0.63	190	21	810	<1.0	44 X	150	<5.0	37	69
G-WGM-23	P	3.2	21	520	870	1.1	3.8	<400	18	780	<1.0	730 X	590	<5.0	70	97
G-WGM-24	P	1.2	22	370	700	1	0.39	<400	12	500	<1.0	64 X	570	<5.0	54	96
G-WGM-25	P	0.52	32	300	430	<1.0	<0.25	110	4.3	160	<1.0	12 X	530	<5.0	48	71
G-WGM-26	P	<0.50	31	320	590	<1.0	<0.25	140	14	300	<1.0	<2.0 X	740	<5.0	44	110
G-WGM-27	P	1.8	33	360	960	<1.0	<0.25	140	7.6	230	<1.0	<2.0 X	780	<5.0	54	150
G-WGM-28	P	0.56	24	210	460	<1.0	<0.25	150	7.8	130	<1.0	<2.0 X	600	<5.0	37	44
G-WGM-28	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G-WGM-29	P	<0.50	24	360	450	<1.0	<0.25	280	28	550	<1.0	<2.0 X	520	<5.0	45	96
G-WGM-30	P	0.62	24	460	650	<1.0	0.3	<400	17	600	<1.0	7.8 X	600	<5.0	50	100
G-WGM-31	FD	0.68	30	340	620	<1.0	<0.25	<400	23	430	<1.0	13 X	650	<5.0	48	120
G-WGM-31	P	0.65	22	240	500	<1.0	<0.25	120	14	320	<1.0	6.2 X	580	<5.0	40	66
G-WGM-31	SS	0.62	28	300	590	<1.0	2.4	160	26	370	<1.0	470 X	830	<5.0	50	120
G-WGM-32	P	0.98	24	290	530	<1.0	<0.25	150	15	370	<1.0	22 X	940	<5.0	53	140
G-WGM-33	P	1.2	11	1000	720	<1.0	2.1	110	9.6	1000	<1.0	260 X	61	8.1	14	69
G-WGM-34	LD	1.9	28	510	830	<1.0	<0.25	<400	8.5	230	<1.0	7.1 X	890	<5.0	70	71
G-WGM-34	P	1.9	29	500	790	<1.0	<0.25	<400	8.9	220	<1.0	3.5 X	890	<5.0	67	69
G-WGM-35	P	2.5	7.8	610	700	<1.0	0.76	120	9.9	730	<1.0	37 X	150	5.3	22	110

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
G-WGM-36	P	0.51	18	550	440	1.7	<0.25	<400	19	980	<1.0	2.4 X	270	14	37	40
G-WGM-37	P	<0.50	2.4	180	620	<1.0	<0.25	<400	5.4	160	<1.0	9.8 X	24	<5.0	4.8	22
G-WGM-38	P	0.69	15	610	600	<1.0	3.5	150	9	930	<1.0	500 X	57	<5.0	13	64
G-WGM-39	P	0.72	20	1000	830	<1.0	0.56	<400	40	1500	<1.0	21 X	110	5.2	23	180
G-WGM-40	P	<0.50	28	160	430	<1.0	<0.25	<400	7.4	190	<1.0	2.1 X	720	<5.0	52	37
G-WGM-40	SS	<0.50	28	250	460	<1.0	<0.25	160	12	270	<1.0	3.2 X	670	<5.0	48	34
G-WGM-41	FD	5.9	15	320	970	<1.0	<0.25	<400	6.4	190	<1.0	<2.0 X	890	<5.0	49	80
G-WGM-41	P	6.7	14	340	810	<1.0	<0.25	110	6.2	210	<1.0	<2.0 X	790	<5.0	40	80
G-WGM-42	P	<0.50	25	530	2000	<1.0	<0.25	280	13	240	<1.0	<2.0 X	660	<5.0	35	45
G-WGM-43	P	1	4.3	740	410	1.1	0.27	<400	4.1	390	<1.0	<2.0 X	91	9.9	13	21
G-WGM-44	LD	1.1	22	560	880	<1.0	0.36	<400	6.4	420	<1.0	<2.0 X	570	11	44	72
G-WGM-44	P	1	19	610	910	<1.0	0.32	<400	6.5	450	<1.0	<2.0 X	530	11	38	62
G-WGM-45	P	2.7	4.2	230	340	<1.0	<0.25	<400	3.9	170	<1.0	<2.0 X	100	<5.0	12	19
G-WGM-46	P	1.2	12	750	1800	<1.0	0.48	<400	20	1400	<1.0	6.1 X	160	<5.0	16	140
G-WGM-47	P	1.1	18	610	940	1	0.56	<400	8.2	710	<1.0	24 X	570	<5.0	41	98
G-WGM-48	P	1.3	18	400	520	<1.0	0.4	<400	11	500	<1.0	13 X	410	<5.0	38	54
G-WGM-49	LD	1.2	8.7	610	560	<1.0	0.7	94	6.3	730	<1.0	16 X	69	12	11	58
G-WGM-49	P	1.9	14	970	750	<1.0	1	130	11	1100	<1.0	8.2 X	170	21	18	92
G-WGM-50	P	2.3	15	660	690	<1.0	0.98	<400	14	1400	<1.0	5.3 X	160	<5.0	18	64
G-WGM-51	FD	0.62	30	440	570	<1.0	<0.25	130	8.3	340	<1.0	<2.0 X	630	<5.0	54	110
G-WGM-51	P	0.79	29	400	640	<1.0	<0.25	<400	7.5	210	<1.0	<2.0 X	940	<5.0	66	98
G-WGM-52	P	<0.50	23	250	590	<1.0	0.3	<400	13	420	<1.0	8.4 X	380	<5.0	29	100
G-WGM-53	P	0.7	13	500	630	<1.0	1.2	130	11	830	<1.0	2.6 X	250	<5.0	21	59
IL-01	P	0.53	17	350	630	<1.0	<0.25	100	12	300	<1.0	<2.0 X	820	<5.0	40	73
IL-02	P	0.72	11	840	600	<1.0	<0.25	88	11	860	<1.0	49 X	85	32	19	16
IL-02	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IL-03	P	<0.50	5.7	830	1300	<1.0	<0.25	96	20	960	<1.0	<2.0 X	70	<5.0	4.3	30
IL-04	LD	<0.50	12	400	520	<1.0	<0.25	140	18	500	<1.0	33 X	290	7.3	22	47
IL-04	P	<0.50	12	390	560	<1.0	<0.25	140	17	480	<1.0	18 X	310	7.2	22	48
IL-05	P	<0.50	12	700	500	<1.0	<0.25	170	17	980	<1.0	<2.0 X	57	7.7	18	35
IL-06	P	<0.50	6.4	760	440	<1.0	<0.25	<75	27	1300	<1.0	<2.0 X	26	10	2.8	34
IL-07	P	<0.50	2.3	1000	570	<1.0	0.39	83	6	920	<1.0	16 X	45	22	2.8	13
IL-08	P	0.58	1.6	870	570	<1.0	<0.25	86	8.8	1200	<1.0	2.5 X	65	39	3.6	12
IL-09	P	<0.50	1.2	330	430	<1.0	<0.25	100	6.8	430	<1.0	<2.0 X	88	9.2	4.3	20
IL-10	FD	<0.50	9	170	940	<1.0	<0.25	93	7.8	190	<1.0	28 X	290	<5.0	21	36
IL-10	P	<0.50	8	110	570	<1.0	<0.25	84	6.8	120	<1.0	<2.0 X	350	<5.0	21	35
IL-11	P	4.7	11	400	690	<1.0	<0.25	140	15	180	<1.0	28 X	740	53	47	42
IL-11	SS	5.1	13	450	540	<1.0	<0.25	130	14	210	<1.0	3.2 X	720	65	52	43
IL-12	P	<0.50	8.1	680	450	<1.0	<0.25	140	31	740	<1.0	<2.0 X	100	14	10	41
IL-13	P	<0.50	1.9	580	490	<1.0	<0.25	97	24	830	<1.0	<2.0 X	23	8.1	1.8	24
LL-01	P	<2.0	5.2	290	420	<10	<2.0	110	7	200	<1.0	<2.0 X	220	<10	19	80
LL-02	P	<2.0	8.1	2000	330	<10	<2.0	120	8	600	<1.0	<2.0 X	27	<10	<10	30
LL-03	P	<2.0	9.2	1400	460	<10	<2.0	99	6.3	230	<1.0	<2.0 X	470	11	24	48
LL-04	P	<2.0	5.8	700	550	<10	<2.0	100	6.8	200	<1.0	<2.0 X	790	<10	29	39
LL-05	LD	<2	24	460	570	<10	<2	180	7	130	<1	<2 X	810	<10	47	90
LL-05	P	<2	29	500	610	<10	<2	190	9.8	150	<1	<2 X	970	<10	57	100
LL-05	SS	0.88	31	530	580	<1.0	<0.25	230	8.4	150	<1.0	<2.0 X	980	<5.0	65	110

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
LL-06	P	<2.0	30	2100	410	<10	<2.0	130	24	670	<1.0	<2.0 X	170	<10	22	80
LL-07	P	<2.0	8.8	560	650	<10	<2.0	160	16	1200	<1.0	<2.0 X	130	<10	<10	81
LL-08	P	<2.0	11	1200	1100	<10	<2.0	660	41	1200	<1.0	<2.0 X	290	<10	15	57
TX-01	P	<0.50	36	2200	1300	<1.0	<0.25	<75	22	2700	<1.0	<2.0 X	30	<5.0	8.2	100
TX-02	P	1.8	44	630	860	1	<0.25	110	24	1100	<1.0	<2.0 X	250	<5.0	30	23
TX-03	P	0.61	9	900	660	1.5	<0.25	100	29	1000	2.1	<2.0 X	170	<5.0	8.6	200
TX-04	P	1.5	10	3500	960	<1.0	0.25	120	17	3600	<1.0	<2.0 X	25	56	6.1	140
TX-05	LD	1.9	2.9	670	2000	<1.0	<0.25	<75	12	600	<1.0	<2.0 X	5.1	<5.0	1.2	44
TX-05	P	2.1	3.1	690	2000	<1.0	<0.25	<75	13	600	<1.0	<2.0 X	5.5	<5.0	1.2	46
TX-06	P	0.81	9.4	680	620	<1.0	<0.25	150	45	1300	<1.0	<2.0 X	51	<5.0	4	24
TX-07	P	4.9	24	550	480	<1.0	<0.25	260	34	490	<1.0	<2.0 X	1300	<5.0	95	33
TX-08	P	<0.50	17	2300	650	<1.0	<0.25	140	10	2500	<1.0	9 X	77	<5.0	7.1	25
TX-08	SS	0.52	18	2500	860	<1.0	<0.25	110	8.1	3000	<1.0	<2.0 X	50	<5.0	7.6	21
TX-09	P	<0.50	38	950	400	1.1	<0.25	120	15	800	2	2.7 X	280	<5.0	110	200
TX-10	FD	<0.50	51	480	640	1.6	0.39	110	17	700	3.8	<2.0 X	580	<5.0	80	110
TX-10	P	<0.50	53	340	580	<1.0	<0.25	120	11	400	<1.0	<2.0 X	730	<5.0	90	75
TX-11	P	<0.50	63	1200	560	5.4	0.54	100	33	1400	12	2.3 X	240	<10	79	170
TX-11	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-12	P	<0.50	36	350	550	<1.0	<0.25	110	11	90	<1.0	<2.0 X	990	<5.0	62	83
TX-12	SS	<0.50	27	540	1200	<1.0	<0.25	<75	15	450	<1.0	<2.0 X	480	<5.0	42	73
TX-13	P	0.52	14	1700	910	<1.0	0.27	110	23	2200	<1.0	28 X	270	<5.0	21	26
TX-13	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-14	P	<0.50	1.2	340	350	<1.0	<0.25	<75	5.9	490	<1.0	<2.0 X	6.5	<5.0	<1.0	12
TX-15	P	<0.50	18	250	610	<1.0	<0.25	140	15	210	<1.0	<2.0 X	470	<5.0	49	32
TX-16	LD	<0.50	18	1500	710	<1.0	<0.25	120	31	1600	<1.0	2.2 X	220	<5.0	18	82
TX-16	P	<0.50	12	1400	740	1.1	<0.25	110	29	1400	<1.0	<2.0 X	74	<5.0	9.7	71
TX-17	P	<0.50	9.2	970	460	<1.0	<0.25	75	28	1700	<1.0	13 X	41	<5.0	5.5	35
TX-18	P	<0.50	18	1200	960	<1.0	3	88	40	1200	1.9	8.7 X	110	<5.0	53	200
TX-19	P	<0.50	7.2	880	980	1.3	0.86	80	32	1200	1.1	110 X	39	<5.0	3.3	72
TX-20	FD	<0.50	33	1100	520	<1.0	0.42	<75	22	1500	1.2	41 X	93	<5.0	130	100
TX-20	P	0.55	38	990	710	<1.0	<0.25	120	30	1100	1.1	<2.0 X	190	<5.0	72	120
TX-21	LD	<0.50	35	470	620	<1.0	<0.25	250	12	240	<1.0	<2.0 X	870	<5.0	93	67
TX-21	P	<0.50	36	430	640	<1.0	<0.25	240	12	260	<1.0	<2.0 X	810	<5.0	93	67
TX-22	P	<0.50	29	900	580	1.9	<0.25	83	25	1200	1.7	<2.0 X	69	<5.0	18	96
TX-22	SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-23	LD	<0.50	37	1100	1100	<1.0	<0.25	220	31	760	<1.0	13 X	160	<5.0	69	140
TX-23	P	<0.50	35	970	1000	<1.0	<0.25	190	29	730	<1.0	<2.0 X	160	<5.0	66	130
TX-23	SS	<0.50	35	980	1100	<1.0	<0.25	230	30	660	<1.0	<2.0 X	210	<5.0	70	130
TX-24	P	<0.50	11	930	710	<1.0	<0.25	92	32	1600	<1.0	8.4 X	95	<5.0	14	100
TX-25	P	<0.50	9.7	700	860	<1.0	<0.25	79	17	1400	<1.0	<2.0 X	13	<5.0	2.8	36
TX-26	P	<0.50	13	800	450	<1.0	<0.25	97	22	1500	<1.0	2.3 X	420	<5.0	26	48
TX-27	P	<0.50	2.7	440	780	<1.0	<0.25	<75	16	930	<1.0	4.4 X	23	<5.0	3.6	84
TX-28	P	0.5	5.3	1000	590	<1.0	<0.25	<75	12	1500	<1.0	30 X	35	<5.0	7	22
TX-29	P	6.6	14	500	810	<1.0	<0.25	84	21	480	<1.0	4.5 X	210	<5.0	40	52
TX-30	FD	0.83	7.7	2600	580	<1.0	<0.25	<75	9.7	2400	<1.0	5.3 X	43	<5.0	6.2	35
TX-30	P	0.79	8.8	3100	890	<1.0	<0.25	75	14	2700	<1.0	4.8 X	42	<5.0	6.4	41
TX-30	SS	0.91	9.3	3500	850	<1.0	<0.25	93	11	3100	<1.0	<2.0 X	52	<5.0	7.2	41

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
TX-31	P	0.69	24	940	550	<1.0	<0.25	90	39	1200	<1.0	<2.0 X	92	<5.0	20	85
TX-32	P	2.1	30	470	910	1.2	<0.25	150	28	500	<1.0	2.5 X	690	<5.0	60	140
TX-33	LD	0.75	5.3	610	570	<1.0	<0.25	<75	28	1000	<1.0	<2.0 X	20	<5.0	7.1	28
TX-33	P	1.1	8.4	900	860	<1.0	<0.25	<75	41	1400	1.5	<2.0 X	28	<5.0	11	42
TX-34	P	0.55	28	680	670	1.1	0.35	110	57	830	<1.0	6.3 X	610	<5.0	43	79
TX-35	P	<0.50	9.7	630	670	<1.0	<0.25	<75	21	730	<1.0	19 X	95	<5.0	8.4	50
YK-01	P	<0.50	3.9	930	1300	<1.0	<0.25	<400	51	920	1.2	4.5 X	120	<5.0	6	200
YK-02	FD	<0.50	12	210	580	<1.0	<0.25	140	14	220	<1.0	<2.0 X	600	<5.0	33	39
YK-02	P	0.59	16	170	700	<1.0	<0.25	150	12	120	<1.0	5.5 X	900	<5.0	52	48
YK-03	P	<0.50	12	490	510	<1.0	0.32	150	11	220	<1.0	<2.0 X	350	<5.0	33	100
YK-03	SS	<0.50	12	530	510	<1.0	<0.25	150	12	300	<1.0	<2.0 X	330	<5.0	30	110
YK-04	P	<0.50	6.4	250	290	<1.0	<0.25	<400	12	190	<1.0	<2.0 X	260	<5.0	16	100
YK-05	P	0.58	26	1200	730	<1.0	<0.25	170	20	560	<1.0	<2.0 X	490	<5.0	38	38
YK-06	P	<0.50	2.2	950	470	1.1	<0.25	<400	12	1700	<1.0	<2.0 X	66	6	4.7	14
YK-07	P	0.53	27	1100	640	1.2	0.39	<400	28	870	<1.0	<2.0 X	480	<5.0	41	170
YK-08	LD	<0.50	18	190	330	<1.0	<0.25	<400	8.2	210	<1.0	<2.0 X	760	<5.0	55	38
YK-08	P	<0.50	19	190	380	<1.0	<0.25	<400	8.8	140	<1.0	<2.0 X	810	<5.0	64	42
YK-09	P	<0.50	21	310	360	<1.0	<0.25	130	11	200	<1.0	2 X	490	<5.0	32	65
YK-10	P	0.77	22	460	920	<1.0	<0.25	140	17	220	<1.0	<2.0 X	610	<5.0	40	60
YK-11	P	3.9	29	330	780	<1.0	<0.25	<400	12	260	<1.0	<2.0 X	1000	<5.0	76	100
YK-12	FD	0.77	5.8	1800	430	<1.0	<0.25	<400	4.8	1900	<1.0	<2.0 X	47	8.7	8	20
YK-12	P	0.71	7.1	1200	960	<1.0	0.72	<400	8.2	1600	<1.0	<2.0 X	78	5	7.9	42
YK-13	P	0.55	29	790	550	<1.0	0.53	<400	10	1300	<1.0	2.5 X	220	<5.0	17	75
YK-14	P	<0.50	12	290	280	<1.0	0.26	<400	6.9	760	<1.0	<2.0 X	54	<5.0	7.6	40
YK-15	P	0.82	17	390	460	<1.0	0.86	<400	16	410	<1.0	170 X	310	8.3	23	39
YK-16	LD	<0.50	8	750	660	<1.0	<0.25	<400	26	1300	<1.0	4 X	90	<5.0	7.6	45
YK-16	P	<0.50	5.7	490	490	<1.0	<0.25	<400	17	880	<1.0	4.6 X	59	<5.0	5.2	32
YK-17	P	2.3	10	1100	970	<1.0	0.44	140	39	1400	<1.0	52 X	99	5.9	9.7	30
YK-18	P	<0.50	4.6	380	440	<1.0	<0.25	<400	5.9	370	<1.0	<2.0 X	68	<5.0	10	17
YK-19	P	0.71	18	380	460	<1.0	<0.25	<400	6.9	320	<1.0	<2.0 X	420	<5.0	43	48
YK-20	FD	<0.50	14	710	340	<1.0	<0.25	<400	12	680	<1.0	<2.0 X	99	9.3	10	48
YK-20	LD	<0.50	8.2	600	380	<1.0	0.33	88	14	1000	<1.0	2.7 X	54	<5.0	5.4	41
YK-20	P	0.62	9.9	760	440	<1.0	0.36	98	17	1900	<1.0	4.5 X	66	<5.0	6.6	49
YK-21	P	1.6	6.3	770	770	<1.0	<0.25	<400	19	1300	<1.0	5.6 X	55	7.5	5	43
YK-22	P	<0.50	8.1	480	580	<1.0	0.48	<400	18	950	<1.0	27 X	83	<5.0	11	85
YK-23	P	<0.50	50	410	260	1.1	<0.25	<400	19	760	1	<2.0 X	850	<5.0	65	48
YK-23	SS	<0.50	48	400	250	<1.0	<0.25	180	18	650	<1.0	4 X	980	<5.0	63	51
YK-24	P	0.53	93	1400	430	<1.0	0.45	230	17	950	<1.0	<2.0 X	780	<5.0	58	280
YK-25	P	<0.50	16	660	450	<1.0	0.27	92	14	830	<1.0	<2.0 X	170	<5.0	42	62
YK-26	P	1.4	34	690	2500	<1.0	<0.25	280	31	200	<1.0	5.3 X	1200	12	94	100
YK-26	SS	1.2	32	650	2200	<1.0	<0.25	250	28	190	<1.0	3.1 X	930	12	89	100
YK-27	P	0.85	30	550	4200	<1.0	<0.25	590	87	450	<1.0	7.2 X	1000	<5.0	55	64
YK-28	P	<0.50	4.1	910	870	<1.0	0.39	86	27	910	<1.0	11 X	53	<5.0	3.3	89
YK-29	P	0.55	8.9	830	1200	<1.0	<0.25	120	25	810	<1.0	22 X	290	<5.0	16	58
YK-30	FD	0.85	17	190	900	<1.0	<0.25	150	19	110	<1.0	2 X	860	<5.0	50	45
YK-30	P	0.82	17	220	770	<1.0	<0.25	170	19	110	<1.0	4.4 X	800	<5.0	47	55
YK-31	P	0.59	2.8	530	640	<1.0	<0.25	97	19	1100	<1.0	2.9 X	71	<5.0	4.7	55

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
YK-32	P	0.5	5.4	240	370	<1.0	2.6	100	16	320	<1.0	520 X	310	<5.0	16	23
YK-33	FD	0.69	18	350	850	<1.0	<0.25	130	13	130	<1.0	<2.0 X	640	<5.0	40	50
YK-33	P	<0.50	9.8	460	630	<1.0	0.8	120	15	360	<1.0	170 X	280	<5.0	18	33
YK-34	LD	0.59	6	1400	560	<1.0	<0.25	120	20	1500	<1.0	<2.0 X	83	<5.0	4.6	22
YK-34	P	0.56	5.5	1300	560	<1.0	<0.25	110	19	1400	<1.0	26 X	71	<5.0	4.3	24
YK-35	P	<0.50	11	160	350	<1.0	<0.25	120	4.4	190	<1.0	<2.0 X	410	<5.0	20	16
YK-36	P	0.58	15	510	490	<1.0	1.7	140	16	580	<1.0	330 X	280	<5.0	16	31
YK-37	LD	1.2	28	460	1000	<1.0	<0.25	130	9	60	<1.0	2.5 X	700	<5.0	42	40
YK-37	P	1.2	28	260	930	<1.0	1.7	120	9.2	59	<1.0	330 X	700	<5.0	40	39
YK-37	SS	1.1	29	300	1100	<1.0	<0.25	110	8.8	59	<1.0	3.5 X	690	<5.0	43	45
YK-38	P	<0.50	5.7	400	320	<1.0	1.4	<400	47	670	<1.0	260 X	26	<5.0	2.2	140
YK-39	P	<0.50	25	660	470	1.1	2.2	<400	8.6	640	<1.0	430 X	200	<5.0	43	54
YK-40	FD	<0.50	37	550	700	<1.0	<0.25	<400	27	270	<1.0	6.7 X	530	<5.0	38	120
YK-40	P	<0.50	19	530	630	<1.0	<0.25	110	36	440	<1.0	3.3 X	310	<5.0	22	86
YK-41	P	0.65	46	920	470	<1.0	2.3	140	23	660	<1.0	410 X	62	<5.0	19	40
YK-42	LD	<0.50	36	600	890	<1.0	<0.25	190	17	200	<1.0	<2.0 X	700	<5.0	50	120
YK-42	P	<0.50	37	670	960	<1.0	<0.25	200	17	190	<1.0	<2.0 X	720	<5.0	50	120
YK-42	SS	<0.50	37	650	890	<1.0	<0.25	200	21	310	<1.0	<2.0 X	680	<5.0	46	130
YK-43	P	<0.50	60	2500	520	<1.0	<0.25	<400	34	800	<1.0	4.6 X	300	<5.0	26	44
YK-44	P	<0.50	8.2	1200	670	1.3	1.2	<400	33	1200	<1.0	200 X	51	<5.0	4.7	100
YK-45	P	0.86	9.7	570	1300	<1.0	<0.25	190	35	1100	<1.0	<2.0 X	120	25	11	37
YK-45	SS	1.2	15	610	1300	<1.0	0.29	220	52	1300	<1.0	<2.0 X	260	50	17	38
YK-46	P	1.4	4.3	400	650	<1.0	<0.25	140	34	1000	<1.0	<2.0 X	15	91	4.1	16
YK-47	P	<0.50	1.7	300	560	<1.0	<0.25	<75	13	630	<1.0	9.6 X	11	<5.0	1.5	31
YK-48	P	0.71	2.1	350	800	<1.0	<0.25	290	36	970	<1.0	<2.0 X	9.8	<5.0	1.9	22
YK-49	LD	<0.50	1.6	420	930	<1.0	<0.25	<75	17	760	<1.0	<2.0 X	7.6	<5.0	<1.0	47
YK-49	P	<0.50	1.8	520	1200	<1.0	<0.25	<75	20	880	<1.0	<2.0 X	9.2	<5.0	<1.0	57
YK-50	FD	<0.50	2.1	500	1500	<1.0	<0.25	<75	20	680	<1.0	<2.0 X	11	5.5	1.4	41
YK-50	P	<0.50	2.3	810	1300	<1.0	<0.25	82	30	1100	<1.0	<2.0 X	20	<5.0	2.3	86
YK-51	P	1.6	9.5	820	860	<1.0	0.35	150	76	1500	<1.0	<2.0 X	89	13	9.9	37
YK-52	P	0.72	8.8	790	860	<1.0	0.42	100	43	970	<1.0	<2.0 X	67	<5.0	8	63
YK-53	P	0.58	4.2	410	440	<1.0	<0.25	<75	15	840	<1.0	2.3 X	28	<5.0	3.2	32
YK-54	P	<0.50	6.2	470	630	<1.0	<0.25	160	16	640	<1.0	<2.0 X	9	<5.0	<1.0	34
YK-55	P	<0.50	<1.0	580	810	<1.0	<0.25	100	17	560	<1.0	<2.0 X	9.7	<5.0	<1.0	86
YK-56	P	<0.50	1.2	1600	510	<1.0	<0.25	<75	8.4	780	<1.0	<2.0 X	31	<5.0	2.5	18
YK-57	P	<0.50	4.6	910	1300	<1.0	<0.25	79	43	1000	<1.0	<2.0 X	47	<5.0	3.6	120
YK-58	P	<0.50	1.5	570	680	<1.0	0.26	<75	6	450	<1.0	25 X	18	<5.0	1.1	13
YK-59	P	0.89	2.4	640	790	<1.0	<0.25	<75	19	890	<1.0	2.6 X	12	<5.0	1.7	65
YK-60	P	<0.50	1.9	330	780	<1.0	<0.25	<75	4.3	240	<1.0	<2.0 X	31	<5.0	9	23
YK-61	FD	<0.50	2	610	750	<1.0	<0.25	<75	14	740	<1.0	<2.0 X	6.1	<5.0	1.1	25
YK-61	LD	<0.50	2.9	860	940	<1.0	<0.25	<75	23	1000	<1.0	<2.0 X	11	<5.0	1.5	38
YK-61	P	<0.50	2.4	640	970	<1.0	<0.25	<75	17	820	<1.0	<2.0 X	7.9	<5.0	1.2	28
YK-61	SS	<0.50	3.8	810	870	<1.0	<0.25	<75	26	1100	<1.0	<2.0 X	12	<5.0	1.8	43
YK-62	LD	<0.50	2.9	610	780	<1.0	0.25	<75	12	780	<1.0	<2.0 X	36	<5.0	3.3	15
YK-62	P	<0.50	3.2	760	1200	<1.0	0.31	<75	13	980	<1.0	<2.0 X	38	<5.0	3.4	17
YK-63	P	<0.50	9.7	670	570	<1.0	<0.25	110	47	1000	1.2	<2.0 X	86	<5.0	15	110
YK-64	P	0.77	11	610	1600	<1.0	<0.25	180	57	1200	<1.0	<2.0 X	200	<5.0	12	32

mple ID	QAQC	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Sulphur	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
YK-65	P	<0.50	<1.0	490	600	<1.0	<0.25	<75	5.5	590	<1.0	<2.0 X	6.7	9.3	<1.0	11
YK-66	P	<0.50	<1.0	490	620	<1.0	<0.25	<75	4.9	600	<1.0	<2.0 X	5.6	<5.0	<1.0	9.3
YK-67	P	<0.50	5.3	460	570	<1.0	<0.25	<75	28	540	<1.0	<2.0 X	13	<5.0	1.3	25
YK-68	P	<0.50	<1.0	690	1100	<1.0	<0.25	<75	6.5	680	<1.0	<2.0 X	<5.0	<5.0	<1.0	35
YK-69	P	<0.50	2.5	620	1300	<1.0	<0.25	<75	13	640	<1.0	<2.0 X	20	<5.0	1.3	19
YK-70	FD	<0.50	14	480	2400	<1.0	<0.25	220	29	170	<1.0	<2.0 X	660	<5.0	35	39
YK-70	P	<0.50	16	560	2700	<1.0	<0.25	240	34	150	<1.0	<2.0 X	770	<5.0	38	44
YK-71	LD	<0.50	3	410	290	<1.0	<0.25	<75	14	820	<1.0	<2.0 X	22	<5.0	2.2	21
YK-71	P	<0.50	3.7	540	350	<1.0	<0.25	<75	18	1100	<1.0	<2.0 X	26	<5.0	2.6	27
YK-72	P	<0.50	3.8	640	920	<1.0	<0.25	<75	20	730	<1.0	<2.0 X	27	<5.0	2.2	62
YK-73	P	1.8	24	840	2500	4.6	0.54	420	94	1400	5.1	<2.0 X	230	17	33	27
YK-73	SS	1.5	22	850	2300	3.7	0.46	380	93	1500	3.8	<2.0 X	290	13	39	33
YK-74	P	<0.50	18	860	1500	<1.0	0.47	230	29	800	<1.0	<2.0 X	260	<5.0	21	100
YK-74	SS	0.54	22	990	1500	<1.0	0.3	300	34	830	<1.0	<2.0 X	480	<5.0	29	100
YK-75	P	0.65	13	1300	620	<1.0	0.36	95	82	2400	<1.0	<2.0 X	37	<5.0	7.6	110
YK-76	P	<0.50	6.2	540	520	<1.0	<0.25	<75	39	1000	<1.0	<2.0 X	46	<5.0	4.4	100
YK-77	P	<0.50	15	570	520	<1.0	<0.25	98	24	610	<1.0	<2.0 X	230	<5.0	11	82
YK-78	P	<0.50	3.1	280	440	<1.0	<0.25	<75	14	380	<1.0	<2.0 X	6.6	<5.0	<1.0	35
YK-79	FD	<0.50	2.5	480	640	<1.0	<0.25	<75	18	580	<1.0	<2.0 X	16	<5.0	<1.0	67
YK-79	P	<0.50	3.3	370	400	<1.0	<0.25	<75	16	540	<1.0	<2.0 X	31	<5.0	2.5	44
YR-01	P	0.51	4.1	900	900	<1.0	<0.25	79	66	1000	<1.0	7.7 X	25	<5.0	2.2	170
YR-02	P	<0.50	30	920	760	<1.0	0.38	170	21	1100	<1.0	2.3 X	51	<5.0	9.8	39
YR-03	FD	0.55	33	4900	500	<1.0	0.29	<400	8.9	580	<1.0	8 X	6	<5.0	29	98
YR-03	P	<0.50	9.8	820	510	1.1	<0.25	<400	28	1200	<1.0	5 X	15	<5.0	1.7	110
YR-04	P	0.54	18	420	530	<1.0	<0.25	140	7.9	260	<1.0	29 X	160	<5.0	39	28
YR-04	SS	-	-	-	-	-	-	-	-	-	-	- X	-	-	-	-
YR-05	LD	<0.50	26	810	730	2.2	0.32	<400	36	930	1.9	21 X	79	<5.0	6	92
YR-05	P	<0.50	21	620	640	1.9	<0.25	<400	27	720	1.3	<2.0 X	58	<5.0	4.8	76
YR-06	P	0.7	27	330	630	<1.0	<0.25	<400	15	300	<1.0	<2.0 X	360	<5.0	46	75
YR-06	SS	<0.50	26	380	760	<1.0	<0.25	120	20	290	<1.0	31 X	330	<5.0	41	100
YR-07	LD	<0.50	21	220	330	<1.0	<0.25	82	8	140	<1.0	<2.0 X	210	<5.0	19	43
YR-07	LD	<0.50	18	200	280	<1.0	<0.25	<75	7.8	120	<1.0	<2.0 X	170	<5.0	16	34
YR-07	P	<0.50	19	210	310	<1.0	<0.25	84	7.8	120	<1.0	<2.0 X	200	<5.0	17	36
YR-07	SS	<0.50	21	210	320	<1.0	<0.25	77	8.2	130	<1.0	<2.0 X	200	<5.0	18	43
YR-08	P	<0.50	14	1100	580	1.1	<0.25	<400	38	1100	<1.0	<2.0 X	40	<5.0	4	94

Appendix I

Arsenic concentration in soils vs Arsenic load in soils

Arsenic in surface soil is often reported as a concentration (i.e. mg/kg). Surface soil samples are heterogenous, consisting of varying amounts of organic material depending on the location the sample was collected (i.e. outcrop vs. forested area). Therefore, questions remain, whether the density of soil material disproportionally affects the arsenic concentration. Arsenic loading is a way in which density can be taken into consideration.

During the sample processing procedure (Appendix D), the portion of sample submitted to ASU for elemental analysis was measured by volume and by weight (Appendix E). Once the sample was homogenized, a portion of the sample was extracted with a measuring spoon, with a known volume. The portion was then weighed on scale. The bulk density of material analyzed can be calculated by the following:

$$Bulk\ density = \frac{mass\ of\ material(g)}{volume\ of\ spoon\ (cm^3)}$$

The arsenic load in the sample can then be estimated following:

$$Arsenic\ load = bulk\ density\ of\ sample\left(\frac{g}{cm^3}\right) x arsenic\ concentration\ \left(\frac{mg}{kg}\right) x\ 1kg/1000g$$

Figures 1 and 2 compare the concentration of arsenic in soils (mg/kg) with the estimated load of arsenic in soils (mg/cm^3) in terrain units. The distribution of arsenic follows similar patterns between the two methods among terrain units for the entire data set. A Kruskal-Wallis test and Dunn's post hoc analysis was completed for both arsenic concentration and arsenic loading. The same result was observed: forested samples contain significantly less arsenic than forest outcrop and outcrop soils ($p < 0.001$). There was no statistical significance observed between median arsenic concentrations in forest outcrop and outcrop samples ($p > 0.05$).

Figures 3 and 4 compare the arsenic concentration (mg/kg) and arsenic loading (mg/cm^3) in terrain units within the high-density sampling areas. Only 4 forest canopy soils were collected in the two high-density sampling areas and therefore, a Kruskal-Wallis test could not be conducted. Tables 1 and 2 provide summary statistics for arsenic concentration and loading, respectively. The same pattern of forested samples containing less arsenic and variability is observed.

Based on the comparisons displayed below, comparing arsenic concentrations with varying amounts of organic material appears to be valid. Data used for all calculations is provided in Table 3.

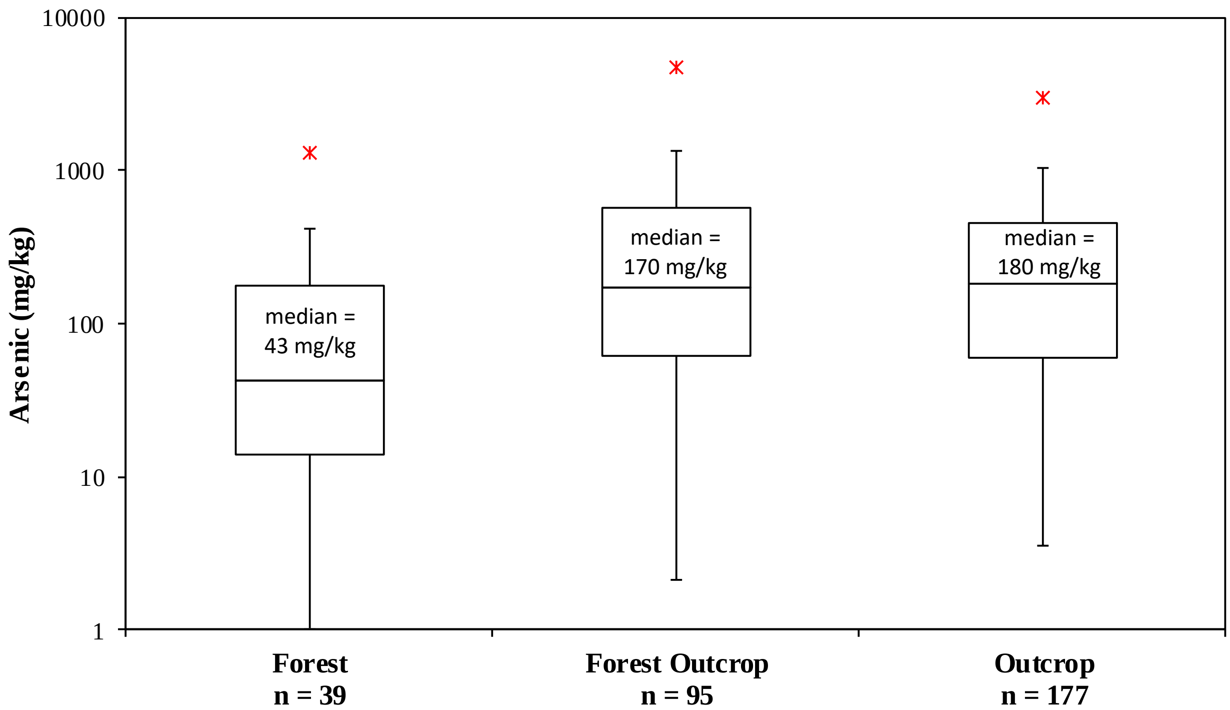


Figure 1: Boxplot showing arsenic concentrations in the PHL based on terrain units for all samples collected (n=311). A Kruskal-Wallis test and Dunn's post hoc analysis determined forest samples (median = 43 mg/kg) had significantly less arsenic than forest outcrop (median = 170 mg/kg) and outcrop (median = 180 mg/kg) samples (p <0.001). There was no statistical significance observed between median arsenic concentrations in forest outcrop and outcrop samples (p >0.05). This boxplot was created by using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1. However, for the Forest terrain unit, the lower whisker was a negative value and therefore the minimum value defines the lower whisker.

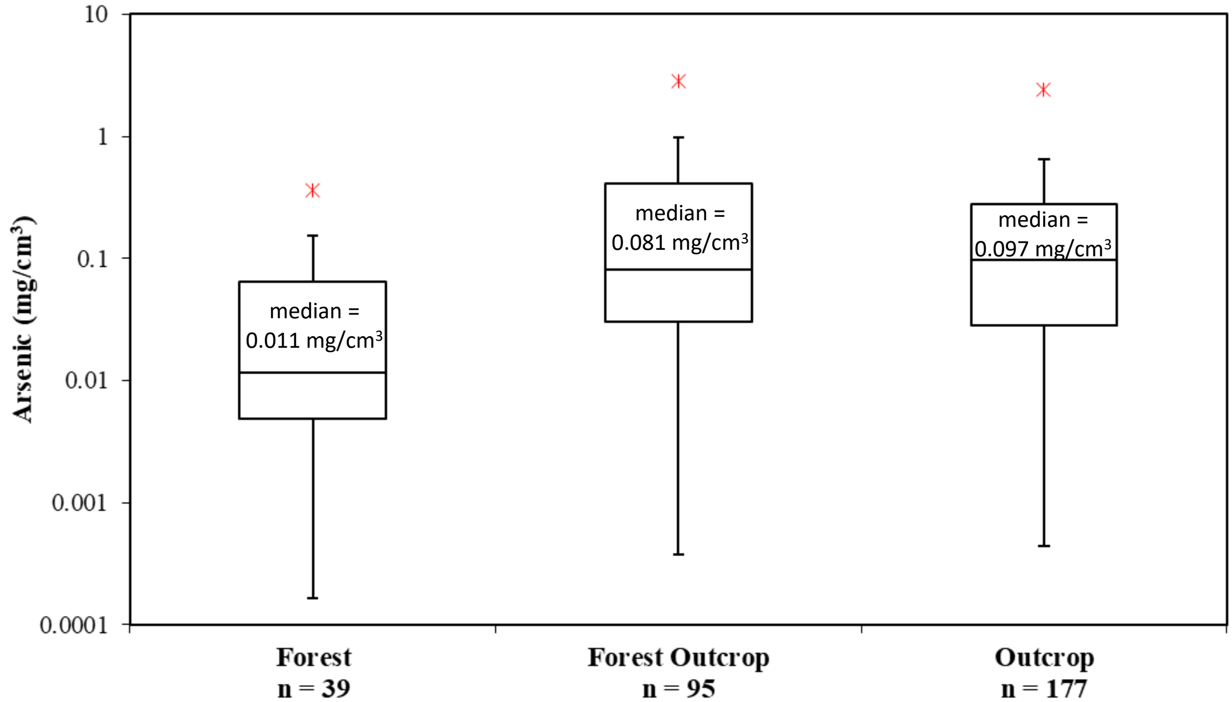


Figure 2: Boxplot showing arsenic loading in the PHL based on terrain units for all samples collected (n=311). A Kruskal-Wallis test and Dunn's post hoc analysis determined forest samples (median = 0.012 mg/cm^3) had significantly less arsenic than forest outcrop (median = 0.081 mg/cm^3) and outcrop (median = 0.097 mg/cm^3) samples (p <0.001). There was no statistical significance observed between median arsenic concentrations in forest outcrop and outcrop samples (p >0.05). This boxplot was created by using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1.

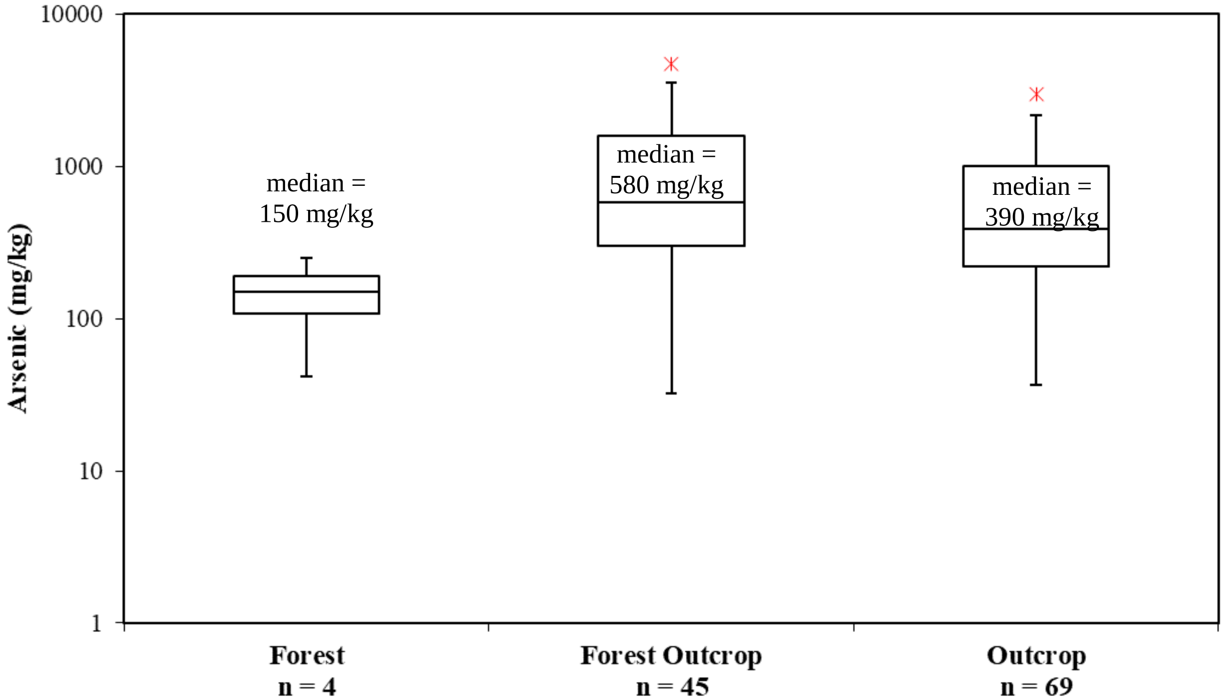


Figure 3: Boxplot showing arsenic concentrations in the PHL based on terrain units for samples collected in the high-density sampling areas (n=118). This boxplot was created by using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1.

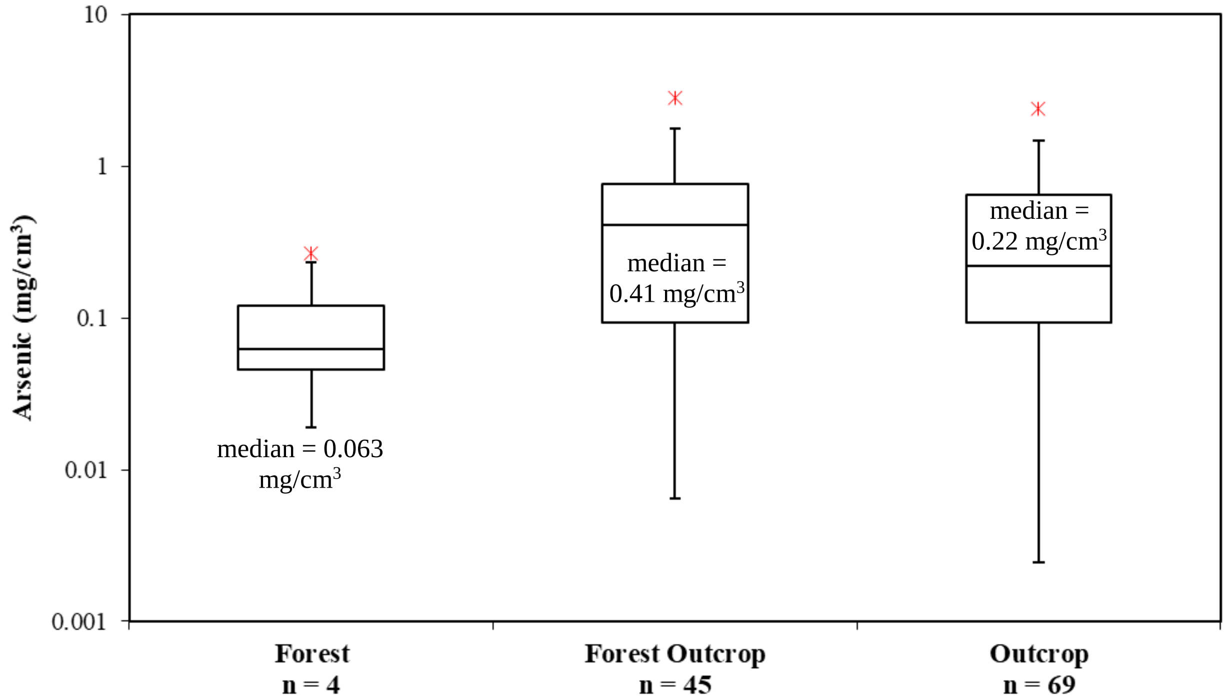


Figure 4: Boxplot showing arsenic loading in the PHL based on terrain units for samples collected in the high-density sampling areas (n = 118). This boxplot was created by using a template provided by Vertex42 (Vertex42 LLC, 2009). The lower and upper boundary of the box represents the quartile 1 and quartile 3 values, respectively, defining the interquartile range (IQR). The red star represents the maximum value. The ends of the whiskers (i.e. error bars) were determined by 1.5*IQR above Q3 and below Q1.

Table 1 – Summary statistics of arsenic concentrations (mg/kg) in terrain units within the high-density sampling areas.

Terrain	Count	Mean	Minimum	Median	Maximum
forest	4	148.0	42.0	150.0	250.0
forest outcrop	45	986	32	580	4700
outcrop	69	624.9	37.0	390.0	3000.0

Table 2 – Summary statistics of arsenic loading (mg/cm³) in terrain units within the high-density sampling areas.

Terrain	Count	Mean	Minimum	Median	Maximum
Forest	4	0.1032	0.0191	0.0629	0.2680
Forest Outcrop	45	0.5484	0.0065	0.4134	2.8200
Outcrop	69	0.4601	0.0025	0.2200	2.3970

Table 3 – Arsenic concentration and arsenic load.

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
CM-01	Outcrop	0.62	190	0.1178
CM-02	Outcrop	0.60	210	0.1255
CM-03	Forest Outcrop	0.86	90	0.0772
CM-04	Forest Outcrop	1.20	190	0.2288
CM-05	Outcrop	0.45	64	0.0287
CM-06	Outcrop	0.52	370	0.1925
CM-07	Outcrop	0.84	110	0.0924
CM-08	Forest	0.50	540	0.2689
CM-09	Forest Outcrop	0.62	95	0.0585
CM-10	Outcrop	0.62	34	0.0209
CM-10-Dup	Outcrop	0.82	53	0.0436
CM-11	Outcrop	0.46	340	0.1550
CM-12	Outcrop	0.86	140	0.1204
CM-13	Outcrop	0.86	170	0.1462
CM-14	Outcrop	1.14	210	0.2402
CM-15	Forest Outcrop	0.77	120	0.0926
CM-16	Outcrop	0.88	180	0.1581
CM-17	Outcrop	0.39	390	0.1537
CM-17-Dup	Outcrop	0.36	450	0.1611
CM-18	Forest Outcrop	0.84	270	0.2268
CM-19	Outcrop	0.54	180	0.0968
CM-20	Forest Outcrop	0.60	73	0.0435
CM-21	Outcrop	0.46	180	0.0821
CM-22	Outcrop	0.73	590	0.4307
CM-23	Outcrop	0.67	330	0.2211
CM-24	Outcrop	1.79	710	1.2681
CM-25	Outcrop	0.98	570	0.5597
CM-26	Forest	0.39	430	0.1686
GRACE-01	Outcrop	0.23	81	0.0185
GRACE-02	Forest	0.72	16	0.0116
GRACE-03	Forest Outcrop	0.33	85	0.0276
GRACE-04	Outcrop	0.36	91	0.0330
GRACE-05	Outcrop	0.32	440	0.1408
GRACE-06	Forest	0.22	83	0.0182
GRACE-06-Dup	Forest	0.17	47	0.0078
G-SIT-01	Forest	0.45	42	0.0191
G-SIT-02	Outcrop	0.20	560	0.1115
G-SIT-03	Forest Outcrop	0.27	390	0.1053
G-SIT-04	Outcrop	0.47	260	0.1217
G-SIT-05	Forest Outcrop	0.25	440	0.1091
G-SIT-06	Forest Outcrop	0.26	350	0.0910
G-SIT-07	Forest Outcrop	0.20	160	0.0318
G-SIT-08	Outcrop	0.85	330	0.2805
G-SIT-09	Outcrop	0.34	360	0.1217
G-SIT-10	Outcrop	0.34	560	0.1904
G-SIT-10-Dup	Outcrop	0.02	130	0.0025

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
G-SIT-11	Outcrop	0.31	150	0.0459
G-SIT-12	Outcrop	0.28	37	0.0104
G-SIT-13	Outcrop	0.76	220	0.1672
G-SIT-14	Outcrop	0.26	600	0.1572
G-SIT-15	Forest Outcrop	0.27	550	0.1463
G-SIT-16	Outcrop	0.19	140	0.0261
G-SIT-17	Forest Outcrop	0.41	120	0.0497
G-SIT-18	Outcrop	0.79	110	0.0867
G-SIT-19	Outcrop	0.37	100	0.0372
G-SIT-20	Outcrop	0.16	390	0.0611
G-SIT-20-Dup	Outcrop	0.56	160	0.0899
G-SIT-21	Outcrop	0.39	240	0.0936
G-SIT-22	Outcrop	0.50	380	0.1885
G-SIT-23	Outcrop	0.31	200	0.0611
G-SIT-24	Outcrop	1.24	360	0.4478
G-SIT-25	Outcrop	0.44	400	0.1776
G-SIT-26	Outcrop	0.47	990	0.4673
G-SIT-27	Outcrop	0.34	3000	1.0200
G-SIT-28	Outcrop	0.50	140	0.0697
G-SIT-29	Outcrop	0.31	320	0.0986
G-SIT-30	Outcrop	0.27	71	0.0192
G-SIT-31	Forest	0.32	170	0.0541
G-SIT-31-Dup	Forest	0.55	130	0.0718
G-SIT-32	Outcrop	0.50	130	0.0650
G-SIT-33	Outcrop	0.72	260	0.1877
G-SIT-35	Outcrop	0.43	230	0.0993
G-SIT-36	Outcrop	0.36	1100	0.3916
G-SIT-37	Outcrop	0.62	390	0.2426
G-SIT-38	Forest Outcrop	0.26	210	0.0538
G-SIT-39	Outcrop	0.18	110	0.0196
G-SIT-40	Outcrop	0.35	220	0.0774
G-SIT-41	Outcrop	0.18	240	0.0427
G-SIT-42	Outcrop	0.18	81	0.0144
G-SIT-43	Outcrop	0.24	420	0.1028
G-SIT-44	Outcrop	0.62	400	0.2492
G-SIT-45	Outcrop	0.96	510	0.4876
G-SIT-46	Forest Outcrop	0.31	37	0.0115
G-SIT-46-Dup	Forest Outcrop	0.74	310	0.2294
G-SIT-47	Outcrop	1.37	1100	1.5048
G-SIT-48	Outcrop	0.88	250	0.2200
G-SIT-49	Outcrop	1.54	200	0.3072
G-SIT-50	Outcrop	0.34	81	0.0274
G-SIT-51	Outcrop	0.44	220	0.0968
G-SIT-52	Forest Outcrop	0.20	32	0.0065
G-SIT-52-Dup	Forest Outcrop	0.22	66	0.0143
G-SIT-53	Forest Outcrop	0.17	450	0.0744
G-SIT-54	Forest Outcrop	0.29	150	0.0438

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
G-SIT-55	Forest Outcrop	0.38	250	0.0940
G-WGM-01	Outcrop	0.80	1300	1.0400
G-WGM-02	Outcrop	0.71	1300	0.9204
G-WGM-03	Forest Outcrop	0.61	1900	1.1514
G-WGM-03-Dup	Forest Outcrop	0.35	2200	0.7656
G-WGM-04	Forest Outcrop	0.46	1000	0.4580
G-WGM-05	Forest Outcrop	0.42	1800	0.7596
G-WGM-06	Forest Outcrop	0.21	280	0.0577
G-WGM-07	Outcrop	0.48	2100	1.0122
G-WGM-08	Forest Outcrop	0.48	990	0.4772
G-WGM-09	Forest Outcrop	0.57	540	0.3067
G-WGM-10	Forest Outcrop	0.96	270	0.2591
G-WGM-11	Forest Outcrop	0.61	680	0.4134
G-WGM-12	Forest Outcrop	0.65	990	0.6395
G-WGM-12-Dup	Forest Outcrop	0.32	1700	0.5508
G-WGM-13	Forest Outcrop	0.66	300	0.1992
G-WGM-14	Forest Outcrop	0.64	2100	1.3356
G-WGM-15	Forest Outcrop	0.29	670	0.1952
G-WGM-16	Forest Outcrop	0.21	150	0.0322
G-WGM-17	Forest Outcrop	0.39	1600	0.6314
G-WGM-18	Forest Outcrop	0.58	3600	2.0736
G-WGM-19	Forest Outcrop	0.70	580	0.4083
G-WGM-20	Forest Outcrop	0.56	2000	1.1200
G-WGM-21	Forest Outcrop	0.60	4700	2.8200
G-WGM-21-Dup	Forest Outcrop	0.62	1900	1.1856
G-WGM-22	Forest Outcrop	0.92	1100	1.0142
G-WGM-23	Forest Outcrop	0.42	1800	0.7524
G-WGM-24	Forest Outcrop	0.61	1300	0.7982
G-WGM-25	Forest Outcrop	1.22	500	0.6090
G-WGM-26	Outcrop	0.78	1000	0.7760
G-WGM-27	Outcrop	0.76	1200	0.9120
G-WGM-28	Outcrop	1.08	580	0.6264
G-WGM-29	Outcrop	0.82	640	0.5274
G-WGM-30	Forest Outcrop	0.71	1200	0.8496
G-WGM-31	Forest Outcrop	0.82	540	0.4450
G-WGM-31-Dup	Forest Outcrop	0.78	690	0.5368
G-WGM-32	Outcrop	1.01	1200	1.2144
G-WGM-33	Outcrop	0.45	670	0.3028
G-WGM-34	Outcrop	1.87	1200	2.2464
G-WGM-35	Outcrop	1.14	970	1.1097
G-WGM-36	Outcrop	0.48	790	0.3792
G-WGM-37	Outcrop	1.28	99	0.1263
G-WGM-38	Forest Outcrop	0.76	2200	1.6808
G-WGM-39	Outcrop	0.42	1200	0.5064
G-WGM-40	Outcrop	1.14	140	0.1596
G-WGM-41	Outcrop	1.02	1200	1.2192
G-WGM-41-Dup	Outcrop	1.12	1100	1.2364

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
G-WGM-42	Forest	1.07	250	0.2680
G-WGM-43	Outcrop	1.25	1000	1.2520
G-WGM-44	Outcrop	1.03	1900	1.9494
G-WGM-45	Outcrop	1.29	380	0.4910
G-WGM-46	Forest Outcrop	0.34	560	0.1904
G-WGM-47	Outcrop	0.45	1500	0.6690
G-WGM-48	Outcrop	0.84	520	0.4358
G-WGM-49	Outcrop	0.50	1300	0.6500
G-WGM-50	Outcrop	0.42	910	0.3840
G-WGM-51	Outcrop	1.13	710	0.8037
G-WGM-51-Dup	Outcrop	1.41	1700	2.3970
G-WGM-52	Forest Outcrop	0.90	1000	0.9000
G-WGM-53	Outcrop	0.31	360	0.1102
IL-01	Outcrop	0.58	120	0.0701
IL-02	Outcrop	0.47	48	0.0227
IL-03	Forest Outcrop	0.21	68	0.0143
IL-04	Forest Outcrop	0.46	41	0.0190
IL-05	Outcrop	0.31	100	0.0306
IL-06	Outcrop	0.26	48	0.0126
IL-07	Outcrop	0.24	39	0.0092
IL-08	Outcrop	0.56	45	0.0251
IL-09	Outcrop	0.30	27	0.0080
IL-10	Forest Outcrop	0.90	10	0.0090
IL-10-Dup	Forest Outcrop	0.56	25	0.0140
IL-11	Outcrop	0.88	13	0.0114
IL-12	Outcrop	0.34	36	0.0124
IL-13	Outcrop	0.21	56	0.0115
LL-01	Outcrop	0.88	380	0.3359
LL-02	Outcrop	0.41	230	0.0945
LL-03	Outcrop	0.91	110	0.0999
LL-04	Outcrop	0.73	450	0.3294
LL-05	Outcrop	0.91	190	0.1728
LL-06	Outcrop	0.39	290	0.1145
LL-07	Outcrop	0.26	320	0.0845
LL-08	Forest Outcrop	0.21	200	0.0416
TX-01	Outcrop	0.23	37	0.0084
TX-02	Forest Outcrop	0.49	200	0.0981
TX-03	Outcrop	0.39	46	0.0180
TX-04	Outcrop	1.09	55	0.0601
TX-05	Outcrop	0.11	8	0.0009
TX-06	Forest	0.25	120	0.0300
TX-07	Forest Outcrop	0.76	140	0.1064
TX-08	Outcrop	0.83	21	0.0174
TX-09	Outcrop	0.56	100	0.0564
TX-10	Forest Outcrop	0.78	170	0.1323
TX-10-Dup	Forest Outcrop	0.53	170	0.0908
TX-11	Outcrop	0.50	310	0.1550

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
TX-12	Outcrop	1.21	83	0.1003
TX-13	Outcrop	0.75	40	0.0302
TX-14	Forest Outcrop	0.21	10	0.0021
TX-15	Outcrop	1.14	68	0.0774
TX-16	Outcrop	0.43	41	0.0178
TX-17	Outcrop	0.50	57	0.0283
TX-18	Outcrop	0.45	160	0.0724
TX-19	Outcrop	0.30	58	0.0173
TX-20	Outcrop	0.64	650	0.4147
TX-20-Dup	Outcrop	0.62	1200	0.7392
TX-21	Outcrop	0.67	33	0.0221
TX-22	Outcrop	0.62	98	0.0604
TX-23	Outcrop	1.94	86	0.1668
TX-24	Outcrop	0.58	37	0.0214
TX-25	Forest Outcrop	0.45	31	0.0140
TX-26	Outcrop	0.99	52	0.0514
TX-27	Forest Outcrop	0.62	24	0.0150
TX-28	Outcrop	0.43	28	0.0120
TX-29	Forest Outcrop	0.61	84	0.0509
TX-30	Outcrop	0.72	24	0.0173
TX-30-Dup	Outcrop	0.65	34	0.0222
TX-31	Outcrop	0.38	68	0.0255
TX-32	Forest Outcrop	0.89	160	0.1424
TX-33	Forest Outcrop	0.25	140	0.0353
TX-34	Outcrop	0.58	100	0.0578
TX-35	Forest Outcrop	0.22	17	0.0038
YK-01	Forest Outcrop	0.46	18	0.0082
YK-02	Forest Outcrop	0.86	35	0.0301
YK-02-Dup	Forest Outcrop	0.54	65	0.0351
YK-03	Outcrop	0.70	57	0.0399
YK-04	Forest Outcrop	0.52	90	0.0468
YK-05	Forest Outcrop	0.38	370	0.1417
YK-06	Outcrop	0.23	110	0.0251
YK-07	Outcrop	0.34	260	0.0884
YK-08	Outcrop	1.25	260	0.3245
YK-09	Outcrop	0.95	160	0.1520
YK-10	Forest Outcrop	1.97	150	0.2958
YK-11	Outcrop	0.68	240	0.1622
YK-12	Outcrop	0.69	220	0.1522
YK-12-Dup	Outcrop	0.70	660	0.4633
YK-13	Outcrop	0.29	670	0.1956
YK-14	Outcrop	0.20	100	0.0198
YK-15	Forest Outcrop	0.48	470	0.2256
YK-16	Forest Outcrop	0.21	320	0.0672
YK-17	Forest	0.24	410	0.0972
YK-18	Forest	0.68	180	0.1217
YK-19	Outcrop	0.72	500	0.3620

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
YK-20	Outcrop	0.62	760	0.4682
YK-20-Dup	Outcrop	0.38	800	0.3040
YK-21	Forest	0.41	430	0.1772
YK-22	Outcrop	0.23	470	0.1081
YK-23	Forest Outcrop	0.26	1600	0.4192
YK-24	Outcrop	0.54	180	0.0979
YK-25	Outcrop	0.25	1100	0.2772
YK-26	Outcrop	1.16	22	0.0255
YK-27	Forest	0.91	7.7	0.0070
YK-28	Forest Outcrop	0.40	23	0.0093
YK-29	Forest Outcrop	0.60	38	0.0226
YK-30	Forest Outcrop	0.98	49	0.0480
YK-30-Dup	Forest Outcrop	1.14	19	0.0216
YK-31	Outcrop	0.34	60	0.0201
YK-32	Forest Outcrop	0.54	95	0.0511
YK-33	Outcrop	0.49	58	0.0282
YK-33-Dup	Outcrop	0.82	55	0.0449
YK-34	Outcrop	0.32	100	0.0318
YK-35	Forest Outcrop	1.22	66	0.0808
YK-36	Forest Outcrop	0.64	53	0.0337
YK-37	Outcrop	1.65	55	0.0909
YK-38	Outcrop	0.25	39	0.0099
YK-39	Outcrop	0.44	63	0.0275
YK-40	Outcrop	0.60	47	0.0282
YK-40-Dup	Outcrop	0.65	43	0.0281
YK-41	Outcrop	0.58	120	0.0698
YK-42	Outcrop	1.38	30	0.0415
YK-43	Forest Outcrop	0.32	160	0.0515
YK-44	Forest Outcrop	0.23	57	0.0130
YK-45	Forest	0.43	130	0.0556
YK-46	Forest	0.20	34	0.0069
YK-47	Forest	0.16	51	0.0082
YK-48	Forest	0.44	25	0.0110
YK-49	Forest	0.15	6.6	0.0010
YK-50	Forest	0.13	43	0.0056
YK-50-Dup	Forest	0.22	66	0.0142
YK-51	Forest	0.57	460	0.2613
YK-52	Forest	0.28	1300	0.3653
YK-53	Forest	0.20	750	0.1536
YK-54	Forest	0.42	10	0.0042
YK-55	Forest	0.13	24	0.0032
YK-56	Outcrop	0.31	42	0.0131
YK-57	Forest	0.13	6.4	0.0008
YK-58	Forest	0.30	26	0.0077
YK-59	Forest Outcrop	0.16	13	0.0020
YK-60	Outcrop	0.13	3.5	0.0004
YK-61	Forest	0.16	1.6	0.0003

Sample ID	Terrain	Bulk density (g/cm^3)	Arsenic (mg/kg)	Arsenic (mg/cm^3)
YK-61-Dup	Forest	0.17	1	0.0002
YK-62	Forest Outcrop	0.16	5.6	0.0009
YK-63	Outcrop	0.21	40	0.0084
YK-64	Forest	0.21	8.3	0.0018
YK-65	Outcrop	0.24	4	0.0009
YK-66	Forest	0.30	12	0.0036
YK-67	Forest Outcrop	0.18	2.1	0.0004
YK-68	Forest	0.25	6.2	0.0015
YK-69	Outcrop	0.12	8.9	0.0011
YK-70	Forest	0.75	16	0.0120
YK-70-Dup	Forest	0.52	16	0.0083
YK-71	Outcrop	0.19	90	0.0175
YK-72	Forest	0.18	41	0.0075
YK-73	Forest	0.25	130	0.0321
YK-74	Forest	0.25	230	0.0582
YK-75	Outcrop	0.25	370	0.0921
YK-76	Outcrop	0.22	250	0.0540
YK-77	Forest Outcrop	0.26	160	0.0413
YK-78	Outcrop	0.27	11	0.0030
YK-79	Forest Outcrop	0.13	12	0.0016
YK-79-Dup	Forest Outcrop	0.14	5.9	0.0008
YR-01	Forest	0.20	10	0.0020
YR-02	Forest Outcrop	0.68	46	0.0311
YR-03	Outcrop	0.35	16	0.0056
YR-03-Dup	Outcrop	0.91	82	0.0745
YR-04	Forest Outcrop	0.82	43	0.0353
YR-05	Forest Outcrop	0.24	73	0.0176
YR-06	Outcrop	0.72	120	0.0869
YR-07	Outcrop	1.30	47	0.0612
YR-08	Outcrop	0.20	60	0.0122

Appendix J

Model Mineralogy from SEM-AM

Model mineralogy results were obtained by using the scanning electron microscope (SEM) to collect the spectra of each mineral and automated mineralogy (AM) used the spectra to identify the phase. The concentration of arsenic was then calculated, shown in the example below:

Sample ID	Phase	Arsenolite	FeOx with As	Arsenopyrite	As-Bearing Pyrite	Enargite	Fe-Ca Arsenate	FeOx/FeOx Mix, with As	MnOx Mix, with As	Organics + FeOx, with As	Realgar	Scorodite
	Density (g/cm3)	3.70	4.9	6.07	5.01	4.45	2.65	4.77	3.40	3.63	3.56	3.27
	Density (g/m3)	3700000	4900000	6070000	5010000	4450000	2650000	4770000	3400000	3630000	3560000	3270000
	wt % As in each Phase	0.76	0.03	0.46	0.1000	0.19	0.25	0.03	0.03	0.03	0.70	0.40
CM-08	Area (micron)	712.83	2261.54	0.00	0.00	4.37	55.34	819.14	22813.48	44.42	53.15	0.00
CM-08	Area (m)	0.000713	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
CM-08	Volume (m3)	0.000000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CM-08	Mass of each phase	0.002637	0.01	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00
CM-08	Mass As in each phase	0.002004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CM-08	Total As in each phase (wt. %)	0.404208	0.07	0.00	0.00	0.00	0.01	0.02	0.47	0.00	0.03	0.00
CM-08	Total As in each phase (mg/kg)	218.27	36.20	0.00	0.00	0.40	4.02	12.76	253.39	0.53	14.42	0.00

The reference for the density of each phase is listed below:

Solid Arsenic Phase Host	**Density (g/cm^3)**	**Mineral**	**Chemical Formula**	**Reference**
Arsenic Trioxide	3.87	Arsenolite	As_2O_3	https://www.mindat.org/min-294.html
Arsenopyrite	6.07	Arsenopyrite	$FeAsS$	https://www.mindat.org/min-305.html
As-Bearing Pyrite	5.01	Pyrite	FeS_2	https://www.mindat.org/min-3314.html
Enargite	4.45	Enargite	Cu_3AsS_4	https://www.mindat.org/min-1380.html
Iron-calcium arsenate	2.65	Yukonite	$Ca_3Fe(AsO_4)_2(OH)_3 \cdot 5H_2O$	https://www.mindat.org/min-4377.html
Natural iron oxides with arsenic	4.77	Goethite Hematite	α-$FeO(OH)$ Fe_2O_3	https://www.mindat.org/min-1719.html https://www.mindat.org/min-1856.html

Roaster-derived iron oxides with arsenic	4.9	Maghemite	Fe_2O_3	https://www.mindat.org/min-2533.html
Natural manganese oxides with arsenic	3.40	Birsnessite	$(Na,Ca)_{0.5}(Mn^{4+},Mn^{3+})_2O_4 \cdot 1.5H_2O$	https://www.mindat.org/min-680.html
Organics with natural iron oxides and arsenic	3.63[1]	Goethite Organic Carbon	α-FeO(OH) Complex Carbon Chain	
Realgar	3.56	Realgar	AsS	https://www.mindat.org/min-3375.html
Scorodite	3.27	Scorodite	$FeAsO_4 \cdot H_2O$	https://www.mindat.org/min-3595.html

1The density for organics with natural iron oxides and arsenic was calculated by summing the contribution of organic carbon and iron oxides to the sample. The average organic carbon measured in the samples submitted (Appendix H) was 28%. This was multiplied by the organic carbon density, measured prior to samples submitted for analysis, which was 0.69 g/cm^3 giving a result of 0.19. The density of natural iron oxides with arsenic (4.77 g/cm^3) was then multiplied by 72% (assuming that if 28% was organic carbon, the remaining 72% was iron oxides with arsenic). This value was 3.43 g/cm^3, giving a total density of organics with natural iron oxides and arsenic a value of 3.63 g/cm^3.

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%
Arsenolite	0.0212	0.0143	0.0382	0.0013	0.0045	0.0000	0.0082	0.0000	0.2176	0.4284	0.0589	0.0031	0.0018	0.0075	0.6443	0.3815	0.0184	0.5122	0.0637	0.0117
Arsenopyrite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000
As-Bearing Pyrite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Enargite	0.0001	0.0002	0.0000	0.0002	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fe Oxides Mix - with As	0.0244	0.0250	0.1751	0.0072	0.0300	0.1600	0.0006	0.0078	0.0081	0.0024	0.0356	3.0300	0.0356	0.0024	0.0300	0.0289	0.0601	0.0165	0.0286	0.0015
Fe-Ca Arsenate	0.0016	0.0000	0.0013	0.0265	0.0003	0.0000	0.0000	0.0001	0.0000	0.0107	0.0000	0.0000	0.0000	0.0000	0.0439	0.0148	0.0000	0.0068	0.0025	0.0003
FeOx with As	0.0674	0.0710	0.3055	0.0415	0.2120	0.0796	0.0415	0.0750	0.5329	0.1335	0.0831	2.6672	0.0541	0.0405	0.2912	0.1670	0.2207	0.4537	0.1282	0.0280
MnOx Mix, with As	0.6800	0.0283	0.1932	0.0001	0.0027	0.0206	0.0000	0.0004	0.0000	0.0000	0.0139	0.0047	0.0025	0.0255	0.8254	0.0004	0.0232	0.0000	0.0005	0.0302
Organics w/As,Fe,CaOx	0.0013	0.0039	0.0043	0.0013	0.0860	0.0001	0.0012	0.0019	0.0040	0.0000	0.0000	0.0010	0.0000	0.0000	0.0319	0.0095	0.0319	0.0006	0.0027	0.0002
Scorodite	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Aluminum	0.2862	0.4121	0.1686	0.3601	0.1470	1.2261	1.3384	0.1139	0.0921	0.0397	1.4021	0.0002	0.0021	0.0070	4.5021	4.3558	0.0189	0.0579	0.7672	0.0135
Amphiboles	7.8620	8.5290	17.72	5.6401	30.91	11.02	3.3764	2.7456	13.9065	7.3431	8.0520	7.0714	8.4991	1.2647	6.0086	4.0337	6.7500	6.4482	3.6983	2.1019
Andalusite	0.0657	0.0600	0.0151	0.0181	0.0323	0.0236	0.0095	0.0605	0.0263	0.0091	0.0327	0.0124	0.1272	0.0097	0.4112	0.1058	0.0168	0.0319	0.0893	0.0770
As-Pb Oxide?	0.0090	0.0298	0.0010	0.0010	0.0026	0.0781	0.0006	0.0039	0.0054	0.0083	0.6452	0.0006	0.0022	0.0000	0.0521	0.0130	0.0208	0.0136	0.0544	0.0001
Barite	0.0245	0.0017	0.0007	0.0053	0.0000	0.0000	0.0018	0.0135	0.0061	0.0978	0.0786	0.0019	0.0001	0.0038	0.0153	0.0244	0.0251	0.0035	0.0153	0.0046
Carbon	1.2721	1.4268	6.3887	0.1976	2.7189	0.3109	1.4651	0.8672	2.3827	2.5387	4.9540	0.9553	1.4005	16.1067	6.6271	0.8517	7.6689	4.7702	1.0053	0.9934
Carbonates	0.4368	1.4070	0.3153	0.1705	0.0874	0.2510	0.0718	0.8981	1.6842	0.2815	18.4441	0.8268	0.1442	1.5545	1.8091	0.2971	6.6828	2.9051	0.1791	0.1106
Chalcopyrite	0.0044	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0020	0.0000	0.0014	0.0002	0.0001
Covellite	0.0000	0.0000	0.0014	0.0000	0.0032	0.0001	0.0009	0.0047	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0085	0.0000	0.0000
Cuprite	0.0010	0.0022	0.0013	0.0000	0.0370	0.0001	0.0045	0.1134	0.0012	0.0034	0.1191	0.0001	0.0005	0.0005	0.0006	0.0008	0.0060	0.0040	0.0002	0.0004
Diopside	0.0060	0.0154	0.0138	0.0587	0.0171	0.0102	0.0038	0.0211	0.0063	0.0074	0.4505	0.0002	0.0024	0.0126	0.0307	0.0207	0.0456	0.0523	0.0035	0.0035
Epidote	1.0824	0.6191	1.9269	0.6019	4.8810	4.4074	0.1183	0.3566	0.9734	0.6196	1.9031	0.1754	0.4457	0.0904	0.6245	0.6920	1.0861	1.0691	0.1985	0.2529
Feldspars	44.1439	40.5136	22.2618	36.7539	39.2762	32.5292	42.5736	43.9832	34.8061	35.6173	17.8643	25.5509	37.6969	14.5899	36.0386	40.9044	30.6503	34.8106	41.2792	43.2920
Fe Oxides - No As	0.2993	0.1263	0.9754	0.2059	0.5386	0.3694	0.0993	0.2464	0.7691	0.1313	0.4856	2.6134	1.0805	0.1317	0.5591	0.3184	0.2738	1.0762	0.3152	0.0963
Galena	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Garnets	0.5385	0.0692	0.2905	0.2926	1.0965	1.2930	0.0640	0.3073	0.0457	0.0410	0.0533	6.2997	1.5969	0.0780	0.7343	0.3627	1.5510	1.2635	0.9184	0.1919
Gold	0.0000	0.0002	0.0000	0.0002	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0004	0.0000	0.0000
Gypsum	0.0454	0.0491	0.0382	0.0042	0.0005	0.0016	0.0000	0.1216	0.0158	0.0017	0.3008	0.0069	0.0021	0.0008	0.0242	0.0032	0.0375	0.0775	0.0053	0.0014
Lead contamination	0.0000	0.0084	0.0000	0.0002	0.0000	0.0870	0.0000	0.0000	0.0000	0.0007	0.0000	0.0047	0.0020	0.0000	0.0125	0.0016	0.0000	0.0000	2.3678	0.0000
Low_Counts	0.5418	1.6105	0.4721	0.2322	0.5734	0.6798	3.4419	1.5241	4.9206	1.6453	7.8320	0.4803	2.0151	2.1029	1.2238	0.2386	3.8391	1.5218	1.1036	0.5148
Micas	11.7581	12.8701	14.5139	15.8753	10.6325	10.0087	10.4277	12.3743	14.3784	17.5390	7.7761	21.7300	16.3016	5.1223	17.0308	15.5616	16.6935	18.9650	25.1237	20.0991
MnOx No As	0.5668	0.2894	1.5281	0.0000	0.0004	0.0285	0.0000	0.0050	0.0000	0.0031	0.0000	0.0788	0.0092	0.1724	0.1233	0.0016	0.0075	0.0000	0.0000	0.0041
NiCr Contamination	0.0035	0.0185	0.0003	0.0001	0.0012	0.0001	0.0000	0.0037	0.0042	0.0000	0.1010	0.0002	0.0017	0.0063	0.0064	0.0036	0.0018	0.0504	0.0000	0.0000
No_XRay	0.0196	0.0152	0.0225	0.0073	0.0024	0.0055	0.0048	0.0099	0.0099	0.0094	0.0119	0.0140	0.0078	0.0026	0.0113	0.0046	0.0128	0.0197	0.0054	0.0037
Olivine	0.0920	0.0508	0.0463	0.1998	0.0400	0.0135	0.0550	0.0420	0.2026	0.0308	0.0095	0.2252	0.0189	0.0524	0.0244	0.0404	0.1571	0.1398	0.0453	0.0419
Organics w/FeOx, no As	0.6500	0.6183	1.3759	0.0600	0.3051	0.5006	0.0564	0.2528	0.1592	0.1378	0.3296	13.2671	0.9493	0.4242	0.6605	0.1298	4.3149	0.4700	0.5418	0.0498
Organics_No As	0.3450	0.7513	5.5173	0.0701	0.1235	0.0448	0.0908	0.5987	0.1819	0.6687	7.1930	0.1468	0.2382	40.7041	1.4424	0.2518	3.5141	2.1296	0.1580	0.0456
Pentlandite	0.0003	0.0000	0.0000	0.0000	0.0000	0.0001	0.0006	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000
Phosphates	0.0263	0.0139	0.0860	0.0190	0.0161	0.0286	0.0075	0.0522	0.0187	0.1923	0.0391	0.0048	0.0225	0.0292	0.0337	0.0032	0.0095	0.0355	0.0033	0.0237
Pyrite	0.0082	0.0025	0.0055	0.0031	0.0017	0.0011	0.0100	0.0335	0.1594	0.0437	0.0415	0.0019	0.0002	0.0050	0.0404	0.0195	0.0133	0.0201	0.0019	0.0009
Pyroxene	0.0282	0.0319	0.0290	0.0304	0.0259	0.0070	0.8038	0.0243	0.2100	0.0882	0.5378	0.5341	0.0265	0.0737	0.0557	0.0216	0.0892	0.0471	0.0127	0.0055
Pyrrhotite	0.0114	0.0499	0.0228	0.0050	0.0049	0.0009	0.0385	0.0383	0.0247	0.3380	0.0499	0.0064	0.0008	0.2788	0.0282	0.0216	0.0164	0.0229	0.0053	0.0033
Quartz	27.3520	28.4907	24.0150	38.5551	6.9795	36.17	35.0809	33.2787	23.0462	29.4586	15.9945	13.6569	27.7816	9.3444	18.8156	30.6093	13.9094	21.6558	21.6185	31.7210
Realgar	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Salts	0.4191	0.4200	0.2903	0.0299	0.0034	0.0006	0.0011	0.2172	0.0076	0.8306	0.6494	0.0415	0.0973	4.0860	0.0319	0.0040	0.1441	0.1271	0.0032	0.0019
Silica	0.0000	0.0265	0.0000	0.0252	0.0057	0.0142	0.0888	0.1850	0.0118	0.0000	0.1951	0.0099	0.0067	0.0000	0.0153	0.0370	0.0728	0.0251	0.0047	0.0067
Sphalerite	0.0000	0.0002	0.0048	0.0019	0.0005	0.0000	0.0000	0.0020	0.0168	0.0037	0.0000	0.0019	0.0001	0.0000	0.0003	0.0004	0.0000	0.0006	0.0004	0.0001

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%
Stibnite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ti - Bearing Minerals	0.5023	0.5955	0.5514	0.3583	1.1515	0.5803	0.3096	0.5330	0.6821	0.7766	0.6942	0.4717	1.2297	0.1455	0.5939	0.3325	0.5489	0.4961	0.1825	0.2174
Unknown	0.6646	0.6483	0.5790	0.1176	0.0330	0.0343	0.0421	0.6298	0.3951	0.7904	3.2432	0.0839	0.1708	3.2858	0.4046	0.0992	1.2321	0.5184	0.0471	0.0293
Vanadium	0.1071	0.0555	0.0874	0.0097	0.0086	0.0015	0.2977	0.2323	0.0424	0.0581	0.1218	0.0105	0.0036	0.2277	0.1067	0.0204	0.2132	0.1479	0.0139	0.0046
Zinc	0.0048	0.0017	0.0032	0.0002	0.0002	0.0014	0.0004	0.0043	0.0033	0.0092	0.1031	0.0012	0.0001	0.0096	0.0207	0.0021	0.0191	0.0140	0.0005	0.0007
Zircon	0.0239	0.0266	0.0164	0.0111	0.0087	0.0052	0.0627	0.0154	0.0266	0.0592	0.0987	0.0068	0.0221	0.0012	0.0106	0.0081	0.0024	0.0096	0.0047	0.0142
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%
Arsenolite	0.0001	0.0000	0.0025	0.0000	0.0757	0.0002	0.0003	0.0032	0.0000	0.0326	0.2588	0.0028	0.0001	0.0011	0.0000	0.0000	0.0078	0.0000	0.0000	0.0000	0.0077	0.0000	0.0037	0.0248
Arsenopyrite	0.0003	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1149	0.0000	0.0000
As-Bearing Pyrite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0116	0.0000	0.0079	0.0000	0.0000
Enargite	0.0001	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0000	0.0036	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000
Fe Oxides Mix - with As	0.0004	0.0025	0.0107	0.0237	0.0070	0.7083	0.0038	0.0040	0.0148	0.0033	0.0202	0.0007	0.5058	0.0362	0.0000	0.0544	0.0096	0.0030	0.0375	0.0390	0.0895	0.0000	0.0294	0.0058
Fe-Ca Arsenate	0.0003	0.0000	0.0000	0.0000	0.0018	0.0001	0.0000	0.0000	0.0004	0.0023	0.0205	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0030	0.0000	0.0000	0.0012	0.0145	0.0028	0.0017
FeOx with As	0.0090	0.0309	0.0294	0.0360	0.2400	0.1741	0.1200	0.1552	0.0312	0.0742	0.5110	0.0051	0.0355	0.0888	0.2330	0.6392	0.2735	0.2466	0.2671	0.3935	0.2390	0.8574	0.1602	0.7199
MnOx Mix, with As	0.0179	0.0019	0.0009	0.0041	0.0015	0.0092	0.1111	0.2253	0.0095	0.0478	0.0000	0.0006	0.2730	0.0016	0.0000	0.0000	0.0109	0.0030	0.0000	0.5862	0.0105	0.0000	0.0004	0.0403
Organics w/As,Fe,CaOx	0.0000	0.0013	0.0033	0.0000	0.0006	0.0000	0.0001	0.0001	0.0012	0.0000	0.0314	0.0000	0.0000	0.0004	0.1128	0.0656	0.0000	0.0194	0.0237	0.0014	0.0000	0.0225	0.0030	0.0305
Scorodite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Aluminum	0.5935	0.0062	0.0005	0.0025	0.0200	1.5832	0.7108	1.6940	0.0036	0.6043	0.1511	0.0013	0.0874	0.6408	0.0732	1.4541	4.0480	0.2445	5.1238	0.0000	0.7266	0.0000	0.0127	0.0830
Amphiboles	0.5970	2.1114	0.9821	0.8753	2.4847	1.6898	12.25	7.7517	0.5297	0.8748	4.8658	0.8763	4.6620	1.1720	0.8034	1.1814	0.9648	0.5408	1.1866	5.7919	1.3882	1.1415	1.7363	2.9169
Andalusite	0.0922	0.0327	0.0054	0.0184	0.2133	0.0158	0.0285	0.0073	0.1194	0.0160	0.0345	0.0885	0.0997	0.2196	0.0235	0.0072	0.7102	0.0000	0.0000	0.0007	0.0201	0.0000	0.0000	0.0000
As-Pb Oxide?	0.0003	0.0002	0.0040	0.0001	0.0042	0.0001	0.0002	0.0090	0.0034	0.0001	0.0148	0.0004	0.0002	0.0000	0.0009	0.0079	0.0104	0.0000	0.0000	0.0000	0.0018	0.0000	0.0025	0.0086
Barite	0.0029	0.0041	0.0000	0.0000	0.0025	0.0178	0.0001	0.0004	0.0012	0.0063	0.0203	0.0005	0.0000	0.0067	0.0720	0.1849	0.0026	0.0469	0.0000	0.0019	0.0359	0.0000	0.0102	0.0000
Carbon	0.0980	0.2987	0.5950	0.1135	0.2788	0.6801	0.9429	1.4776	0.1708	0.1842	8.1498	0.1337	5.0309	1.5394	5.6865	1.3682	0.9080	0.6996	5.0265	5.9766	12.5262	2.2565	0.2775	1.2547
Carbonates	0.0099	0.2303	1.4732	0.0442	0.4489	0.1094	0.0378	0.3471	0.2976	0.3275	14.87	0.0187	0.0241	0.3309	1.2899	2.7968	1.7498	9.9853	0.7967	1.2389	1.8676	14.1745	0.4986	22.6173
Chalcopyrite	0.0000	0.0002	0.0000	0.0000	0.0016	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0118	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Covellite	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0367	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cuprite	0.0000	0.0026	0.0008	0.0000	0.0013	0.0002	0.0001	0.0000	0.0136	0.0018	0.0093	0.0000	0.0001	0.0104	0.0022	0.1213	0.3476	0.0299	0.0456	0.0092	0.0055	0.0119	0.0032	0.0110
Diopside	0.0003	0.0055	0.0143	0.0010	0.0008	0.0005	0.0005	0.0001	0.0018	0.0033	0.1039	0.0014	0.0351	0.0000	0.0004	0.0951	0.1078	0.1759	0.1542	0.0324	0.0018	0.1704	0.0039	0.0467
Epidote	0.1933	0.2715	0.2311	1.7120	0.3032	0.0310	0.1114	0.1736	0.9008	0.0409	1.4193	0.1121	1.0847	0.2102	0.1929	0.0688	0.4508	0.0878	0.3583	1.2640	0.0129	0.0568	0.0448	0.0865
Feldspars	43.2920	44.6149	60.2974	42.6546	49.2305	29.2874	13.1039	44.6161	36.2782	41.2599	48.7235	17.9941	44.2189	48.5234	41.1536	28.0297	17.2781	21.5461	2.8644	9.2713	20.5996	8.9720	5.2555	60.6967
Fe Oxides - No As	0.0716	0.1685	0.0631	0.1336	0.3884	0.7174	0.1796	0.3786	0.0753	0.0983	1.2286	0.0518	0.1095	0.2350	0.6882	1.0771	1.0272	0.3831	0.4958	0.3653	0.8421	0.7055	0.2718	2.1654
Galena	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Garnets	0.1614	0.1200	0.1258	0.3850	1.0591	0.5027	0.3835	0.1159	0.0250	0.0336	0.2240	0.0291	0.7970	0.3261	4.4406	0.4392	0.1720	0.0896	0.0765	0.4489	0.0522	0.0846	0.1008	0.0565
Gold	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0023
Gypsum	0.0001	0.0194	0.0231	0.0007	0.0077	0.0014	0.0010	0.0000	0.0099	0.0024	0.2860	0.0001	0.0005	0.0060	0.0287	0.0924	0.0052	1.3595	0.0000	0.0556	0.0080	0.0251	0.1122	0.0375
Lead contamination	0.0021	0.0000	0.0000	0.0000	0.0046	0.0000	0.0000	0.0097	0.0773	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Low_Counts	0.1154	0.2447	1.9280	0.3000	0.4830	0.2340	0.3040	0.0542	0.5810	0.2049	8.8053	0.0303	0.9077	2.1514	7.9171	7.7989	10.6987	59.1029	23.9686	9.0929	37.1494	31.8012	2.6819	6.0241
Micas	9.3379	12.3910	7.4614	9.6129	21.8217	19.1478	13.2457	15.0762	4.8355	19.0202	12.7426	3.2673	7.6102	8.5204	18.5119	21.9492	43.5198	9.0441	8.2759	17.8073	9.4558	22.7157	16.6750	18.9235
MnOx No As	0.0085	0.0001	0.0000	0.0001	0.0562	0.0762	0.2122	0.7266	0.3229	2.1232	0.0000	0.0001	1.2752	0.0000	0.0000	0.0000	0.4210	1.4855	0.0000	3.2941	0.0000	0.0000	0.0601	1.2801
NiCr Contamination	0.0001	0.0027	0.0005	0.0005	0.0026	0.0167	0.0004	0.0011	0.0022	0.0000	0.0022	0.0002	0.0003	0.0351	0.0009	0.0046	0.0194	0.1621	0.0069	0.0419	0.0525	0.0291	0.0041	0.0161
No_XRay	0.0009	0.0037	0.0030	0.0020	0.0056	0.0021	0.0059	0.0066	0.0023	0.0023	0.0160	0.0009	0.0004	0.0085	0.0039	0.0144	0.0105	0.0319	0.0234	0.0016	0.0198	0.0251	0.0042	0.0236
Olivine	0.0119	0.0374	0.0436	0.0078	0.0379	0.0108	0.0146	0.0740	0.0056	0.0016	0.0100	0.0388	0.0051	0.0117	1.7883	0.0197	0.0069	0.0030	0.0000	0.1264	0.0597	0.0000	0.0037	0.0000

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%
Organics w/FeOx, no As	0.1619	0.0666	0.1872	0.1717	0.6997	1.2798	0.2953	0.4463	0.0517	0.1744	0.6179	0.0205	4.8048	0.4081	0.2126	0.3101	0.3038	0.4171	0.1428	0.5905	0.2129	0.3105	0.1155	0.2922
Organics_No As	0.0058	0.1918	0.7851	0.0666	0.0407	0.2371	0.5124	0.5769	0.3149	1.4105	7.4027	0.0151	######	0.2134	0.9857	0.6687	1.1968	1.9994	0.4417	8.5998	0.4059	3.2236	0.1621	2.3919
Pentlandite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0005	0.0048	0.0024	0.0000	0.0007	0.1070	0.0006	0.0000
Phosphates	0.0103	0.0074	0.0043	0.0035	0.0036	0.0105	0.0384	0.0297	0.0075	0.0603	0.0365	0.0057	0.0146	0.0380	0.1403	0.4170	0.0305	0.0463	0.1596	0.0000	0.0445	0.1030	0.0983	0.0628
Pyrite	0.0018	0.0033	0.0054	0.0001	0.0005	0.0015	0.0037	0.0179	0.0018	0.0000	0.0429	0.0017	0.0004	0.0162	0.0300	0.0000	0.0147	0.0000	0.1263	0.0263	0.0234	0.0000	0.0783	0.2011
Pyroxene	0.0028	0.0138	0.0161	0.0022	0.0339	0.0589	0.0200	0.0292	0.0062	0.0062	0.1847	0.0914	0.0023	0.0052	0.0000	0.0846	0.0560	0.0469	0.2281	0.0883	0.0139	0.0000	0.0000	0.0836
Pyrrhotite	0.0020	0.0041	0.0009	0.0002	0.0047	0.0038	0.0046	0.0179	0.0022	0.0011	0.0081	0.0010	0.3083	0.0625	0.2164	0.1016	0.0564	0.0875	0.0600	0.1709	0.2515	0.1797	0.0696	0.0501
Quartz	43.4621	22.8203	42.7936	36.9483	41.2017	59.0240	25.5423	33.3898	49.7861	25.2323	16.3098	50.7723	10.5155	41.2934	26.9684	34.6814	9.9114	8.1364	39.5190	18.7081	21.5399	10.8506	14.4874	21.5396
Realgar	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Salts	0.0001	0.0496	0.0316	0.0004	0.1040	0.0026	0.0049	0.0044	0.1871	0.0000	0.2863	0.0007	0.3226	0.0407	0.0732	0.0485	0.0063	0.0328	0.1756	0.2503	1.0446	0.2920	0.0209	0.0184
Silica	0.0030	0.1306	0.1125	0.0188	0.0200	0.0003	0.0000	0.0000	0.0026	0.0000	0.1264	0.0061	0.0001	0.0716	0.1626	0.0000	0.0237	0.0000	0.9069	0.0000	0.3629	0.0000	0.1138	0.2634
Sphalerite	0.0000	0.0003	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	0.0003	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0006	0.0066	0.0000	0.0000
Stibnite	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ti - Bearing Minerals	0.3066	0.2134	0.1432	0.2443	0.3513	0.4425	0.2078	0.4432	0.0477	0.4402	0.2892	0.1792	0.0865	0.2296	0.2377	1.4902	0.4223	0.3726	0.3172	0.8525	0.4299	0.2959	0.1730	1.1106
Unknown	0.0622	0.1369	0.2410	0.0123	0.2756	0.0833	0.0733	0.3899	0.1955	0.1670	2.0531	0.0148	0.0596	0.3465	0.1523	1.0712	0.2391	0.3715	0.1795	0.4719	0.3290	0.5945	0.1149	0.2888
Vanadium	0.0307	0.0583	0.0068	0.0022	0.0096	0.0063	0.0154	0.0738	0.0978	0.0642	0.7744	0.0043	0.0216	0.5555	0.6558	4.2515	0.6982	1.8671	2.5916	3.0136	1.7588	4.5659	1.1514	2.0495
Zinc	0.0001	0.0026	0.0061	0.0002	0.0003	0.0003	0.0002	0.0087	0.0010	0.0007	0.0026	0.0000	0.0001	0.0006	0.2297	0.0800	0.0026	0.0000	0.0000	0.0249	0.0006	0.0000	0.0005	0.2818
Zircon	0.0100	0.0130	0.0098	0.0250	0.0139	0.0158	0.0036	0.0023	0.0020	0.0133	0.0724	0.0067	0.0006	0.0107	0.0349	0.0282	0.0076	0.0024	0.0096	0.0222	0.0349	0.0000	0.0133	0.1372
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count
Arsenolite	38	11	18	26	18	2	6	0	86	244	8	13	5	11	904	1178	16	141	585	141
Arsenopyrite	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0	0	0	0
As-Bearing Pyrite	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enargite	1	1	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Fe Oxides Mix - with As	16	9	181	38	175	1242	2	10	3	2	4	2289	36	2	56	60	9	12	129	19
Fe-Ca Arsenate	1	0	1	18	1	0	0	1	0	7	0	0	0	0	72	38	0	5	41	3
FeOx with As	135	80	391	404	1795	1148	31	143	168	37	11	4234	161	23	622	903	55	199	731	489
MnOx Mix, with As	421	29	245	2	26	274	0	2	0	0	1	10	9	12	371	1	7	0	3	186
Organics w/As,Fe,CaOx	5	14	15	21	1360	3	3	14	1	0	0	3	0	0	62	40	9	1	16	5
Scorodite	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	27	73	36	247	1792	118	13	27	5	2	61	1	3	4	48	77	6	5	26	17
Amphiboles	4796	4213	12641	18840	303912	70334	894	2636	1328	1401	508	8688	11455	668	3818	6384	1064	1275	14467	16804
Andalusite	51	54	14	56	172	197	3	69	5	2	8	6	124	3	169	53	11	8	193	358
As-Pb Oxide?	5	18	5	29	4	69	2	3	5	9	10	7	28	0	87	31	13	8	151	5
Barite	62	5	2	118	2	2	3	53	8	110	39	8	3	1	36	155	3	2	191	12
Carbon	1430	1440	6205	2467	12301	5992	133	1245	94	1017	569	2826	1948	3353	5383	2737	1490	1175	5506	9567
Carbonates	389	676	348	859	1950	1543	54	992	46	80	1314	450	316	152	1189	730	1108	608	1002	989
Chalcopyrite	1	0	0	3	1	3	0	0	1	0	0	0	0	0	4	4	0	1	3	2
Covellite	0	0	1	0	2	1	1	8	0	0	0	0	0	0	0	0	0	1	0	0
Cuprite	3	11	5	1	78	4	3	207	2	6	7	2	1	3	2	8	5	2	6	9
Diopside	6	14	22	44	537	96	2	30	1	1	18	2	9	9	18	60	10	5	26	33
Epidote	553	481	1350	1801	27696	27722	45	287	136	113	154	326	1150	42	418	1244	157	134	1079	2449

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count
Feldspars	19268	15420	12105	50523	697737	103241	3373	22070	2572	4582	1137	23463	46098	3081	13138	15825	4395	5106	63879	76783
Fe Oxides - No As	407	149	630	1836	5098	7535	53	365	174	40	31	6345	1291	53	1088	1529	112	400	3563	1400
Galena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnets	808	102	494	2026	14633	27797	43	660	20	14	9	14445	4204	61	1045	580	448	412	9244	3338
Gold	0	1	0	3	1	0	0	2	0	0	1	0	0	0	1	0	0	1	0	0
Gypsum	21	34	24	21	2	11	0	87	3	1	22	5	5	1	15	5	6	12	12	16
Lead contamination	0	1	0	4	0	14	0	0	0	1	0	2	8	0	2	4	0	0	18	0
Low_Counts	319	345	293	2090	28890	20546	248	695	196	191	455	2265	1947	552	2006	955	708	499	10301	10570
Micas	9168	8082	10426	39436	229322	97352	2694	9930	1213	2364	596	27420	25989	1721	12463	13784	3095	3956	60656	80660
MnOx No As	350	95	971	0	12	393	0	3	0	3	0	104	27	52	75	2	5	0	0	23
NiCr Contamination	6	3	2	5	8	2	0	16	6	0	7	4	9	5	6	5	3	8	1	2
No_XRay	487	317	581	2067	1494	3953	54	387	55	106	43	1109	1191	66	319	403	90	135	1400	2050
Olivine	75	44	44	410	288	238	11	47	20	11	3	394	34	6	43	134	12	14	120	140
Organics w/FeOx, no As	994	315	2123	845	4090	10611	54	491	91	53	63	28015	1845	188	1407	898	1058	296	2962	1097
Organics_No As	438	647	4723	684	775	768	38	799	44	265	841	593	312	5901	1021	838	820	419	1138	704
Pentlandite	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	1	0	0	0
Phosphates	23	12	56	99	102	188	6	51	3	20	5	13	69	7	17	17	3	7	34	152
Pyrite	6	5	7	18	11	7	7	16	10	5	4	5	1	3	19	29	5	5	12	20
Pyroxene	12	24	18	152	639	159	5	31	50	14	12	1046	100	12	22	78	11	17	66	48
Pyrrhotite	19	36	19	47	60	38	10	52	12	54	12	25	11	66	69	74	15	15	42	57
Quartz	14759	10760	10888	42758	134326	77006	2097	15866	2033	3035	967	15585	37102	2275	8209	10910	2283	3216	39982	54151
Realgar	1	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0
Salts	274	280	251	247	27	14	1	256	3	169	28	67	97	1446	25	13	29	20	16	24
Silica	0	3	0	97	15	81	13	57	1	0	7	1	9	0	7	42	2	3	8	27
Sphalerite	0	1	3	4	4	0	0	5	3	2	0	1	1	0	2	10	0	1	4	3
Stibnite	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ti - Bearing Minerals	709	711	776	2537	7185	8218	189	818	194	241	56	974	2938	85	678	1237	116	213	1755	3284
Unknown	324	366	393	1025	912	859	29	580	76	269	248	252	673	1024	289	265	212	117	387	508
Vanadium	325	160	265	301	82	76	238	694	25	48	50	48	33	85	201	173	131	119	222	124
Zinc	5	6	5	10	3	7	1	18	1	2	6	5	2	2	10	8	7	8	5	7
Zircon	27	42	23	150	240	208	11	45	16	31	27	52	249	2	28	55	5	13	95	225
Total	56766	45090	66600	172371	1477784	468074	10371	59771	8710	14557	7343	141103	139494	20977	55467	61577	17535	18594	220078	266501

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count
Arsenolite	6	0	6	1	180	4	3	4	0	88	54	94	3	1	0	0	4	0	0	0	3	0	4	3
Arsenopyrite	1	1	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
As-Bearing Pyrite	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0
Enargite	1	3	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	1	0
Fe Oxides Mix - with As	6	12	12	189	14	714	22	5	5	4	5	14	4620	7	0	2	4	1	3	6	7	0	6	1
Fe-Ca Arsenate	3	1	0	0	10	2	0	0	1	7	4	1	1	0	0	0	0	1	0	0	1	1	1	1
FeOx with As	144	198	37	647	394	1093	330	156	46	117	111	193	660	37	15	30	135	41	28	27	60	16	82	29
MnOx Mix, with As	82	7	2	26	3	123	458	199	11	56	0	5	2223	1	0	0	7	1	0	29	2	0	1	2

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count	Grain Count
Organics w/As,Fe,CaOx	3	5	5	2	1	0	1	1	6	0	3	1	0	1	16	5	0	4	3	1	0	1	2	3
Scorodite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	120	17	1	31	9	431	160	111	1	65	15	6	255	7	3	6	11	3	4	0	8	0	4	3
Amphiboles	3708	7452	811	21322	2898	20936	35687	6019	468	525	403	4399	77905	399	362	36	213	27	57	282	94	20	203	79
Andalusite	300	118	4	148	18	210	52	9	2	6	11	92	976	13	2	1	8	0	0	1	5	0	0	0
As-Pb Oxide?	9	3	4	4	15	8	3	29	2	1	3	21	1	0	1	1	4	0	0	0	3	0	2	2
Barite	42	9	0	1	16	12	1	2	3	19	2	20	1	7	5	24	4	3	0	3	3	0	9	0
Carbon	1392	1112	532	2331	474	6922	4382	1414	231	227	593	2446	27804	89	398	30	191	39	64	291	147	23	102	61
Carbonates	115	981	1020	1115	240	814	98	206	143	186	1367	354	249	87	82	51	215	449	52	60	183	189	131	431
Chalcopyrite	0	3	0	1	2	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Covellite	2	5	0	0	0	0	1	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0
Cuprite	2	17	4	5	6	8	2	0	21	5	7	7	5	2	2	11	4	7	2	1	5	1	1	3
Diopside	3	19	12	59	3	11	1	1	2	5	8	19	125	0	1	1	21	19	5	3	1	1	3	1
Epidote	555	1027	169	8254	188	387	527	139	441	53	105	1049	9901	68	23	7	27	7	11	16	3	2	15	5
Feldspars	27793	30211	3668	109858	10024	45392	55267	11943	3156	4502	1159	38706	64193	4895	4554	385	1126	136	320	803	628	66	857	269
Fe Oxides - No As	580	1062	105	3432	737	3328	1048	236	65	127	115	699	2622	61	55	37	470	23	29	22	85	12	75	32
Galena	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnets	2344	1389	168	11695	1215	9702	3445	250	57	45	29	872	20911	97	165	11	62	13	9	15	16	3	28	3
Gold	0	2	1	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1
Gypsum	2	65	11	11	5	23	2	0	11	1	23	2	5	3	2	3	2	31	0	2	3	2	4	1
Lead contamination	2	0	0	0	4	0	1	8	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Low_Counts	756	587	543	15397	138	2777	1278	54	180	70	661	1206	7439	183	1196	58	491	174	247	665	603	57	116	75
Micas	21012	23524	2028	90274	7262	48437	34544	5751	2767	2786	1024	18849	93521	1593	2083	494	3817	391	448	607	881	210	1267	400
MnOx No As	59	1	0	6	29	510	631	647	182	664	0	2	4309	0	0	0	54	46	0	173	0	0	19	37
NiCr Contamination	4	16	2	15	6	130	4	5	3	0	2	9	2	4	2	2	6	6	2	2	12	1	7	2
No_XRay	360	644	122	3165	233	1395	1038	186	74	78	50	768	436	62	22	10	65	75	50	5	96	9	35	19
Olivine	51	72	8	191	33	521	58	18	7	4	4	180	94	10	27	2	6	1	0	2	9	0	3	0
Organics w/FeOx, no As	1231	467	203	3371	959	9834	1626	675	71	156	114	477	24828	172	108	45	164	36	40	60	92	13	103	27
Organics_No As	141	721	737	465	70	2002	1176	651	286	182	866	335	8035	62	71	38	81	151	36	340	61	51	74	81
Pentlandite	2	0	0	1	0	1	3	0	1	1	0	0	0	1	0	0	1	3	1	0	1	1	2	0
Phosphates	75	32	14	78	9	120	85	14	10	23	10	37	143	13	6	11	10	8	9	0	14	5	26	5
Pyrite	12	12	3	4	4	21	5	7	3	0	9	8	3	1	2	0	4	0	1	3	4	0	7	4
Pyroxene	30	38	13	100	72	1770	181	29	4	5	10	181	57	3	0	2	4	4	3	3	3	0	0	2
Pyrrhotite	34	37	2	20	11	63	15	14	8	8	6	27	72	34	12	12	19	7	8	12	18	8	30	7
Quartz	21065	45360	1838	83862	8044	36635	28617	6915	1991	2726	1132	26749	75251	4505	2894	691	876	353	457	708	1256	110	934	296
Realgar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salts	3	199	27	12	110	17	6	1	73	0	27	15	87	8	18	3	4	2	11	16	5	3	4	1
Silica	20	139	25	166	8	2	0	0	3	0	4	48	2	2	3	0	3	0	3	0	15	0	3	3
Sphalerite	1	6	1	4	0	2	1	1	0	2	1	1	0	0	0	0	2	0	0	0	1	1	0	0
Stibnite	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ti - Bearing Minerals	1521	1624	233	6173	631	8807	1725	533	88	232	72	2319	4414	103	105	42	105	32	27	55	54	7	63	30
Unknown	449	530	211	514	321	3273	434	367	154	195	176	490	823	32	22	26	44	18	13	29	34	10	30	22
Vanadium	843	667	20	174	20	304	208	201	260	200	195	178	285	407	370	311	365	298	363	149	557	142	842	202
Zinc	2	11	8	10	2	7	3	2	2	3	3	3	4	1	3	13	2	0	0	1	1	0	1	3
Zircon	166	131	20	252	50	139	72	11	8	27	43	160	49	7	4	4	8	1	3	2	25	0	15	7
Total	85052	118537	12630	363386	34469	206895	173201	36816	10849	13401	8426	101048	432315	12980	12634	2408	8639	2413	2310	4395	4999	968	5112	2153

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron
Arsenolite	712.83035	385.17595	1239.262	436.144413	2487.26096	23.299868	116.4993	0	1254.983	4187.557	275.229696	213.97838	203.81441	209.69882	23708.344	40623.321	174.02089	4663.6143	17932.8894	6347.0298
Arsenopyrite	0	0	0	0	0	0	0	0	0	0	0	0	4.279568	0	16.01866	2.912484	0	0	0	0
As-Bearing Pyrite	0	0	0	0	7.281209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enargite	4.368725	6.553088	0	73.54021	0	5.824967	0	40.77477	0	0	0	0	0	0	0	0	0	0	3.640604	0
Fe Oxides Mix - with As	819.136	672.05558	5685.168	2359.8398	16529.8004	112088.386	8.00933	378.62286	46.5403	23.00268	166.011563	206623.41	4071.4737	65.53088	1105.2875	3079.9514	569.39054	149.992903	8066.85134	816.951639
Fe-Ca Arsenate	55.337188	0	42.95913	8649.34805	170.380288	0	0	4.368725	0	104.8494	0	0	0	0	1616.4284	1570.5568	0	61.890276	711.37411	186.398948
FeOx with As	2261.5435	1909.133	9919.919	13540.1361	116938.399	55799.5444	588.3217	3653.7106	3073.799	1304.733	388.088434	181881.09	6194.1393	1127.8593	10717.211	17778.528	2090.4351	4131.35793	36127.9023	15190.7861
MnOx Mix, with As	22813.484	760.88633	6273.49	32.76544	1502.1134	14437.181	0	17.474901	0	0	64.802759	318.29285	286.19609	709.91787	30371.379	39.318528	219.89251	0	147.808541	16398.7387
Organics w/As,Fe,CaOx	44.415374	104.12129	141.2555	415.757028	47467.6571	51.696583	17.4749	94.655716	23.00268	0	0	70.612867	0	0	1172.2746	1006.2631	302.17017	5.096846	753.605121	118.683705
Scorodite	0	0	0	0	597.787251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	9601.7302	11079.087	5474.013	117563.127	81127.2296	859076.345	18992.31	5544.6406	531.2013	388.3708	6547.263043	13.373649	238.5859	195.1364	165670.07	463801.36	179.11774	527.159524	216151.424	7317.61494
Amphiboles	263776.35	229317.31	575374.2	1841347.1	17051228.2	7722458.17	47911.81	133672.8	80210.87	71783.86	37600.16276	482216.87	973208.46	35195.908	221107.01	429503.95	63939.208	58713.48421	1041962.84	1139970.09
Andalusite	2203.2938	1612.0597	489.2972	5923.26344	17809.1088	16546.5472	134.7024	2947.4334	151.9247	89.33598	152.905387	846.81946	14563.904	270.13285	15130.352	11265.486	159.45848	290.520235	25155.1205	41733.7051
As-Pb Oxide?	302.89829	800.20486	32.03732	331.295005	1454.05742	54724.838	8.00933	190.76767	31.02687	81.31179	3012.964243	42.260731	252.49449	0	1918.5985	1388.5265	196.59264	123.780551	15318.2073	37.134165
Barite	822.04849	45.143495	21.11551	1722.73403	5.824967	29.852956	25.48423	655.3088	35.30643	955.9484	366.972929	126.24725	14.443541	107.03377	561.38121	2595.0229	238.09553	32.037319	4324.30997	2520.0264
Carbon	42680.99	38362.505	207481.7	64501.3172	1500012.04	217861.051	20790.04	42223.002	13743.3	24817.21	23133.85692	65147.859	160367.7	448254.52	243864.43	90694.01	72643.165	43435.32357	283234.657	538791.256
Carbonates	14656.345	37829.521	10240.29	55651.0077	48193.5936	175863.767	1019.369	43726.572	9714.084	2751.762	86127.96384	56379.56	16512.177	43262.759	66569.909	31640.493	63302.102	26452.63193	50473.3401	59977.5021
Chalcopyrite	147.80854	0	0	51.696583	20.387385	94.655716	0	0	86.66125	0	0	0	0	0	77.180814	210.42694	0	12.378055	44.415374	38.590407
Covellite	0	0	45.1435	0	1746.76202	54.609067	13.10618	230.0862	0	0	0	0	0	0	0	0	0	77.180814	0	0
Cuprite	34.221682	59.705913	42.95913	3.640604	20407.7723	74.268331	64.07464	5519.1563	6.954297	33.7016	556.28436	10.163973	61.518785	15.290539	21.843627	85.918265	56.793429	36.406044	52.424704	208.242575
Diopside	201.68949	412.84455	447.7943	19179.4324	9429.89365	7111.55673	54.60907	1028.8348	36.37633	72.21771	2103.541251	12.303757	271.75255	350.22615	1130.7717	2204.7501	431.77569	476.191062	992.428773	1920.05479
Epidote	36315.029	16646.3	62579.08	196507.45	2692864.1	3088075.01	1678.319	17361.315	5614.258	6056.658	8886.715462	11962.997	51035.984	2514.9296	22981.68	73688.747	10287.62	9734.248178	55916.0437	137154.676
Feldspars	1481064.9	1089278.3	722982.5	11999154.1	21668797.6	22791954.6	604127.7	2141372.2	200757.7	348183.5	83420.81037	1742392.3	4316572.6	406041.71	1326153.5	4355499	290333.11	316967.0421	11630045.6	23479277.5
Fe Oxides - No As	10042.971	3396.684	31676.17	67235.4111	297142.495	258857.17	1409.642	11996.52	4436.307	1283.87	2267.368451	178215.64	123723.91	3665.3606	20574.512	33906.405	2593.5666	9799.050938	88814.7299	52206.2678
Galena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnets	18068.32	1861.077	9433.534	95515.6265	604916.282	905935.293	908.6949	14960.7	263.7284	400.6745	249.017344	429593.7	182854.69	2169.8003	27019.838	38619.532	14692.023	11504.31006	258755.961	104102.356
Gold	0	5.824967	0	54.609067	132.518002	0	0	5.824967	0	0	3.640604	0	0	0	5.824967	0	0	3.640604	0	0
Gypsum	1521.7727	1320.8113	1239.99	1359.4017	265.036004	1104.55939	0	5922.5353	90.94081	16.58333	1404.545197	468.61266	238.05095	21.115506	889.03561	335.66373	355.32299	705.549142	1485.36662	754.333242
Lead contamination	0	227.17372	0	79.365177	0	60948.8153	0	0	0	6.419352	0	322.03747	230.56171	0	461.62864	171.83653	0	0	667107.272	0
Low_Counts	18178.266	43300.621	15332.04	75795.2003	316351.052	476298.096	48841.62	74203.528	28381.56	16083.69	36572.78418	32756.346	230740.92	58524.173	45032.093	25401.953	36365.27	13856.86866	310930.192	279216.886
Micas	394492.99	346035.81	471358.5	5182843.86	5865985.08	7012717.96	147970.9	602457.42	82933.21	171455.5	36312.11691	1481833.5	1866650.1	142555.88	626701.66	1657002.2	158128.2	172685.519	7078385.73	10900676
MnOx No As	19015.605	7779.9717	49627.26	0	222.076871	19998.5684	0	241.00802	0	30.49192	0	5373.5322	1049.029	4797.5885	4536.9213	166.01156	71.355847	0	0	2228.77804
NiCr Contamination	117.22746	498.03469	10.92181	42.231012	634.193295	76.452693	0	179.84586	24.07257	0	471.822337	14.443541	196.86011	176.20526	236.63929	378.62286	17.474901	458.716161	5.824967	14.562418
No_XRay	657.49316	408.47582	729.5771	2382.41155	1344.83928	3839.38145	68.44336	482.01603	57.23922	92.01071	55.337188	953.80865	897.10438	71.355847	415.02891	492.93784	121.59619	179.117739	1526.86951	2007.42929
Olivine	3085.7763	1366.6829	1504.298	65241.8161	22069.3442	9457.56224	779.8175	2042.3791	1168.857	300.6396	44.415374	15354.554	2160.1118	1456.9699	896.31682	4298.0976	1488.2791	1272.755316	12772.6967	22731.9342
Organics w/FeOx, no As	21807.221	16623.728	44684.05	19597.3738	168331.356	350764.229	800.933	12309.612	917.9673	1347.529	1539.247561	904722.54	108702.62	11805.024	24304.675	13817.55	40872.338	4279.894591	152646.176	27032.9443
Organics_No As	11574.938	20198.802	179182.5	22881.9271	68131.7279	31363.8073	1288.774	29150.32	1049.029	6536.505	33588.94478	10013.653	27275.825	1132809.8	53079.285	26812.324	33287.503	19390.58742	44503.4769	24732.0823
Pentlandite	10.193692	0	0	0	0	59.705913	8.00933	13.106176	0	0	0	0	0	0	0	0	8.737451	0	0	0
Phosphates	883.93876	374.25414	2793.8	6197.0369	8859.77499	20073.5648	107.0338	2543.3263	108.0591	1879.8	182.758343	327.92187	2581.6492	811.85479	1238.5336	340.03246	90.28699	323.285675	940.73219	12876.0898
Pyrite	276.68594	67.715243	179.8459	1023.73797	922.529168	779.817473	141.9836	1630.2627	919.5721	427.4218	193.680157	126.78219	23.537622	140.52733	1487.551	2072.2321	125.96491	182.758343	526.431403	489.297238
Pyroxene	945.82904	858.45453	942.1884	9934.48142	14315.5848	4929.37843	11406.74	1183.1964	1211.118	861.7979	2511.28895	36424.47	3030.4689	2051.8447	2049.6603	2295.037	845.34835	428.863204	3574.34545	3009.32364
Pyrrhotite	382.26347	1342.6549	740.4989	1630.26267	2699.87226	664.774373	546.0907	1864.7176	142.2956	3304.361	232.998685	438.12074	93.080597	7758.1281	1039.0285	2298.6777	155.08975	208.242575	1480.26977	1815.9335
Quartz	917681.34	766021.77	779920.9	12587173.6	3850609.81	25345294.8	497803.9	1620210.2	132927.7	287977.5	74689.18465	931306.68	3181199.5	260057.11	692377.44	3259281	131755.66	197186.0588	6090831.73	17203767.3
Realgar	53.152825	0	0	0	0	0	0	0	0	16.04838	5.096846	0	0	0	0	0	0	0	0	0

Salts	14060.743	11291.699	9429.166	9753.17932	1900.39552	449.97871	16.01866	10572.315	43.86557	8119.41	3032.623507	2829.3292	11145.064	113715.74	1173.7309	427.40696	1365.2267	1156.984094	910.879233	1018.64113
Silica	0	711.37411	0	8214.65988	3165.86963	9914.09404	1260.377	9004.671	67.93814	0	910.879233	676.17169	763.36789	0	563.56557	3939.134	689.53048	228.629959	1322.26754	3610.02337
Sphalerite	0	4.368725	155.0898	634.193295	270.13285	0	0	98.29632	96.82522	36.37633	0	128.38703	9.629027	0	9.465572	44.415374	0	5.824967	101.936925	46.599737
Stibnite	0	0	0	0	5.824967	0	0	0	0	2.139784	0	0	0	0	0	0	0	0	0	0
Ti - Bearing Minerals	16853.814	16009.922	17908.13	116958.787	635294.942	406576.88	4392.753	25950.957	3934.528	7591.418	3241.594202	32164.696	140807.41	4049.8084	21855.277	35404.878	5199.5113	4517.262002	51422.8097	117923.547
Unknown	22297.974	17431.214	18802.99	38397.4551	18208.1191	24033.8143	597.7873	30662.627	2278.87	7726.225	15144.91451	5723.9218	19557.089	91443.974	14890.072	10563.578	11671.05	4720.40773	13268.547	15875.9479
Vanadium	3594.0047	1492.6478	2838.943	3182.61641	4763.36686	1064.51274	4224.557	11308.446	244.4703	568.1126	568.662415	718.43242	407.09388	6336.108	3927.4841	2174.8971	2019.0792	1347.023647	3908.55294	2517.11392
Zinc	160.1866	45.871616	102.665	69.899605	126.693035	1008.44743	5.096846	207.51445	19.25806	90.40587	481.287908	82.381678	12.303757	266.49225	762.34257	224.26123	181.3021	127.421156	133.246123	366.244808
Zircon	800.93298	714.28659	532.9845	3612.20774	4783.75425	3617.30458	889.7637	752.14888	153.5295	578.8115	460.900523	463.2632	2524.9449	33.493561	391.72904	861.36701	22.571748	87.374507	1331.00499	7691.86908
Total	3355082	2688670.8	3247638	32647255.1	55170249.9	70066160.2	1419019	4868615.3	576788.9	977567.7	466968.6829	6819291	11450734	2783039	3679813	10648009	947245.23	910546.4821	28174101.9	54234716.5

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron
Arsenolite	56.793429	0	99.752562	12.378055	2772.6249	87.731137	33.701595	87.196191	0	937.76027	1093.64	2377.31471	114.31498	11.64993	0	0	61.90478	0	0	0	37.86229	0	41.50289	31.3092
Arsenopyrite	136.158606	8.00933	0	0	0	97.360165	0	2.139784	0	0	0	0	0	0	0	0	0	0	0	0	0	63.3465	0	0
As-Bearing Pyrite	0	0	0	0	0	0	0	0	0	0	0	0	0	2.184363	0	0	0	0	0	48.7841	0	4.36873	0	0
Enargite	69.171485	215.523783	0	0	0	0	0	7.489243	0	0	0	0	0	10.92181	0	0	0	8.737451	0	0	0	0	5.824967	0
Fe Oxides Mix - with As	178.389618	447.794347	432.50381	33575.8386	255.70417	345730.759	500.70942	109.66392	594.87477	95.755327	85.1901	589.777921	502506.807	379.351	0	60.4482	76.47061	7.281209	91.0151	163.827	440.5131	0	330.5669	7.28121
Fe-Ca Arsenate	139.07109	2.912484	0	0	66.333299	60.983839	0	0	16.74678	65.263407	86.6464	5.824967	2.912484	0	0	0	0	7.281209	0	0	5.824967	8.00933	32.03732	2.18436
FeOx with As	4367.99722	5487.11903	1184.6527	50934.9687	8785.4175	84963.327	15673.382	4281.1725	1253.0961	2131.7597	2159.61	4227.46989	35310.2226	931.9947	1434.398	710.084	2184.146	601.4279	648.028	1655.02	1176.643	472.55	1802.827	909.423
MnOx Mix, with As	8733.81008	334.207489	37.134165	5863.55753	54.564488	4512.80412	14507.734	6215.0022	380.80723	1372.6713	0	514.781469	271203.188	16.74678	0	0	86.6667	7.281209	0	2465.42	51.69658	0	4.368725	50.9685
Organics w/As,Fe,CaOx	18.203022	233.726806	131.78988	56.793429	21.397838	0	11.233865	1.604838	49.512221	0	132.518	6.553088	0	4.368725	694.6273	72.8292	0	47.32786	57.5216	5.82497	0	12.3781	34.22168	38.5904
Scorodite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	288988.997	1100.19067	18.203022	3569.97672	733.41091	772764.211	92858.06	46722.715	142.71169	17362.206	638.562	1111.11248	86827.688	6723.468	450.7068	1615.35	32330.32	596.331	12431.9	0	3577.986	0	142.7117	104.849
Amphiboles	290658.578	374454.371	39563.905	1239017.11	90957.931	824823.547	1599954.4	213799.71	21242.927	25132.296	20565.8	732105.896	4631839.1	12296.51	4946.125	1312.38	7705.325	1318.627	2878.99	24359.3	6835.599	629.096	19545.68	3685.02
Andalusite	44909.7684	5803.12349	217.70815	26075.4653	7806.4664	7704.82666	3720.5492	201.13968	4788.123	460.05353	145.624	73901.3579	99081.2345	2303.774	144.8961	8.01121	5671.935	0	0	2.91248	99.02444	0	0	0
As-Pb Oxide?	169.652167	40.77477	160.1866	123.780551	155.13433	71.682759	25.677406	247.67998	135.43049	3.744622	62.6184	369.885412	155.81787	0	5.824967	8.7395	83.02524	0	0	0	8.737451	0	28.39672	10.9218
Barite	1429.30131	734.673978	0	45.143495	92.010705	8663.98477	16.583325	11.768811	47.327858	179.74184	85.9183	378.622863	2.912484	70.62773	443.4256	205.378	21.12046	114.315	0	8.00933	176.9334	0	115.0431	0
Carbon	47734.8774	52981.7166	23971.196	160651.865	10206.234	331986.393	123180.94	40752.718	6849.4332	5292.2204	34445.9	111686.463	4998423.22	16150.45	35010.24	1519.94	7252.327	1705.987	12196	25136.2	61679.12	1243.63	3123.639	1585.12
Carbonates	4808.51036	40834.4758	59349.134	62592.9123	16432.47	53395.0961	4938.6211	9572.858	11936.814	9407.5597	62860.1	15643.6773	23950.8086	3471.68	7941.615	3106.89	13975.19	24349.09	1933.16	5210.43	9196.167	7812.01	5613.084	28572.9
Chalcopyrite	0	35.677924	0	2.912484	59.913948	84.521462	0	0	0	0	0	0	16.74678	0	0	13.1092	0	0	0	0	0	0	0	0
Covellite	8.00933	278.14218	0	0	0	0	8.024189	0	0	0	0	24.027989	0	0	0	40.7843	0	0	0	0	0	0	0	0
Cuprite	8.737451	452.891194	31.309198	50.240341	47.075244	82.381678	6.954297	0	546.09067	50.819866	39.3185	40.046649	145.624178	109.2181	13.8343	134.734	2776.247	72.81209	110.674	38.5904	26.94047	6.55309	35.67792	13.8343
Diopside	128.149277	976.410113	575.2155	1470.8042	28.887082	259.983737	70.612867	2.139784	73.54021	93.615543	439.057	1143.87792	34895.1937	0	2.184363	105.602	860.8406	428.8632	374.254	136.159	8.737451	93.9276	43.68725	58.9778
Epidote	94135.1093	48157.1875	9311.9381	2423571.5	11100.129	15141.1105	14554.81	4788.3013	36127.902	1174.7413	5998.99	93642.8995	1077688.82	2205.478	1187.565	76.4706	3600.673	214.0675	869.376	5316.01	63.34652	31.3092	504.5878	109.218
Feldspars	21722463.7	10693448.4	1718412.6	69691164.1	1072118.9	6396211.36	5828547.6	1000584.9	1654793.8	1399802.2	76053.7	36941809	48209728	431763.3	172570.5	19194.1	172082.9	6984.864	22495.3	86636.9	44178.01	2896.46	683252.6	18762.9
Fe Oxides - No As	34858.7876	29879.1688	2542.5981	189109.742	14217.259	350158.507	23460.055	10443.215	3019.5173	2822.9098	5192.96	43280.2338	108806.017	2465.417	4236.935	1196.58	8204.204	934.1791	1202.86	1536.34	4146.648	388.817	3059.564	2735.55
Galena	0	0	0	0	0	96.825219	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnets	78597.0095	21275.6924	5069.9058	544998.486	38768.604	245356.709	50101.434	3196.3021	1004.0787	966.1124	946.557	24306.8597	791880.252	3421.44	27339.48	487.955	1373.558	218.4363	185.671	1888.02	257.0267	46.5997	1135.14	71.3558
Gold	0	11.649934	2.912484	0	0	9.629027	0	0	0	0	0	2.184363	0	0	0	0	0	0	2.91248	0	0	0	0	2.91248
Gypsum	66.259001	3435.27436	931.26662	1001.89435	281.38158	697.034586	136.94617	0	396.09776	68.473083	1208.68	63.346517	478.375425	63.34652	176.9334	102.689	41.51262	3315.134	0	233.727	39.31853	13.8343	1263.29	47.3279
Lead contamination	1025.92233	0	0	0	167.43809	0	3.209676	268.00793	3101.0669	0	0	551.187514	0	0	0	0	0	0	0	0	0	0	0	0
Low_Counts	56199.2828	43399.6456	77672.296	424638.647	17682.639	114212.032	39710.109	1495.7089	23301.325	5887.6152	37216.4	25349.5288	901855.631	22571.75	48743.32	8663.76	85447.54	144122.8	58155.7	38242.4	182923.6	17526.6	30190.08	7610.32

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron	micron
Micas	4546522.27	2197491.42	300595.24	13608145.5	798821.96	9346359.16	1730389.7	415814.03	193935	546441.41	53857.6	2729637.84	7560988.62	89391.4	113972	24383.2	347580.8	22054.05	20080.1	74893.1	46560.42	12519.3	187707.4	23906.4
MnOx No As	4161.93901	16.74678	0	120.139947	2058.4721	37179.8141	27718.76	20040.68	12949.63	60997.213	0	47.327858	1266989.33	0	0	0	3362.522	3622.401	0	13854	0	0	676.4243	1617.16
NiCr Contamination	43.687253	485.656634	18.931143	748.508275	96.825219	8146.69203	57.774164	29.956974	88.830749	0	9.46557	171.83653	274.501576	368.4292	5.824967	5.09804	155.1261	395.3696	16.7468	176.205	258.4829	16.0187	46.59974	20.3874
No_XRay	418.669512	653.124438	119.41183	2883.35872	204.8843	1012.11776	766.57756	181.34668	91.743232	65.263407	67.7152	766.711297	382.991588	88.83075	24.02799	16.0224	83.75353	77.90894	56.7934	6.55309	97.5682	13.8343	47.32786	29.853
Olivine	5782.00799	6630.99695	1757.6838	11067.4375	1387.6498	5289.01071	1902.8028	2040.8188	222.80499	44.935461	42.231	32392.6422	5093.93375	123.0524	11009.92	21.8487	55.35016	7.281209	0	531.528	294.1608	0	41.50289	0
Organics w/FeOx, no As	78848.2112	11809.3927	7541.1481	243007.435	25613.213	624696.518	38582.977	12309.641	2071.5039	5011.3738	2611.77	17145.7907	4773770.98	4282.079	1309.161	344.482	2426.667	1017.185	346.586	2483.62	1048.494	171.108	1299.696	369.157
Organics_No As	2830.2059	34009.7987	31629.571	94218.8432	1488.7546	115742.513	66935.113	15912.503	12627.801	40524.296	31288.1	12643.0911	12712417	2238.972	6068.888	742.857	9558.827	4875.497	1071.79	36168.7	1998.692	1776.61	1824.671	3021.7
Pentlandite	11.649934	0	0	2.912484	0	14.443541	12.838703	0	3.640604	3.744622	0	0	0	7.281209	0	0	3.641458	11.64993	5.82497	0	3.640604	58.9778	7.281209	0
Phosphates	5002.19051	1314.98633	173.29277	4914.81601	131.06176	5110.8737	5021.5377	817.93237	301.44205	1732.155	154.362	4742.25136	14485.237	398.2821	863.5514	463.193	243.9777	112.8587	387.36	0	219.1644	56.7934	1106.744	79.3652
Pyrite	891.219969	586.865437	218.43627	144.167936	19.258055	712.548019	486.80082	494.29007	71.355847	0	181.302	1391.43902	439.785018	169.6522	184.9427	0	117.2549	0	306.539	110.674	115.0431	0	881.7544	254.114
Pyroxene	1342.65492	2438.47686	648.02759	3113.44493	1242.6795	28733.0174	2608.9314	804.02378	250.47359	178.13701	780.546	76394.4438	2330.71497	54.60907	0	93.9496	447.171	114.315	553.372	371.342	68.44336	0	0	105.578
Pyrrhotite	969.857025	731.761494	37.862286	331.295005	173.85744	1863.75173	596.99969	494.29007	86.646386	30.49192	34.2217	822.776606	306297.887	656.0369	1332.461	112.885	450.8125	213.3394	145.624	718.655	1238.534	99.0244	783.4581	63.3465
Quartz	21161194.7	4047068.47	1724014.1	52304331.1	1508263	28810552.5	3336782.1	920920.17	1996749.9	724911.15	68934.8	42416746.5	10447497.9	433229.7	166036.3	38527.4	79159.47	19840.57	95886.2	78681.5	106062.5	5980.06	163082.3	27211.3
Realgar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salts	37.134165	8796.42847	1274.2116	601.427855	3806.1405	1259.79774	638.19053	120.89779	7505.4701	0	1210.14	597.787251	320491.147	426.6788	450.7068	53.8936	50.25212	80.0933	425.951	1052.86	5143.446	160.915	235.183	23.2999
Silica	1454.05742	23168.0786	4532.5525	26658.6901	733.41091	163.693464	0	0	105.57753	0	534.441	5110.68053	49.512221	750.6926	1001.166	0	189.3558	0	2200.38	0	1786.809	0	1280.765	332.751
Sphalerite	8.737451	49.512221	2.912484	149.264782	0	24.072568	14.443541	2.139784	0	9.629027	3.6406	15.290539	0	0	0	0	12.38096	0	0	0	2.912484	3.6406	0	0
Stibnite	0	0	0	0	6.954297	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ti - Bearing Minerals	149257.501	37853.5488	5767.4456	345879.994	12860.101	215987.106	27145.298	12224.05	1912.7736	12646.122	1222.51	149692.918	85977.2428	2409.352	1463.523	1655.41	3372.718	908.6949	769.624	3585.27	2116.647	163.099	1946.995	1403.09
Unknown	30266.5292	24276.2786	9709.4921	17346.024	10090.151	40645.729	9570.1832	10753.484	7839.6776	4799.0002	8677.74	12340.921	59164.9192	3635.508	937.8197	1190.03	1909.58	905.7824	435.416	1984.86	1620.069	327.654	1293.871	364.789
Vanadium	14968.7093	10332.0354	273.04533	3178.24769	350.92455	3082.35862	2017.2812	2034.3995	3923.1154	1844.4937	3272.9	3555.41431	21446.0727	5827.88	4037.43	4722.97	5576.528	4552.94	6288.05	12674.4	8660.27	2516.39	12961.28	2589.2
Zinc	34.949803	468.181732	246.83298	252.657949	10.163973	122.502625	20.327946	239.12084	41.502891	20.862892	10.9218	25.484231	69.899605	6.553088	1414.011	88.8516	21.12046	0	0	104.849	2.912484	0	5.824967	356.051
Zircon	4892.97238	2304.50262	396.09776	35406.3345	510.33845	7731.03901	473.42718	64.728461	78.637056	383.02131	305.811	5636.38381	586.137316	112.1306	214.7957	31.3165	60.4482	5.824967	23.2999	93.1995	171.8365	0	149.9929	173.293
Total	48688830.1	17734515	4028672.5	141561030	3660681.7	48811602	13063763	2758089.9	4010658.8	2872950.8	422658	83543009.4	99353666.7	1049151	615669.2	111089	798673.7	243850.6	242633	420575	492399.8	55112.9	1125684	126332

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Arsenolite	38	11	18	26	16	2	6	0	86	234	8	12	5	11	823
Arsenopyrite	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
As-Bearing Pyrite	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Enargite	1	1	0	2	0	1	0	1	0	0	0	0	0	0	0
Fe Oxides Mix - with As	15	9	164	32	143	495	2	10	3	2	4	1059	24	2	54
Fe-Ca Arsenate	1	0	1	9	1	0	0	1	0	7	0	0	0	0	69
FeOx with As	132	76	385	342	1308	827	31	142	167	34	11	2608	128	20	598
MnOx Mix, with As	362	28	220	2	14	244	0	2	0	0	1	9	9	11	267
Organics w/As,Fe,CaOx	5	14	15	19	1126	3	3	14	1	0	0	3	0	0	58
Scorodite	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Aluminum	26	70	34	226	950	96	13	26	5	2	60	1	3	4	39
Amphiboles	4372	3090	9562	10203	134626	20717	363	2409	1280	1248	474	5759	6914	447	3370
Andalusite	48	53	14	54	110	89	3	64	5	2	8	6	119	3	145
As-Pb Oxide?	5	16	5	29	4	44	2	3	5	9	8	7	28	0	87
Barite	62	5	2	118	1	2	3	53	8	102	39	8	3	1	33
Carbon	1324	1345	5303	2258	10877	4350	128	1174	90	925	535	2509	1679	2130	4714
Carbonates	388	670	340	837	1016	1443	54	957	46	78	1267	431	307	114	1164

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Chalcopyrite	1	0	0	3	1	3	0	0	1	0	0	0	0	0	4
Covellite	0	0	1	0	2	1	1	8	0	0	0	0	0	0	0
Cuprite	3	11	5	1	74	4	3	173	2	6	6	2	1	3	2
Diopside	6	13	22	43	284	93	2	30	1	1	18	2	8	7	17
Epidote	529	418	1255	852	12921	9892	45	264	131	109	139	302	874	40	402
Feldspars	17518	13979	10192	34402	325754	47439	2987	19894	2474	3991	1078	16676	25221	2035	11511
Fe Oxides - No As	394	144	609	1108	3177	3712	52	357	169	36	31	3027	464	46	1027
Galena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnets	748	99	459	1596	11331	11496	40	635	20	14	9	8081	2184	51	982
Gold	0	1	0	3	1	0	0	2	0	0	1	0	0	0	1
Gypsum	21	33	24	20	2	9	0	86	3	1	22	5	5	1	15
Lead contamination	0	1	0	4	0	8	0	0	0	1	0	2	8	0	2
Low_Counts	319	345	293	2090	28890	20546	248	695	196	191	455	2265	1947	552	2006
Micas	8450	7237	9054	21930	117666	31335	1744	9118	1182	2122	567	16335	12302	1228	10404
MnOx No As	279	83	743	0	7	317	0	3	0	2	0	73	20	28	51
NiCr Contamination	6	3	2	5	7	2	0	16	6	0	7	4	9	5	6
No_XRay	487	317	581	2067	1494	3953	54	387	55	106	43	1109	1191	66	319
Olivine	72	44	43	300	243	197	9	47	19	11	3	323	31	6	43
Organics w/FeOx, no As	946	302	1891	777	3490	6590	54	486	91	53	61	18639	1251	175	1339
Organics_No As	426	626	4275	641	739	669	37	754	37	244	779	559	253	4548	959
Pentlandite	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0
Phosphates	21	12	55	73	97	162	6	47	3	20	5	13	53	7	17
Pyrite	6	5	6	15	11	7	6	14	10	5	4	5	1	3	19
Pyroxene	12	24	18	109	385	114	5	31	49	14	10	605	84	12	21
Pyrrhotite	18	27	19	44	54	32	10	49	12	51	12	24	11	63	68
Quartz	13766	9920	9648	33360	84238	38016	1845	14716	1991	2808	945	11405	22378	1560	7395
Realgar	1	0	0	0	0	0	0	0	0	4	1	0	0	0	0
Salts	255	267	239	230	19	13	1	248	3	154	27	66	76	960	23
Silica	0	2	0	85	14	72	11	41	1	0	7	1	9	0	6
Sphalerite	0	1	3	4	3	0	0	5	3	2	0	1	1	0	2
Stibnite	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Ti - Bearing Minerals	674	654	738	1576	4826	4156	144	790	190	234	53	879	2195	78	641
Unknown	298	316	359	762	532	486	28	556	75	256	226	214	470	610	269
Vanadium	325	160	265	301	80	76	238	694	25	48	50	48	33	75	200
Zinc	5	6	5	10	3	7	1	18	1	2	6	5	2	2	10
Zircon	27	42	23	142	222	198	11	45	16	31	27	52	232	2	28
Total	45204	35168	40252	91654	582438	133525	7469	46298	7516	10317	6116	58859	53674	8583	38204

Mineral	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Arsenolite	993	15	135	547	131	6	0	6	1	178	4	3	4	0	88
Arsenopyrite	1	0	0	0	0	1	1	0	0	0	2	0	1	0	0
As-Bearing Pyrite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enargite	0	0	0	1	0	1	3	0	0	0	0	0	1	0	0
Fe Oxides Mix - with As	44	8	12	77	19	5	10	10	115	10	341	16	5	5	4

Mineral	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Fe-Ca Arsenate	37	0	5	41	3	3	1	0	0	10	2	0	0	1	7
FeOx with As	826	54	195	594	432	134	180	35	487	359	485	285	155	41	115
MnOx Mix, with As	1	7	0	3	96	58	7	2	22	2	68	426	189	8	52
Organics w/As,Fe,CaOx	39	8	1	16	5	3	5	5	2	1	0	1	1	6	0
Scorodite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	76	3	2	24	15	110	17	1	23	9	382	151	107	1	65
Amphiboles	4722	991	1162	8441	8052	2594	2832	556	8906	1478	9780	17377	4805	317	449
Andalusite	40	9	6	106	320	208	104	4	127	17	121	43	5	2	6
As-Pb Oxide?	31	13	8	89	3	9	3	4	4	15	8	3	29	2	1
Barite	153	3	2	180	12	42	9	0	1	16	10	1	2	3	19
Carbon	2370	1353	1070	4616	7002	1205	889	490	1828	438	5064	3717	1324	203	194
Carbonates	710	1079	593	990	952	113	954	981	1009	236	790	94	203	142	171
Chalcopyrite	4	0	1	3	2	0	3	0	1	2	3	0	0	0	0
Covellite	0	0	1	0	0	2	4	0	0	0	0	1	0	0	0
Cuprite	8	5	2	6	9	2	16	4	5	6	8	2	0	21	5
Diopside	58	10	5	26	32	3	18	12	54	3	11	1	1	2	5
Epidote	642	150	130	881	1234	453	637	142	4420	183	349	496	135	26	49
Feldspars	12108	4001	4367	42254	36374	22429	14864	2004	47354	7586	19670	32083	10289	1932	3361
Fe Oxides - No As	1232	107	359	1844	1157	382	741	91	2161	629	972	776	223	48	121
Galena	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Garnets	522	409	376	6543	2495	1649	897	120	6241	686	4639	2687	234	49	25
Gold	0	0	1	0	0	0	2	1	0	0	2	0	0	0	0
Gypsum	5	6	10	12	16	2	64	11	11	5	23	2	0	9	1
Lead contamination	4	0	0	13	0	2	0	0	0	4	0	1	8	2	0
Low_Counts	955	708	499	10301	10570	756	587	543	15397	138	2777	1278	54	180	70
Micas	9690	2820	3447	36615	37379	15159	8124	1173	27134	4029	18571	16620	4197	871	1794
MnOx No As	2	4	0	0	9	43	1	0	3	29	331	554	596	143	636
NiCr Contamination	4	3	8	1	2	4	16	2	15	6	51	4	5	3	0
No_XRay	403	90	135	1400	2050	360	644	122	3165	233	1395	1038	186	74	78
Olivine	113	12	14	104	120	50	69	8	172	27	237	33	18	7	4
Organics w/FeOx, no As	805	1024	285	2533	954	1009	448	182	2265	869	6826	1449	643	65	132
Organics_No As	803	765	391	1073	671	139	662	687	429	70	1514	1056	594	251	160
Pentlandite	0	1	0	0	0	2	0	0	1	0	1	3	0	1	1
Phosphates	17	3	7	34	99	55	32	11	74	9	95	38	14	10	15
Pyrite	24	5	5	11	14	11	12	3	4	4	19	4	7	3	0
Pyroxene	69	11	17	57	47	29	37	11	90	62	458	59	29	4	5
Pyrrhotite	72	15	15	42	49	33	37	2	19	11	56	13	13	8	8
Quartz	9265	2177	2896	26033	30154	18971	14121	1378	39264	6507	23326	16214	6121	1621	2477
Realgar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salts	13	28	20	16	22	3	192	27	12	110	11	6	1	62	0
Silica	36	2	3	8	26	16	121	20	122	7	2	0	0	3	0
Sphalerite	10	0	1	4	3	1	6	1	4	0	2	1	1	0	2
Stibnite	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Ti - Bearing Minerals	919	115	206	1457	2198	1071	1023	155	4006	512	3024	1318	421	74	185
Unknown	226	204	113	320	391	261	481	192	431	294	1278	353	317	126	134
Vanadium	173	131	119	222	124	843	667	20	174	20	304	208	201	260	200
Zinc	8	7	8	5	6	2	11	8	10	2	7	3	2	2	3

Mineral	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Zircon	52	5	13	95	219	161	124	20	247	50	126	69	11	8	27
Total	36817	13481	12846	105649	101761	57276	35045	7207	109090	19354	60059	55796	23322	5354	9484

Mineral	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Arsenolite	52	93	3	1	0	0	4	0	0	0	3	0	4	3
Arsenopyrite	0	0	0	0	0	0	0	0	0	0	0	2	0	0
As-Bearing Pyrite	0	0	0	1	0	0	0	0	0	1	0	1	0	0
Enargite	0	0	0	1	0	0	0	2	0	0	0	0	1	0
Fe Oxides Mix - with As	5	14	474	6	0	2	4	1	3	6	6	0	6	1
Fe-Ca Arsenate	4	1	1	0	0	0	0	1	0	0	1	1	1	1
FeOx with As	107	183	237	36	15	30	134	39	28	27	59	16	82	26
MnOx Mix, with As	0	5	514	1	0	0	7	1	0	27	1	0	1	2
Organics w/As,Fe,CaOx	3	1	0	1	16	5	0	4	3	1	0	1	2	3
Scorodite	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	14	6	172	7	3	6	11	3	4	0	8	0	4	3
Amphiboles	383	2740	7647	370	254	34	175	22	53	221	91	17	143	78
Andalusite	11	79	588	12	2	1	5	0	0	1	5	0	0	0
As-Pb Oxide?	3	19	1	0	1	1	4	0	0	0	3	0	2	2
Barite	2	20	1	7	5	24	4	3	0	2	3	0	9	0
Carbon	559	2124	7077	86	378	28	188	37	57	252	138	21	94	57
Carbonates	1340	349	161	84	80	50	213	436	50	59	181	187	122	431
Chalcopyrite	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Covellite	0	2	0	0	0	2	0	0	0	0	0	0	0	0
Cuprite	7	7	5	2	2	11	4	7	2	1	5	1	1	3
Diopside	8	19	109	0	1	1	20	16	5	3	1	1	1	1
Epidote	100	476	2723	66	22	7	27	7	11	16	3	2	13	4
Feldspars	1114	25633	16226	4659	2986	382	914	134	302	695	619	66	734	268
Fe Oxides - No As	112	513	482	53	39	37	225	23	28	21	82	12	69	31
Galena	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnets	28	731	3729	89	143	11	62	13	9	15	16	3	26	3
Gold	0	1	0	0	0	0	0	0	1	0	0	0	0	1
Gypsum	23	2	5	3	2	3	2	31	0	2	3	2	4	1
Lead contamination	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Low_Counts	661	1206	7439	183	1196	58	491	174	247	665	603	57	116	75
Micas	988	9752	10873	1510	1608	494	3413	387	443	559	878	210	1177	397
MnOx No As	0	2	688	0	0	0	51	46	0	151	0	0	19	35
NiCr Contamination	2	9	2	4	2	2	6	6	2	2	12	1	6	2
No_XRay	50	768	436	62	22	10	65	75	50	5	96	9	35	19
Olivine	4	128	79	10	27	2	6	1	0	2	9	0	3	0
Organics w/FeOx, no As	111	422	4156	162	90	45	163	36	40	58	92	13	101	27
Organics_No As	833	319	4874	57	66	38	79	137	35	312	56	49	66	79
Pentlandite	0	0	0	1	0	0	1	3	1	0	1	1	2	0
Phosphates	10	33	110	13	6	11	10	8	9	0	14	5	26	5
Pyrite	9	7	3	1	2	0	4	0	1	3	3	0	7	4

Mineral	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count	Particle Count
Pyroxene	10	111	49	3	0	2	4	3	3	3	3	0	0	2
Pyrrhotite	6	26	68	31	12	12	19	7	8	12	18	8	30	7
Quartz	1113	20096	11927	4269	2426	690	834	350	436	616	1236	110	877	295
Realgar	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salts	27	13	75	8	17	3	4	2	11	14	5	3	4	1
Silica	4	46	2	2	3	0	3	0	3	0	14	0	3	2
Sphalerite	1	1	0	0	0	0	2	0	0	0	1	1	0	0
Stibnite	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ti - Bearing Minerals	66	1253	1761	103	89	42	84	32	27	54	52	7	57	30
Unknown	161	388	450	32	22	25	43	18	13	28	33	10	29	22
Vanadium	195	177	239	407	370	311	365	298	363	147	557	142	842	202
Zinc	3	3	4	1	3	13	2	0	0	1	1	0	1	3
Zircon	43	142	48	7	4	4	8	1	3	2	25	0	15	7
Total	7305	50330	35701	11483	8488	2338	7085	2229	2104	2936	4738	922	4392	2023

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%
Arsenolite	0.0384	0.0270	0.0790	0.0026	0.0087	0.0001	0.0161	0.0000	0.4278	0.8139	0.1202	0.0046	0.0032	0.0206	1.1602	0.6993	0.0329	0.9074	0.1068	0.0206
Arsenopyrite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0013	0.0001	0.0000	0.0000	0.0000	0.0000
As-Bearing Pyrite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Enargite	0.0003	0.0006	0.0000	0.0005	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fe Oxides Mix - with As	0.0585	0.0624	0.4800	0.0183	0.0764	0.4336	0.0015	0.0190	0.0210	0.0059	0.0960	5.8696	0.0858	0.0085	0.0716	0.0702	0.1427	0.0387	0.0636	0.0035
Fe-Ca Arsenate	0.0008	0.0000	0.0007	0.0137	0.0002	0.0000	0.0000	0.0000	0.0000	0.0055	0.0000	0.0000	0.0000	0.0000	0.0214	0.0073	0.0000	0.0033	0.0011	0.0002
FeOx with As	0.0330	0.0362	0.1709	0.0215	0.1104	0.0441	0.0220	0.0375	0.2832	0.0685	0.0458	1.0544	0.0267	0.0300	0.1417	0.0827	0.1069	0.2173	0.0581	0.0133
MnOx Mix, with As	1.3298	0.0576	0.4324	0.0002	0.0057	0.0456	0.0000	0.0007	0.0000	0.0000	0.0306	0.0074	0.0049	0.0754	1.6068	0.0007	0.0450	0.0000	0.0010	0.0574
Organics w/As,Fe,CaOx	0.0019	0.0059	0.0073	0.0020	0.1344	0.0001	0.0020	0.0029	0.0064	0.0000	0.0000	0.0012	0.0000	0.0000	0.0465	0.0140	0.0464	0.0008	0.0036	0.0003
Scorodite	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Aluminum	0.1399	0.2098	0.0943	0.1865	0.0766	0.6782	0.7095	0.0569	0.0489	0.0204	0.7727	0.0001	0.0010	0.0052	2.1912	2.1578	0.0092	0.0277	0.3478	0.0064
Amphiboles	3.8440	4.3430	9.9141	2.9211	16.0930	6.0967	1.7900	1.3712	7.3893	3.7710	4.4374	2.7956	4.1878	0.9348	2.9244	1.9982	3.2707	3.0877	1.6767	0.9976
Andalusite	0.0321	0.0305	0.0084	0.0094	0.0168	0.0131	0.0050	0.0302	0.0140	0.0047	0.0180	0.0049	0.0627	0.0072	0.2001	0.0524	0.0082	0.0153	0.0405	0.0365
As-Pb Oxide?	0.0279	0.0957	0.0035	0.0033	0.0087	0.2727	0.0019	0.0124	0.0180	0.0270	2.2444	0.0015	0.0069	0.0000	0.1602	0.0408	0.0635	0.0411	0.1556	0.0002
Barite	0.0537	0.0038	0.0016	0.0122	0.0000	0.0001	0.0043	0.0301	0.0146	0.2250	0.1940	0.0033	0.0003	0.0127	0.0333	0.0541	0.0546	0.0075	0.0312	0.0099
Carbon	0.6220	0.7265	3.5750	0.1023	1.4157	0.1720	0.7767	0.4331	1.2661	1.3037	2.7301	0.3777	0.6901	11.9051	3.2254	0.4219	3.7159	2.2842	0.4558	0.4715
Carbonates	0.6514	2.1852	0.5382	0.2693	0.1387	0.4235	0.1162	1.3681	2.7294	0.4409	31.0014	0.9969	0.2167	3.5045	2.6854	0.4490	9.8761	4.2429	0.2477	0.1601
Chalcopyrite	0.0090	0.0000	0.0000	0.0003	0.0001	0.0003	0.0000	0.0000	0.0335	0.0000	0.0000	0.0000	0.0000	0.0000	0.0043	0.0041	0.0000	0.0027	0.0003	0.0001
Covellite	0.0000	0.0000	0.0036	0.0000	0.0077	0.0002	0.0023	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0190	0.0000	0.0000
Cuprite	0.0030	0.0069	0.0045	0.0000	0.1175	0.0004	0.0146	0.3454	0.0039	0.0108	0.4005	0.0004	0.0016	0.0025	0.0018	0.0024	0.0177	0.0117	0.0005	0.0011
Diopside	0.0100	0.0266	0.0262	0.1034	0.0303	0.019	0.0069	0.0359	0.0114	0.0129	0.8440	0.0002	0.0040	0.0316	0.0508	0.0349	0.0751	0.0851	0.0054	0.0057
Epidote	0.5292	0.3153	1.0783	0.3117	2.5415	2.4380	0.0627	0.1781	0.5172	0.3182	1.0488	0.0694	0.2196	0.0668	0.3040	0.3428	0.5262	0.5119	0.0900	0.1200
Feldspars	57.9520	55.3906	33.4483	51.1097	54.9111	48.3134	60.6005	58.9788	49.6577	49.1115	26.4336	27.1220	49.8723	28.9549	47.0942	54.4077	39.8759	44.7560	50.2489	55.1708
Fe Oxides - No As	0.7171	0.3152	2.6744	0.5226	1.3742	1.0014	0.2581	0.6030	2.0026	0.3305	1.3112	5.0626	2.6087	0.4770	1.3334	0.7730	0.6501	2.5251	0.7003	0.2239
Galena	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Garnets	1.1059	0.1480	0.6827	0.6364	2.3979	3.0039	0.1426	0.6446	0.1020	0.0884	0.1234	10.4602	3.3047	0.2420	1.5009	0.7546	3.1565	2.5410	1.7488	0.3826
Gold	0.0000	0.0021	0.0000	0.0017	0.0024	0.0000	0.0000	0.0012	0.0000	0.0000	0.0083	0.0000	0.0000	0.0000	0.0015	0.0000	0.0000	0.0037	0.0000	0.0000
Gypsum	0.0510	0.0575	0.0491	0.0050	0.0006	0.0020	0.0000	0.1397	0.0193	0.0020	0.3812	0.0062	0.0024	0.0013	0.0270	0.0036	0.0418	0.0853	0.0055	0.0015

Mineral	CM-08	CM-18	CM-22	CM-23	CM-24	CM-25	Grace-01	Grace-05	G-SIT-03	G-SIT-20	G-SIT-20-Dup	G-SIT-27	G-SIT-47	G-SIT-53	G-WGM-14	G-WGM-17	G-WGM-21	G-WGM-21-Dup	G-WGM-23	G-WGM-44
Unit	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%
Lead contamination	0.0000	0.0043	0.0000	0.0001	0.0000	0.0481	0.0000	0.0000	0.0000	0.0003	0.0000	0.0019	0.0010	0.0000	0.0061	0.0008	0.0000	0.0000	1.0735	0.0000
Low_Counts	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Micas	16.2408	18.5137	22.9441	23.2271	15.6401	15.6404	15.6170	17.4584	21.5832	25.4449	12.1062	24.2689	22.6912	10.6957	23.4158	21.7781	22.8506	25.6547	32.1776	26.9496
MnOx No As	1.3288	0.7065	4.1003	0.0000	0.0010	0.0757	0.0000	0.0119	0.0000	0.0077	0.0000	0.1494	0.0216	0.6110	0.2877	0.0037	0.0175	0.0000	0.0000	0.0094
NiCr Contamination	0.0150	0.0830	0.0017	0.0006	0.0053	0.0005	0.0000	0.0162	0.0195	0.0000	0.4900	0.0007	0.0075	0.0412	0.0275	0.0155	0.0079	0.2123	0.0001	0.0001
No_XRay	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Olivine	0.0450	0.0259	0.0259	0.1035	0.0208	0.0075	0.0291	0.0210	0.1077	0.0158	0.0052	0.0890	0.0093	0.0387	0.0119	0.0200	0.0761	0.0669	0.0206	0.0199
Organics w/FeOx, no As	0.9534	0.9445	2.3098	0.0933	0.4766	0.8308	0.0898	0.3788	0.2537	0.2124	0.5450	15.7351	1.4033	0.9406	0.9644	0.1929	6.2722	0.6752	0.7369	0.0710
Organics_No As	0.1687	0.3825	3.0874	0.0363	0.0643	0.0248	0.0481	0.2990	0.0966	0.3434	3.9640	0.0581	0.1174	30.0860	0.7020	0.1247	1.7027	1.0197	0.0716	0.0216
Pentlandite	0.0007	0.0000	0.0000	0.0000	0.0000	0.0002	0.0014	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0000	0.0000
Phosphates	0.0411	0.0226	0.1536	0.0314	0.0267	0.0506	0.0128	0.0832	0.0318	0.3150	0.0688	0.0061	0.0354	0.0688	0.0523	0.0050	0.0147	0.0542	0.0048	0.0359
Pyrite	0.0202	0.0064	0.0155	0.0081	0.0044	0.0031	0.0266	0.0838	0.4244	0.1125	0.1145	0.0037	0.0005	0.0187	0.0986	0.0483	0.0323	0.0482	0.0042	0.0021
Pyroxene	0.0138	0.0163	0.0162	0.0158	0.0135	0.0039	0.4262	0.0121	0.1116	0.0453	0.2964	0.2112	0.0130	0.0545	0.0271	0.0107	0.0432	0.0226	0.0058	0.0026
Pyrrhotite	0.0257	0.1174	0.0589	0.0119	0.0118	0.0024	0.0942	0.0883	0.0605	0.8011	0.1269	0.0117	0.0018	0.9509	0.0634	0.0494	0.0366	0.0505	0.0110	0.0073
Quartz	13.3734	14.5076	13.4386	19.9681	3.6342	20.0096	18.5978	16.6200	12.2457	15.1283	8.8144	5.3991	13.6889	6.9068	9.1574	15.1635	6.7397	10.3698	9.8012	15.0558
Realgar	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0030	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Salts	0.2049	0.2139	0.1625	0.0155	0.0018	0.0004	0.0006	0.1085	0.0040	0.4265	0.3579	0.0164	0.0480	3.0201	0.0155	0.0020	0.0698	0.0608	0.0015	0.0009
Silica	0.0000	0.0135	0.0000	0.0130	0.0030	0.0078	0.0471	0.0924	0.0063	0.0000	0.1075	0.0039	0.0033	0.0000	0.0075	0.0183	0.0353	0.0120	0.0021	0.0032
Sphalerite	0.0000	0.0003	0.0108	0.0041	0.0010	0.0000	0.0000	0.0041	0.0361	0.0077	0.0000	0.0030	0.0002	0.0000	0.0005	0.0008	0.0000	0.0012	0.0007	0.0002
Stibnite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ti - Bearing Minerals	0.2456	0.3032	0.3086	0.1855	0.5996	0.3210	0.1641	0.2662	0.3625	0.3988	0.3826	0.1865	0.6059	0.1076	0.2891	0.1647	0.2660	0.2376	0.0827	0.1032
Unknown	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vanadium	0.0524	0.0283	0.0489	0.0050	0.0045	0.0008	0.1578	0.1160	0.0225	0.0298	0.0671	0.0042	0.0018	0.1683	0.0519	0.0101	0.1033	0.0708	0.0063	0.0022
Zinc	0.0023	0.0009	0.0018	0.0001	0.0001	0.0008	0.0002	0.0021	0.0018	0.0047	0.0568	0.0005	0.0001	0.0071	0.0101	0.0010	0.0093	0.0067	0.0002	0.0003
Zircon	0.0543	0.0629	0.0427	0.0266	0.0210	0.0133	0.1546	0.0359	0.0658	0.1414	0.2529	0.0125	0.0505	0.0041	0.0241	0.0186	0.0054	0.0214	0.0100	0.0313
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%
Arsenolite	0.0002	0.0000	0.0049	0.0000	0.1428	0.0004	0.0005	0.0060	0.0000	0.0533	0.5256	0.0058	0.0002	0.0022	0.0000	0.0000	0.0132	0.0000	0.0000	0.0000	0.0271	0.0000	0.0058	0.0425
Arsenopyrite	0.0009	0.0001	0.0000	0.0000	0.0000	0.0007	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4552	0.0000	0.0000
As-Bearing Pyrite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0323	0.0000	0.0259	0.0000	0.0000
Enargite	0.0003	0.0024	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0000	0.0000	0.0000	0.0168	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000
Fe Oxides Mix - with As	0.0009	0.0055	0.0280	0.0574	0.0174	2.0748	0.0093	0.0100	0.0403	0.0072	0.0542	0.0019	1.1464	0.0949	0.0000	0.1516	0.0215	0.0154	0.1632	0.1060	0.4183	0.0000	0.0615	0.0131
Fe-Ca Arsenate	0.0001	0.0000	0.0000	0.0000	0.0009	0.0001	0.0000	0.0000	0.0002	0.0010	0.0113	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031	0.0000	0.0000	0.0011	0.0095	0.0012	0.0008
FeOx with As	0.0046	0.0137	0.0157	0.0178	0.1223	0.1041	0.0591	0.0795	0.0173	0.0328	0.2805	0.0028	0.0164	0.0476	0.1196	0.3635	0.1255	0.2601	0.2371	0.2186	0.2280	0.5594	0.0684	0.3333
MnOx Mix, with As	0.0371	0.0033	0.0020	0.0082	0.0030	0.0221	0.2190	0.4614	0.0211	0.0844	0.0000	0.0014	0.5051	0.0034	0.0000	0.0000	0.0199	0.0126	0.0000	1.3025	0.0401	0.0000	0.0007	0.0747
Organics w/As,Fe,CaOx	0.0001	0.0018	0.0052	0.0001	0.0009	0.0000	0.0001	0.0001	0.0021	0.0000	0.0516	0.0000	0.0000	0.0007	0.1738	0.1119	0.0000	0.0614	0.0631	0.0023	0.0000	0.0440	0.0039	0.0424
Scorodite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Aluminum	0.3070	0.0027	0.0002	0.0012	0.0102	0.9464	0.3504	0.8671	0.0020	0.2668	0.0829	0.0007	0.0404	0.3431	0.0376	0.8270	1.8583	0.2579	4.5487	0.0000	0.6933	0.0000	0.0054	0.0384
Amphiboles	0.3087	0.9356	0.5235	0.4320	1.2662	1.0102	6.0374	3.9677	0.2940	0.3863	2.6712	0.4845	2.1564	0.6275	0.4125	0.6719	0.4429	0.5702	1.0534	3.2174	1.3246	0.7447	0.7421	1.3505
Andalusite	0.0477	0.0145	0.0029	0.0091	0.1087	0.0094	0.0140	0.0037	0.0663	0.0071	0.0189	0.0489	0.0461	0.1176	0.0121	0.0041	0.3260	0.0000	0.0000	0.0004	0.0192	0.0000	0.0000	0.0000
As-Pb Oxide?	0.0011	0.0006	0.0134	0.0003	0.0136	0.0006	0.0006	0.0290	0.0118	0.0004	0.0513	0.0015	0.0005	0.0000	0.0031	0.0282	0.0301	0.0000	0.0000	0.0000	0.0107	0.0000	0.0068	0.0253
Barite	0.0068	0.0082	0.0000	0.0001	0.0057	0.0475	0.0003	0.0010	0.0029	0.0124	0.0500	0.0011	0.0000	0.0161	0.1657	0.4710	0.0054	0.2215	0.0000	0.0047	0.1536	0.0000	0.0196	0.0000
Carbon	0.0507	0.1324	0.3172	0.0560	0.1421	0.4066	0.4648	0.7563	0.0948	0.0813	4.4741	0.0739	2.3271	0.8242	2.9195	0.7781	0.4168	0.7377	4.4624	3.3200	#####	1.4721	0.1186	0.5809

Mineral	IL-01	IL-11	LL-01	LL-04	LL-06	TX-02	TX-20	TX-20-Dup	YK-01	YK-05	YK-20	YK-20-Dup
Unit	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%
Carbonates	0.0156	0.3112	2.3953	0.0666	0.6977	0.1995	0.0568	0.5418	0.5039	0.4410	#####	0.0316
Chalcopyrite	0.0000	0.0004	0.0000	0.0000	0.0035	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Covellite	0.0000	0.0033	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
Cuprite	0.0001	0.0069	0.0025	0.0001	0.0040	0.0006	0.0002	0.0000	0.0461	0.0048	0.0312	0.0002
Diopside	0.0005	0.0083	0.0259	0.0017	0.0014	0.0011	0.0009	0.0001	0.0035	0.0049	0.1939	0.0026
Epidote	0.1000	0.1203	0.1232	0.8451	0.1545	0.0185	0.0549	0.0889	0.5001	0.0181	0.7792	0.0620
Feldspars	61.9533	71.7358	61.0539	65.2490	40.0721	21.0335	59.0538	49.8574	61.4998	57.7639	26.5234	65.6428
Fe Oxides - No As	0.1814	0.3658	0.1649	0.3231	0.9698	2.1014	0.4338	0.9496	0.2048	0.2126	3.3050	0.1403
Galena	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Garnets	0.3506	0.2233	0.2818	0.7982	2.2667	1.2621	0.7940	0.2491	0.0584	0.0624	0.5164	0.0676
Gold	0.0000	0.0006	0.0007	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gypsum	0.0002	0.0197	0.0283	0.0008	0.0090	0.0020	0.0012	0.0000	0.0126	0.0024	0.3611	0.0001
Lead contamination	0.0011	0.0000	0.0000	0.0000	0.0023	0.0000	0.0000	0.0050	0.0429	0.0000	0.0000	0.0004
Low_Counts	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Micas	13.6430	15.5103	11.2368	13.4051	31.4140	32.3374	18.4462	21.7996	7.5833	23.7251	19.7620	5.1033
MnOx No As	0.0212	0.0002	0.0000	0.0002	0.1374	0.2183	0.5015	1.7833	0.8595	4.4952	0.0000	0.0002
NiCr Contamination	0.0004	0.0107	0.0022	0.0023	0.0119	0.0878	0.0019	0.0049	0.0108	0.0000	0.0108	0.0010
No_XRay	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Olivine	0.0061	0.0166	0.0233	0.0039	0.0193	0.0065	0.0072	0.0379	0.0031	0.0007	0.0055	0.0214
Organics w/FeOx, no As	0.2513	0.0885	0.2994	0.2542	1.0696	2.2953	0.4368	0.6853	0.0860	0.2311	1.0177	0.0340
Organics_No As	0.0030	0.0850	0.4185	0.0329	0.0207	0.1418	0.2526	0.2953	0.1748	0.6228	4.0639	0.0084
Pentlandite	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0000	0.0002	0.0003	0.0000	0.0000
Phosphates	0.0170	0.0105	0.0073	0.0055	0.0058	0.0200	0.0604	0.0484	0.0133	0.0849	0.0640	0.0100
Pyrite	0.0047	0.0073	0.0145	0.0003	0.0013	0.0044	0.0092	0.0460	0.0049	0.0000	0.1180	0.0046
Pyroxene	0.0014	0.0061	0.0086	0.0011	0.0173	0.0352	0.0098	0.0149	0.0035	0.0027	0.1014	0.0506
Pyrrhotite	0.0048	0.0084	0.0023	0.0005	0.0112	0.0105	0.0104	0.0423	0.0055	0.0022	0.0205	0.0025
Quartz	22.4777	10.1115	22.8130	18.2385	20.9958	35.2854	12.5913	17.0905	27.6382	11.1412	8.9537	28.0713
Realgar	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Salts	0.0000	0.0220	0.0169	0.0002	0.0530	0.0015	0.0024	0.0022	0.1039	0.0000	0.1572	0.0004
Silica	0.0015	0.0579	0.0600	0.0093	0.0102	0.0002	0.0000	0.0000	0.0015	0.0000	0.0694	0.0034
Sphalerite	0.0000	0.0005	0.0002	0.0002	0.0000	0.0001	0.0002	0.0002	0.0000	0.0006	0.0019	0.0000
Stibnite	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ti - Bearing Minerals	0.1585	0.0946	0.0763	0.1206	0.1790	0.2645	0.1024	0.2269	0.0265	0.1944	0.1588	0.0991
Unknown	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vanadium	0.0159	0.0258	0.0036	0.0011	0.0049	0.0038	0.0076	0.0378	0.0543	0.0283	0.4251	0.0024
Zinc	0.0000	0.0012	0.0033	0.0001	0.0001	0.0002	0.0001	0.0044	0.0006	0.0003	0.0014	0.0000
Zircon	0.0242	0.0268	0.0244	0.0574	0.0330	0.0440	0.0083	0.0056	0.0051	0.0274	0.1847	0.0173
Total	100	100	100	100	100	100	100	100	100	100	100	100

Mineral	YK-24	YK-36	YK-39	YK-54	YK-59	YK-61	YK-62	YK-63	YK-66	YK-68	YK-69	YK-78
Unit	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%
Carbonates	0.0340	0.5404	2.0198	4.8512	2.4499	#####	2.1573	2.0990	5.4352	#####	0.6500	#####
Chalcopyrite	0.0000	0.0000	0.0000	0.0282	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Covellite	0.0000	0.0000	0.0000	0.0977	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cuprite	0.0004	0.0340	0.0070	0.4208	0.9734	0.1921	0.2470	0.0311	0.0318	0.0473	0.0083	0.0309
Diopside	0.0552	0.0000	0.0006	0.1838	0.1682	0.6305	0.4656	0.0611	0.0058	0.3780	0.0056	0.0735
Epidote	0.5017	0.1126	0.0990	0.0391	0.2070	0.0926	0.3181	0.7021	0.0123	0.0371	0.0192	0.0400
Feldspars	60.2643	59.1624	38.6383	26.3839	26.5569	8.1099	22.0997	30.7245	22.9858	9.2059	69.6495	18.4631
Fe Oxides - No As	0.2482	0.6165	1.7312	3.0017	2.3106	1.9794	2.1566	0.9943	3.9373	2.2553	0.5692	4.9125
Galena	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Garnets	1.5484	0.7334	9.5752	1.0492	0.3316	0.3967	0.2853	1.0474	0.2092	0.2317	0.1810	0.1098
Gold	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0205	0.0000	0.0000	0.0000	0.0000	0.0206
Gypsum	0.0005	0.0074	0.0339	0.1209	0.0055	3.2972	0.0000	0.0710	0.0175	0.0377	0.1103	0.0399
Lead contamination	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Low_Counts	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0002	0.0001	0.0004	0.0002	0.0000	0.0000
Micas	9.9444	12.8875	26.8488	35.2643	56.4378	26.9412	20.7556	27.9446	25.4885	41.8652	20.1322	24.7510
MnOx No As	2.8284	0.0000	0.0000	0.0000	0.9267	7.5110	0.0000	8.7740	0.0000	0.0000	0.1231	2.8418
NiCr Contamination	0.0011	0.1655	0.0043	0.0230	0.0785	1.5045	0.0539	0.2048	0.4408	0.1669	0.0156	0.0658
No_XRay	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Olivine	0.0024	0.0063	0.9181	0.0112	0.0032	0.0031	0.0000	0.0702	0.0570	0.0000	0.0016	0.0000
Organics w/FeOx, no As	6.6675	0.6556	0.3275	0.5291	0.4184	1.3196	0.3804	0.9841	0.6095	0.6076	0.1480	0.4059
Organics_No As	5.9185	0.1143	0.5061	0.3803	0.5494	2.1083	0.3922	4.7772	0.3873	2.1030	0.0693	1.1074
Pentlandite	0.0000	0.0018	0.0000	0.0000	0.0010	0.0242	0.0102	0.0000	0.0034	0.3351	0.0013	0.0000
Phosphates	0.0215	0.0648	0.2297	0.7564	0.0447	0.1557	0.4521	0.0000	0.1355	0.2145	0.1340	0.0928
Pyrite	0.0010	0.0434	0.0773	0.0000	0.0338	0.0000	0.5619	0.0732	0.1117	0.0000	0.1677	0.4666
Pyroxene	0.0011	0.0028	0.0000	0.0481	0.0257	0.0494	0.2025	0.0490	0.0133	0.0000	0.0000	0.0387
Pyrrhotite	0.6581	0.1545	0.5128	0.2667	0.1196	0.4257	0.2459	0.4381	1.1076	0.5410	0.1373	0.1071
Quartz	4.8640	22.1092	13.8456	19.7240	4.5499	8.5796	35.0839	10.3923	20.5528	7.0788	6.1915	9.9726
Realgar	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Salts	0.1492	0.0218	0.0376	0.0276	0.0029	0.0346	0.1559	0.1391	0.9967	0.1905	0.0089	0.0085
Silica	0.0000	0.0383	0.0835	0.0000	0.0109	0.0000	0.8051	0.0000	0.3462	0.0000	0.0486	0.1219
Sphalerite	0.0000	0.0000	0.0000	0.0000	0.0029	0.0000	0.0000	0.0000	0.0023	0.0175	0.0000	0.0000
Stibnite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ti - Bearing Minerals	0.0400	0.1230	0.1220	0.8475	0.1939	0.3929	0.2816	0.4735	0.4102	0.1931	0.0739	0.5142
Unknown	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vanadium	0.0100	0.2974	0.3367	2.4179	0.3205	1.9688	2.3007	1.6740	1.6782	2.9787	0.4921	0.9489
Zinc	0.0000	0.0003	0.1179	0.0455	0.0012	0.0000	0.0000	0.0138	0.0006	0.0000	0.0002	0.1305
Zircon	0.0013	0.0266	0.0833	0.0746	0.0162	0.0117	0.0396	0.0572	0.1548	0.0000	0.0265	0.2953
Total	100	100	100	100	100	100	100	100	100	100	100	100

Appendix K

EMPA Results

Electron microprobe analysis used an accelerating potential was 15 kV, beam current was 10 nA, and the beam was defocused to between 2 and 5 microns depending on grain size for oxides other than arsenic trioxide. Data reduction was performed using JEOL PC-EPMA version 1.11.2.0 with the XPP atomic number and absorption corrections of Pouchou and Pichoir (1991) and characteristic fluorescence correction of Reed (1965). Mass absorption coefficients were those of Chantler (1995). Elements, X-ray lines, standards, diffracting crystals, and count times (peak time = total background time) were as follows:

As La, synthetic loellingite, TAP, 120 s

Si Ka, natural anorthite, TAP, 60 s

Fe Ka, natural hematite, LiFL, 20 s

Mn Ka, natural rhodonite, LiFL, 60 s

Ti Ka, natural rutile, LiFL, 60 s

K Ka, natural adularia, PET, 60 s

Ca Ka, natural anorthite, PET, 60 s

S Ka, natural anhydrite, PET, 60 s

Al Ka, natural anorthite, TAP, 60 s

Mg Ka, natural olivine, TAP, 60 s

Zn Ka, natural gahnite, LiFH, 40 s

Cu Ka, elemental Cu, LiFH, 40 s

Sb La, elemental Sb, PETH, 40 s

Pb Ma, natural cerussite, PETH, 40 s

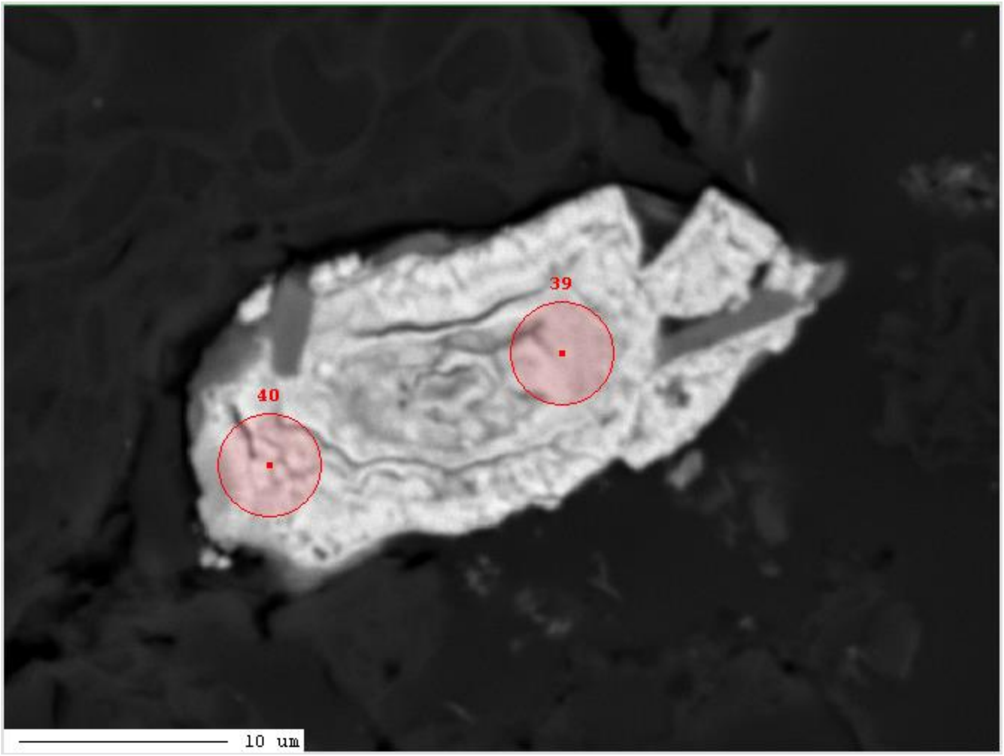
For the arsenic trioxide, all conditions were the same except that As La peak and total background times were 10 s each.

EMPA data for iron oxides and scorodite from around Con Mine (CM and Grace samples) and Giant Mine (G-WGM samples). Scan# corresponds to the iron oxide figures shown below, in order of Sample ID. Data presented as weight percent.

Scan #	Sample	Al_2O_3	As_2O_5	CaO	Cu_2O	Fe_2O_3	K_2O	MgO	MnO	PbO	Sb_2O_5	SiO_2	SO_3	TiO_2	ZnO	Total
39	CM-08 oxide 1 1	0.16	1.70	0.19	0.07	86.35	0.00	0.00	0.00	0.12	0.13	0.43	0.39	0.00	0.04	89.57
40	CM-08 oxide 1 2	0.08	2.93	0.02	0.03	88.73	0.00	0.01	0.01	0.14	0.61	0.21	0.10	0.00	0.00	92.86
43	CM-08 oxide 4	0.07	1.23	0.03	0.04	81.32	0.01	0.05	0.02	0.10	0.43	1.34	0.06	0.02	0.07	84.80
4	CM-18 oxide 3	0.09	2.23	0.09	0.09	84.83	0.02	0.04	0.00	0.28	0.41	0.22	0.27	0.08	0.22	88.86
5	CM-18 oxide 4	0.39	1.25	0.12	0.03	83.66	0.04	0.06	0.01	0.15	0.17	0.24	0.25	0.08	0.06	86.49
6	CM-18 oxide 5	0.03	1.80	0.30	0.00	77.55	0.05	0.72	0.16	0.06	0.00	4.98	0.08	0.01	0.13	85.87
44	CM-22 oxide 1 1	0.05	1.67	0.11	0.07	79.66	0.00	0.00	0.00	0.13	0.11	0.13	0.13	0.05	0.07	82.19
45	CM-22 oxide 1 2	0.06	2.68	0.10	0.05	82.90	0.00	0.00	0.02	0.20	0.20	0.13	0.19	0.05	0.06	86.64
57	CM-22 oxide 10	0.04	0.17	0.13	0.04	75.47	0.00	0.00	0.01	0.10	0.05	0.08	0.05	0.43	0.06	76.63
58	CM-22 oxide 11	0.15	5.32	0.30	0.05	84.91	0.01	0.03	0.00	0.20	0.47	0.10	1.44	0.02	0.13	93.11
46	CM-22 oxide 2 1	2.97	0.64	0.59	0.01	77.52	0.02	0.06	0.00	0.02	0.00	0.45	0.15	0.18	0.12	82.73
47	CM-22 oxide 2 2	3.01	0.60	0.58	0.03	75.30	0.01	0.06	0.00	0.18	0.04	0.44	0.14	0.20	0.06	80.67
48	CM-22 oxide 3	0.12	4.42	0.10	0.00	84.20	0.00	0.06	0.02	0.35	0.44	0.19	0.10	0.02	0.09	90.11
49	CM-22 oxide 4	0.07	0.36	0.09	0.06	90.59	0.01	0.04	0.00	0.08	0.01	0.04	0.15	0.12	0.06	91.67
50	CM-22 oxide 5	0.10	4.18	0.00	0.19	82.97	0.01	0.02	0.16	0.22	2.82	0.08	0.15	0.00	0.01	90.92
52	CM-22 oxide 7 1	0.01	0.34	0.04	0.05	94.45	0.00	0.03	0.02	0.17	0.12	0.06	0.03	0.00	0.02	95.34
53	CM-22 oxide 7 2	0.01	0.33	0.03	0.01	93.52	0.00	0.01	0.01	0.17	0.11	0.04	0.03	0.00	0.00	94.28
54	CM-22 oxide 8	0.37	8.34	0.66	0.03	76.20	0.00	0.07	0.02	0.07	0.07	1.75	1.09	0.00	0.00	88.67
55	CM-22 oxide 9 1	0.14	3.95	0.30	0.00	82.42	0.03	0.01	0.00	0.16	0.18	0.29	4.66	0.03	0.07	92.24
56	CM-22 oxide 9 2	0.04	3.08	0.15	0.05	84.68	0.00	0.02	0.00	0.15	0.33	0.03	0.49	0.00	0.08	89.11
7	CM-23 oxide 1 1	0.04	2.74	0.01	0.05	94.42	0.02	0.06	0.00	0.27	0.36	0.40	0.05	0.10	0.03	98.56
8	CM-23 oxide 1 2	0.06	2.47	0.04	0.02	94.10	0.02	0.02	0.00	0.21	0.32	0.67	0.07	0.09	0.02	98.10
9	CM-23 oxide 1 3	0.07	2.32	0.02	0.05	91.20	0.02	0.03	0.01	0.30	0.37	0.62	0.05	0.11	0.05	95.21
10	CM-23 oxide 2 1	0.04	0.00	0.03	0.00	99.56	0.00	0.03	0.05	0.03	0.00	0.07	0.00	0.07	0.04	99.90
11	CM-23 oxide 2 2	0.02	0.00	0.04	0.00	99.61	0.00	0.00	0.03	0.07	0.02	0.07	0.01	0.04	0.04	99.95
12	CM-23 oxide 3 1	0.03	1.90	0.00	0.17	96.28	0.01	0.00	0.01	0.22	0.20	0.17	0.17	0.03	0.04	99.22
13	CM-23 oxide 3 2	0.00	2.19	0.02	0.17	95.63	0.01	0.00	0.00	0.31	0.23	0.16	0.14	0.08	0.05	99.01
14	CM-23 oxide 4 1	0.19	3.83	0.00	0.10	86.72	0.01	0.00	0.00	0.18	0.71	0.52	0.11	0.05	0.03	92.44
15	CM-23 oxide 4 2	0.14	2.64	0.05	0.16	92.50	0.01	0.03	0.02	0.11	0.33	0.42	0.13	0.06	0.32	96.93
16	CM-23 oxide 5 1	0.88	2.02	0.12	0.01	88.09	0.19	0.00	0.01	0.07	0.08	0.74	0.60	0.01	0.02	92.85
19	CM-23 oxide 6 2	0.19	4.06	0.07	0.36	86.83	0.02	0.01	0.01	0.08	0.12	0.45	0.27	0.02	0.07	92.56

Scan #	Sample	Al_2O_3	As_2O_5	CaO	Cu_2O	Fe_2O_3	K_2O	MgO	MnO	PbO	Sb_2O_5	SiO_2	SO_3	TiO_2	ZnO	Total
20	CM-23 oxide 6 3	0.10	5.14	0.00	0.05	89.52	0.00	0.02	0.01	0.09	0.27	0.22	0.07	0.03	0.08	95.60
21	CM-23 oxide 7	0.55	7.19	0.17	0.02	75.22	0.21	0.04	0.01	0.80	0.25	0.58	2.05	0.19	0.11	87.38
22	CM-23 oxide 8 1	0.16	1.68	0.07	1.45	86.78	0.04	0.02	0.00	0.24	0.12	0.72	0.19	0.02	0.05	91.55
23	CM-23 oxide 8 2	0.49	1.95	0.11	0.18	80.52	0.02	0.03	0.02	0.34	0.18	2.17	0.13	0.02	0.00	86.15
24	CM-23 oxide 9 1	1.01	0.00	0.61	0.01	96.37	0.07	0.87	0.02	0.00	0.02	2.55	0.00	1.16	0.00	102.69
25	CM-23 oxide 9 2	0.24	0.00	0.32	0.01	96.81	0.04	0.14	0.04	0.05	0.00	0.77	0.01	0.73	0.00	99.16
26	CM-23 oxide 9 3	0.16	0.00	0.36	0.00	95.45	0.01	0.11	0.28	0.00	0.02	0.68	0.00	4.70	0.00	101.78
25	CM-24 oxide 1 1	1.06	0.16	0.16	-	92.93	0.04	0.02	0.06	0.02	0.02	3.28	0.03	0.74	0.03	98.55
26	CM-24 oxide 1 2	1.12	0.22	0.15	-	92.17	0.05	0.04	0.11	0.08	0.00	3.45	0.00	0.87	0.05	98.31
27	CM-24 oxide 1 3	0.54	0.23	0.10	-	93.41	0.00	0.02	0.02	0.01	0.00	1.84	0.43	0.31	0.06	96.97
28	CM-24 oxide 1 4	0.99	0.15	0.12	-	92.67	0.04	0.04	0.08	0.01	0.01	3.60	0.06	0.77	0.01	98.55
29	CM-24 oxide 1 5	0.75	0.20	0.04	-	92.91	0.00	0.00	0.00	0.04	0.00	1.97	0.42	0.46	0.00	96.79
30	CM-24 oxide 1 6	0.95	0.14	0.12	-	92.88	0.04	0.05	0.11	0.04	0.01	3.38	0.02	0.77	0.00	98.49
32	CM-24 oxide 3	0.10	2.24	0.04	-	88.48	0.01	0.07	0.00	0.26	0.17	0.68	0.15	0.59	0.09	92.89
33	CM-24 oxide 4 1	1.71	0.53	0.12	-	82.99	0.04	0.34	0.08	0.07	0.00	3.24	0.10	2.62	0.04	91.87
34	CM-24 oxide 4 2	1.67	0.62	0.13	-	81.48	0.06	0.38	0.10	0.01	0.00	3.69	0.10	2.65	0.04	90.95
35	CM-24 oxide 4 3	2.07	0.66	0.17	-	77.76	0.08	0.71	0.07	0.08	0.02	4.72	0.10	2.77	0.00	89.21
11	CM-25 oxide 1 1	10.18	0.29	0.25	-	74.57	0.03	0.03	0.25	0.01	0.00	0.48	0.13	1.20	0.11	87.51
12	CM-25 oxide 1 2	8.77	0.24	0.15	-	68.67	0.00	0.00	0.15	0.02	0.00	0.35	0.11	0.84	0.11	79.41
13	CM-25 oxide 1 3	10.60	0.31	0.26	-	71.20	0.02	0.02	0.23	0.01	0.00	0.62	0.11	0.98	0.13	84.49
14	CM-25 oxide 2 1	1.38	0.12	0.11	-	93.18	0.01	0.02	0.05	0.02	0.00	0.65	0.17	0.00	0.02	95.73
15	CM-25 oxide 2 2	1.91	0.08	0.11	-	91.97	0.02	0.00	0.01	0.06	0.00	0.79	0.18	0.04	0.02	95.19
16	CM-25 oxide 2 3	1.33	0.16	0.12	-	94.63	0.01	0.00	0.02	0.05	0.03	0.71	0.17	0.04	0.01	97.27
17	CM-25 oxide 3 1	0.41	0.11	0.10	-	97.12	0.02	0.00	0.00	0.03	0.00	0.17	0.14	0.01	0.03	98.14
18	CM-25 oxide 3 2	0.90	0.05	0.09	-	96.08	0.01	0.02	0.02	0.03	0.00	0.27	0.13	0.02	0.06	97.68
19	CM-25 oxide 3 3	1.27	0.08	0.07	-	94.88	0.01	0.00	0.07	0.02	0.00	0.17	0.07	0.04	0.00	96.68
20	CM-25 oxide 4 1	1.39	0.12	0.10	-	93.30	0.00	0.04	0.06	0.03	0.00	0.80	0.10	0.08	0.01	96.03
21	CM-25 oxide 4 2	1.68	0.17	0.11	-	91.81	0.01	0.00	0.04	0.01	0.00	0.96	0.10	0.13	0.07	95.08
22	CM-25 oxide 5 1	4.78	0.18	0.13	-	78.40	0.00	0.01	1.59	0.02	0.00	0.49	0.05	0.34	0.02	86.02
23	CM-25 oxide 5 2	4.96	0.15	0.14	-	80.37	0.00	0.00	1.67	0.04	0.01	0.32	0.06	0.29	0.07	88.08
24	CM-25 oxide 5 3	4.33	0.12	0.13	-	79.20	0.00	0.00	1.74	0.03	0.00	0.29	0.07	0.31	0.07	86.29
30	Grace-05 oxide 1 1	0.01	0.00	0.00	0.00	98.72	0.00	0.00	0.03	0.00	0.00	0.33	0.00	0.00	0.00	99.11
31	Grace-05 oxide 1 2	0.00	0.00	0.01	0.00	98.60	0.00	0.00	0.01	0.02	0.00	0.14	0.02	0.02	0.00	98.83

Scan #	Sample	Al_2O_3	As_2O_5	CaO	Cu_2O	Fe_2O_3	K_2O	MgO	MnO	PbO	Sb_2O_5	SiO_2	SO_3	TiO_2	ZnO	Total
32	Grace-05 oxide 2 1	4.24	0.15	0.05	0.00	75.73	0.00	0.01	0.00	0.01	0.00	0.75	0.11	0.57	0.06	81.67
33	Grace-05 oxide 2 2	4.45	0.20	0.04	0.00	72.24	0.03	0.03	0.03	0.05	0.00	0.77	0.12	0.68	0.00	78.63
34	Grace-05 oxide 3	0.08	0.01	0.01	0.02	95.87	0.02	0.00	0.02	0.06	0.00	0.07	0.04	0.07	0.01	96.29
35	Grace-05 oxide 4	0.65	0.21	0.29	0.23	75.05	0.03	0.43	0.12	0.08	0.00	3.07	0.14	0.10	0.03	80.42
36	Grace-05 oxide 5	2.77	0.29	0.31	0.27	73.49	0.03	0.50	0.62	0.04	0.02	1.95	0.09	0.11	0.14	80.62
37	Grace-05 oxide 6	1.73	0.09	0.17	0.00	79.32	0.01	0.07	0.02	0.01	0.03	9.36	0.14	0.07	0.00	91.03
8	G-WGM-23 oxide 1	3.46	3.15	0.22	-	68.93	0.02	0.04	0.74	0.07	0.03	2.23	0.12	0.70	0.00	79.71
9	G-WGM-23 oxide 3	4.17	4.99	0.13	-	52.29	0.02	0.03	1.35	0.03	0.05	2.21	0.10	0.32	0.04	65.74
10	G-WGM-23 oxide 4	0.04	3.39	0.01	-	86.56	0.02	0.00	0.01	0.10	0.39	0.11	0.07	0.03	0.02	90.76
6	CM-24 1 1 (scorodite)	1.95	54.72	0.00	-	32.42	0.09	0.10	0.03	0.10	0.82	0.97	0.19	0.06	0.07	91.51
7	CM-24 1 2 (scorodite)	2.35	54.31	0.00	-	32.06	0.09	0.07	0.02	0.12	0.80	0.32	0.17	0.69	0.06	91.05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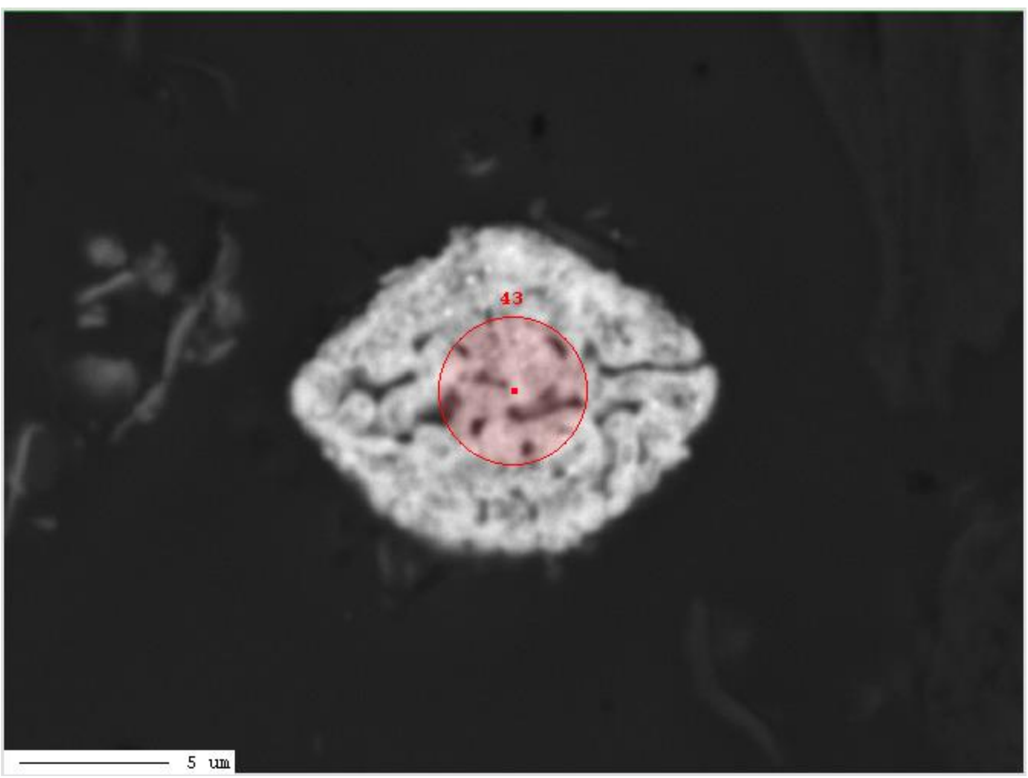
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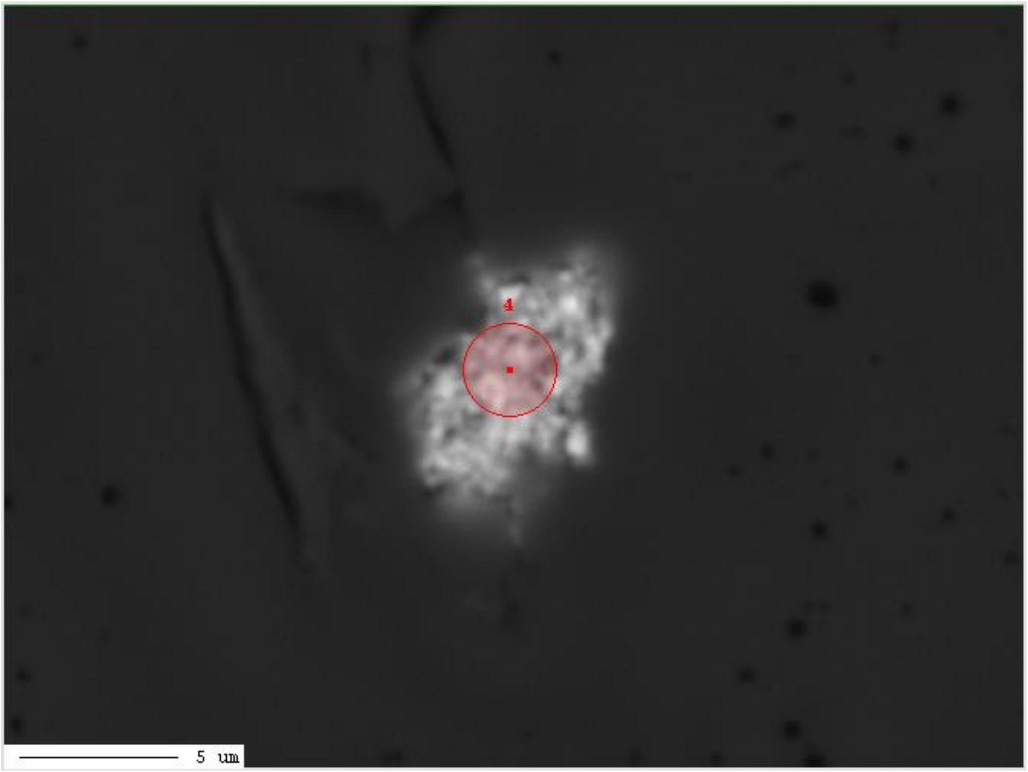
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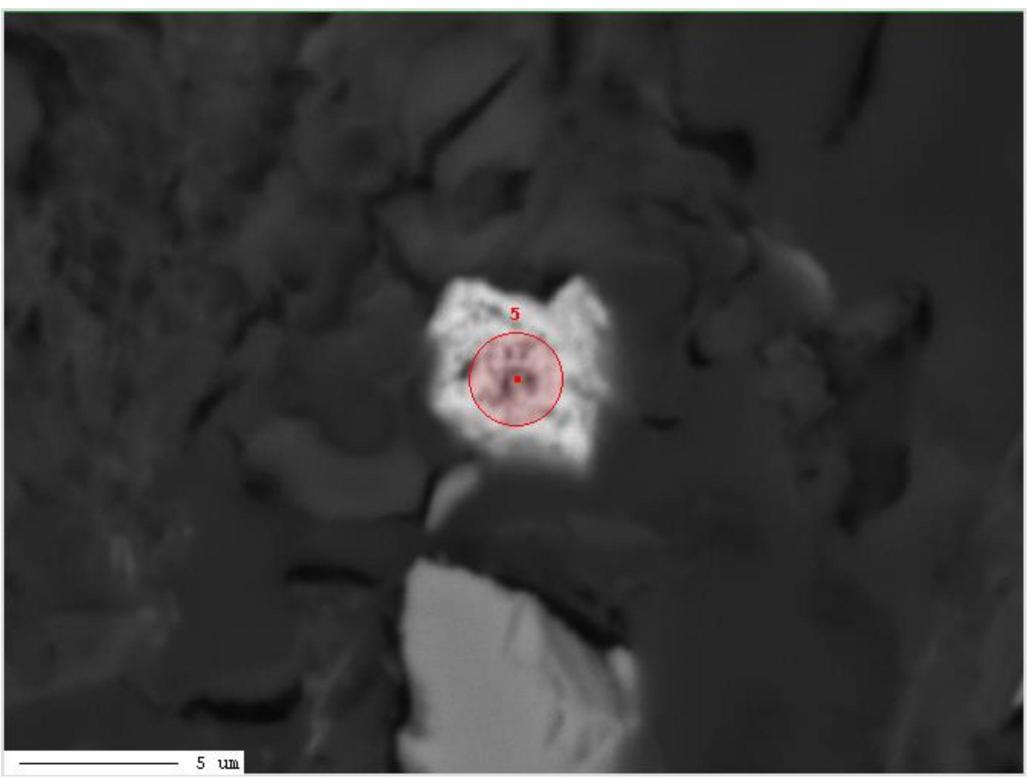
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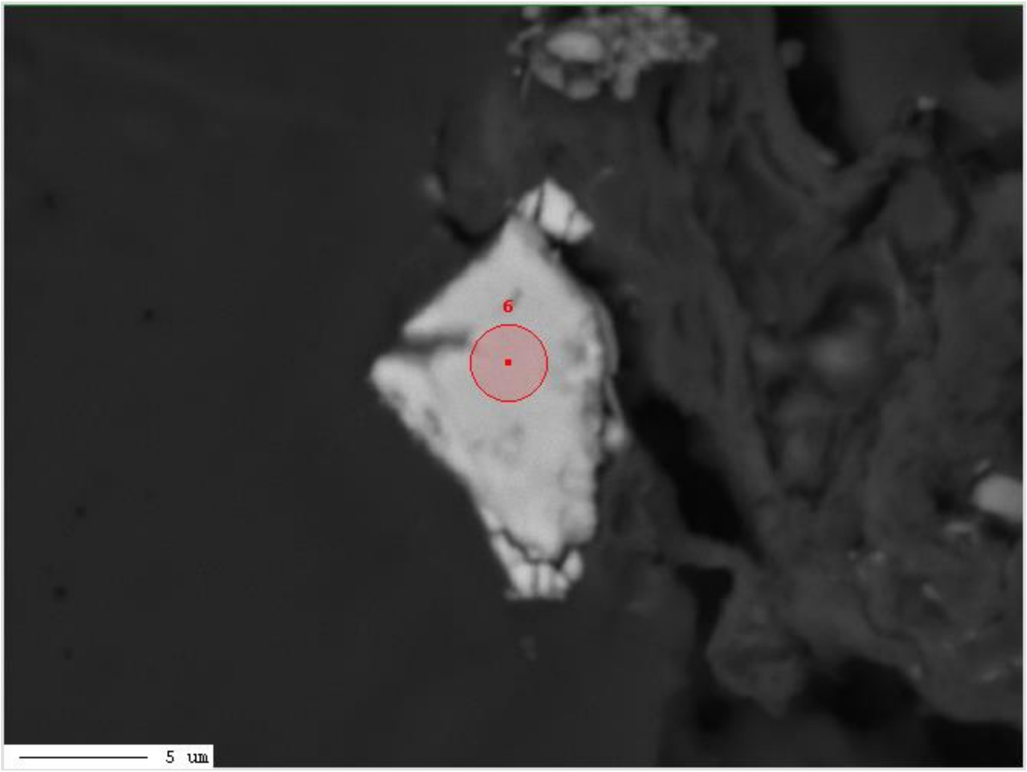
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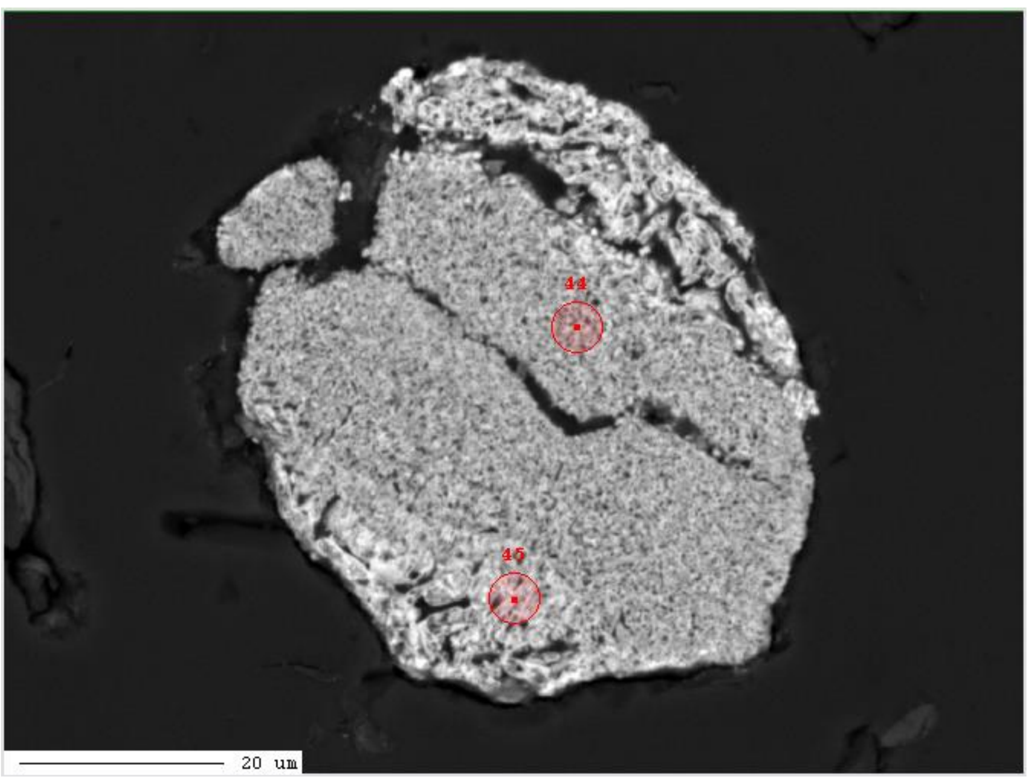
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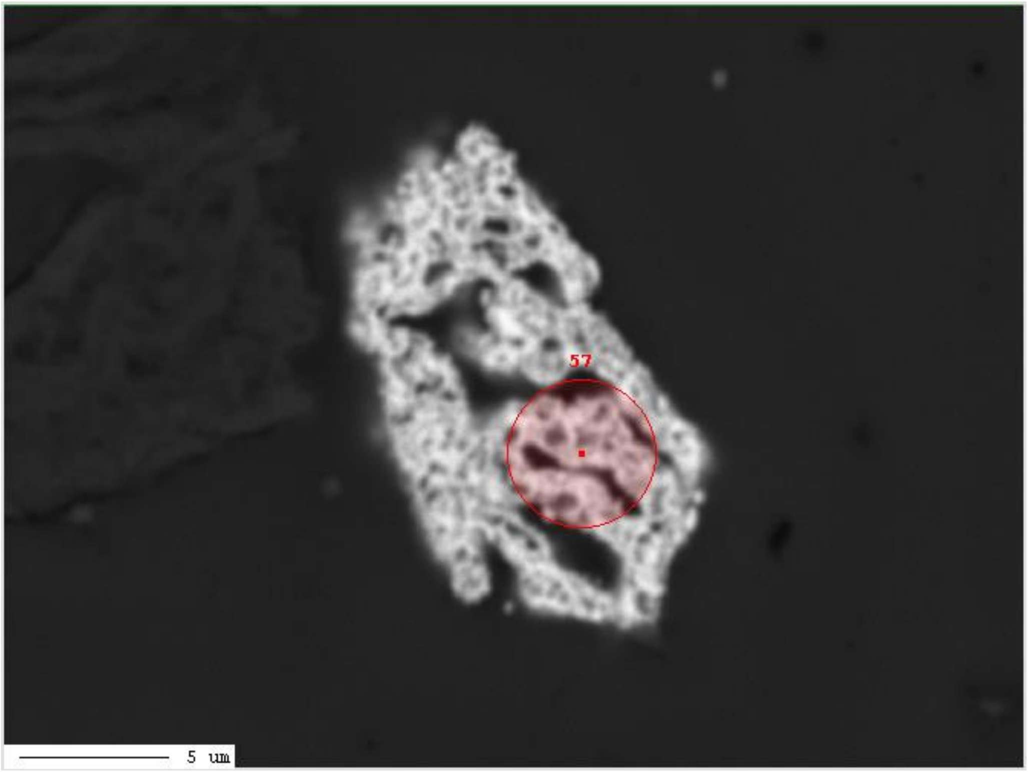
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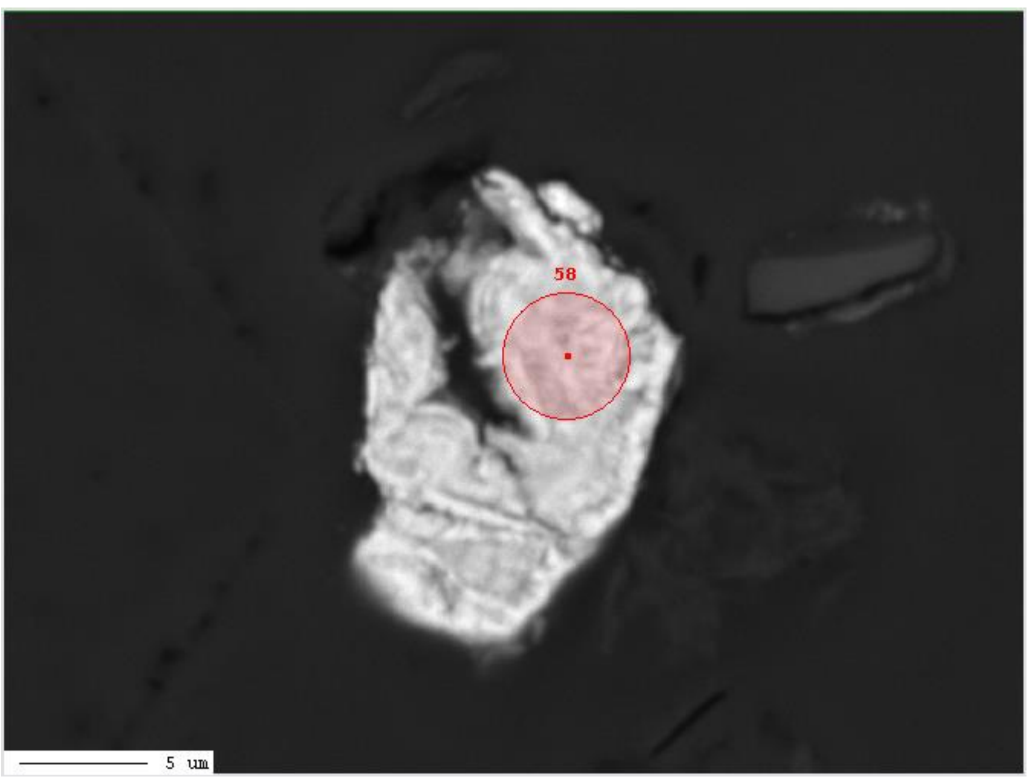
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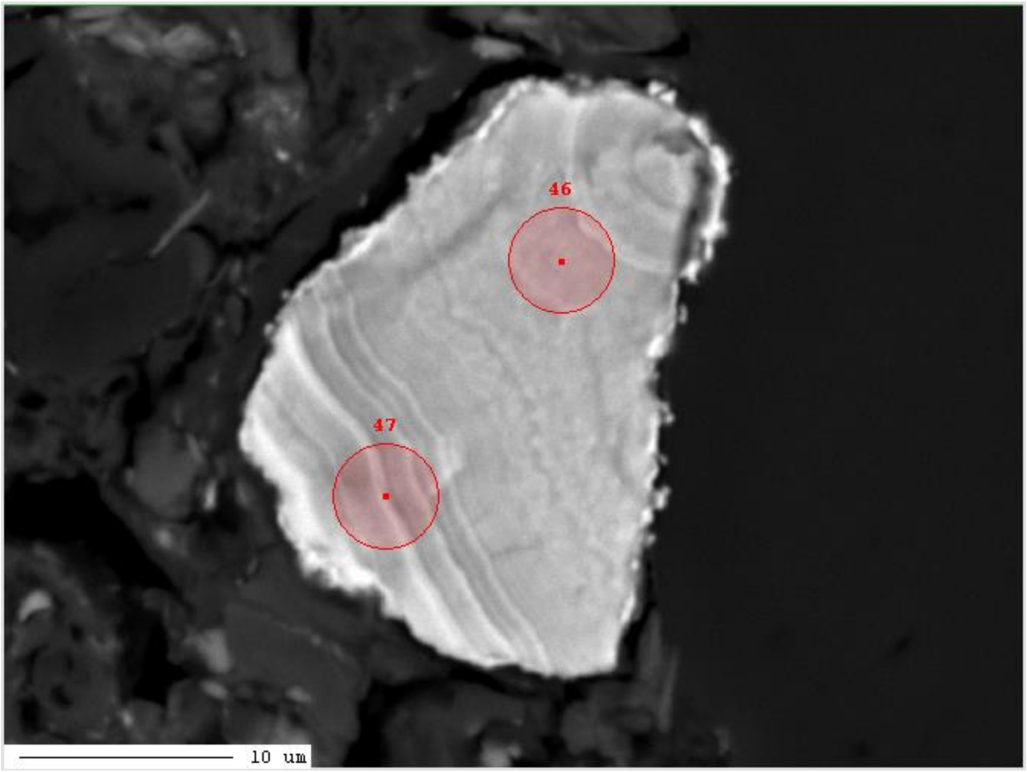
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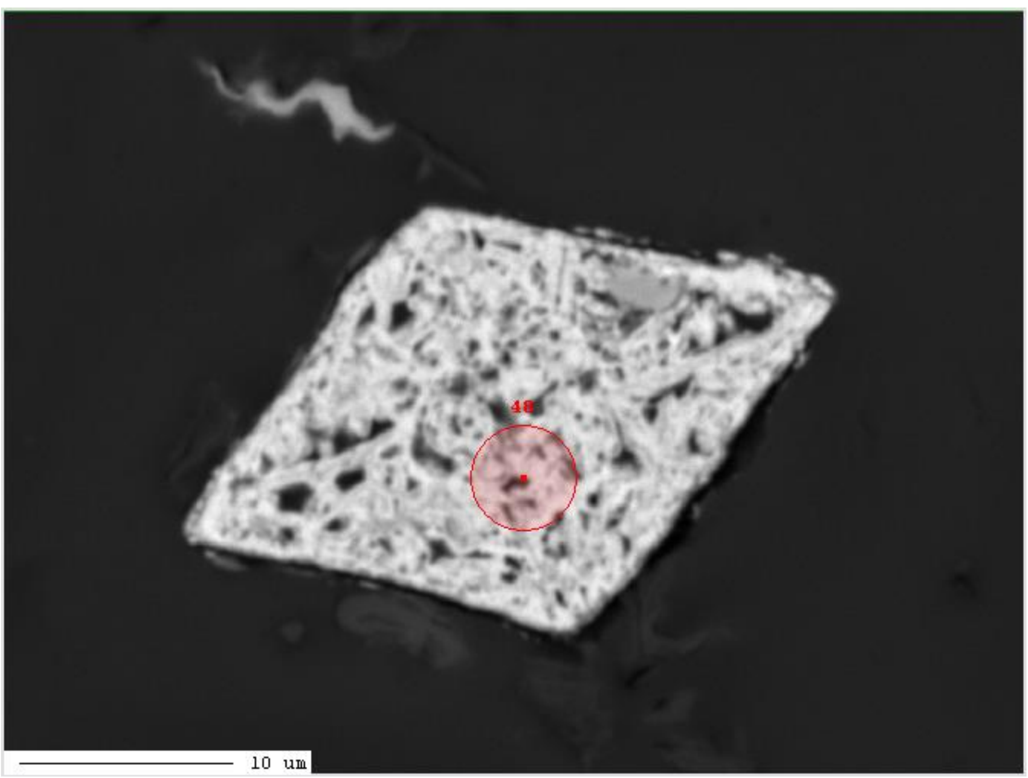
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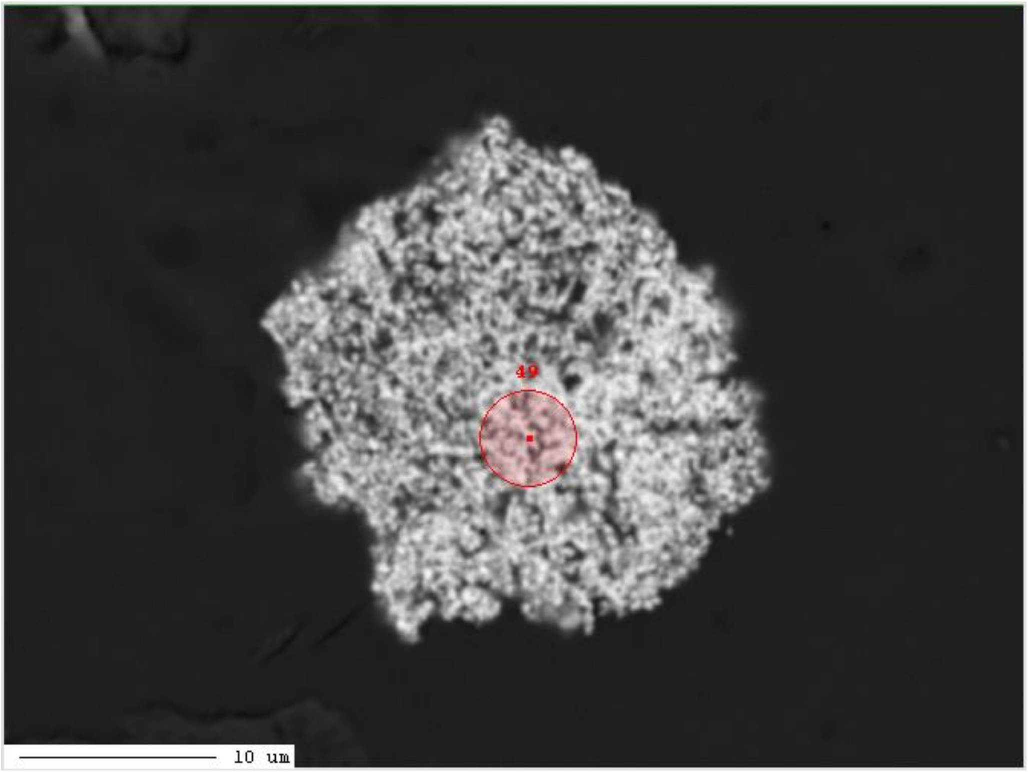
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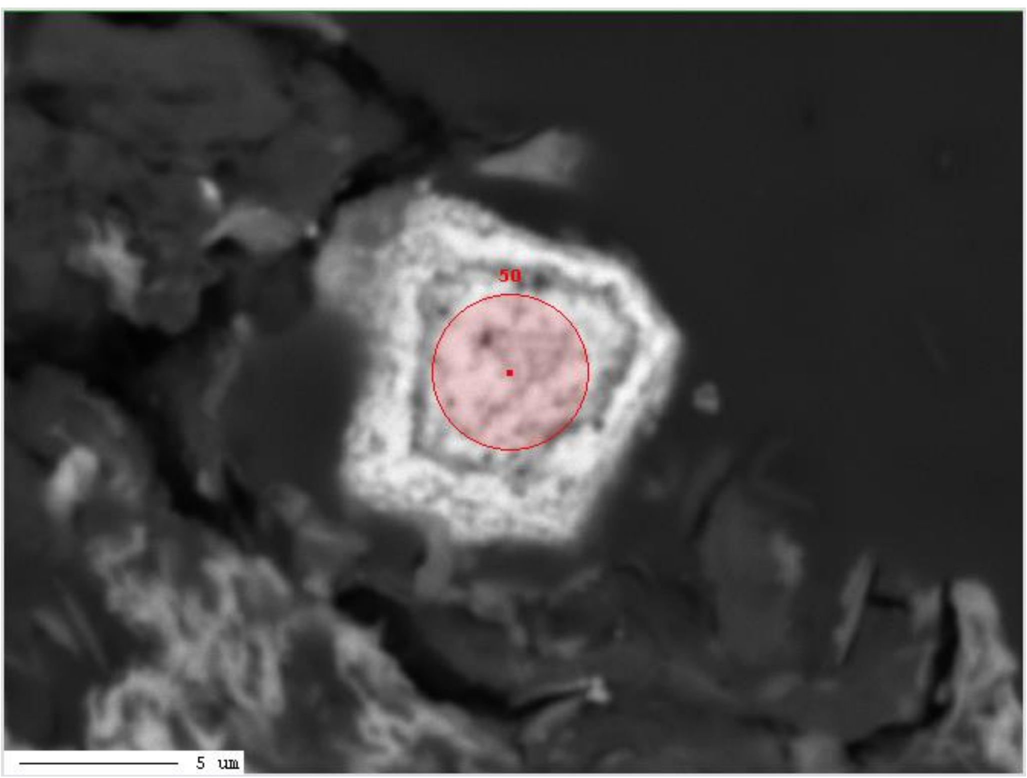
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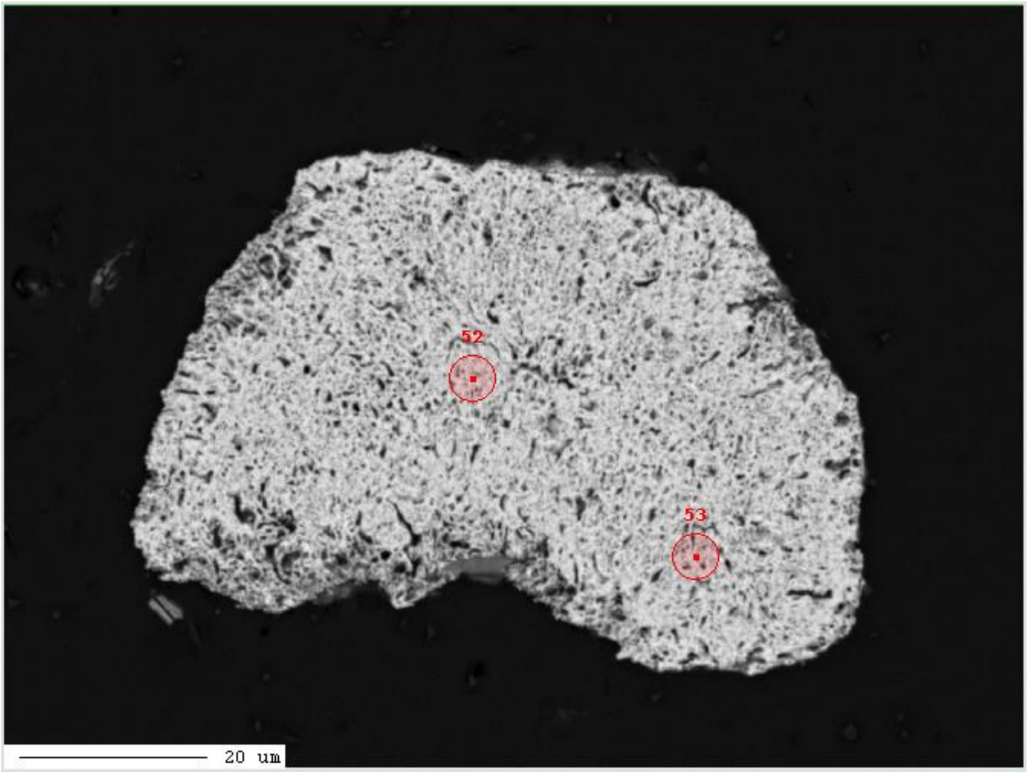
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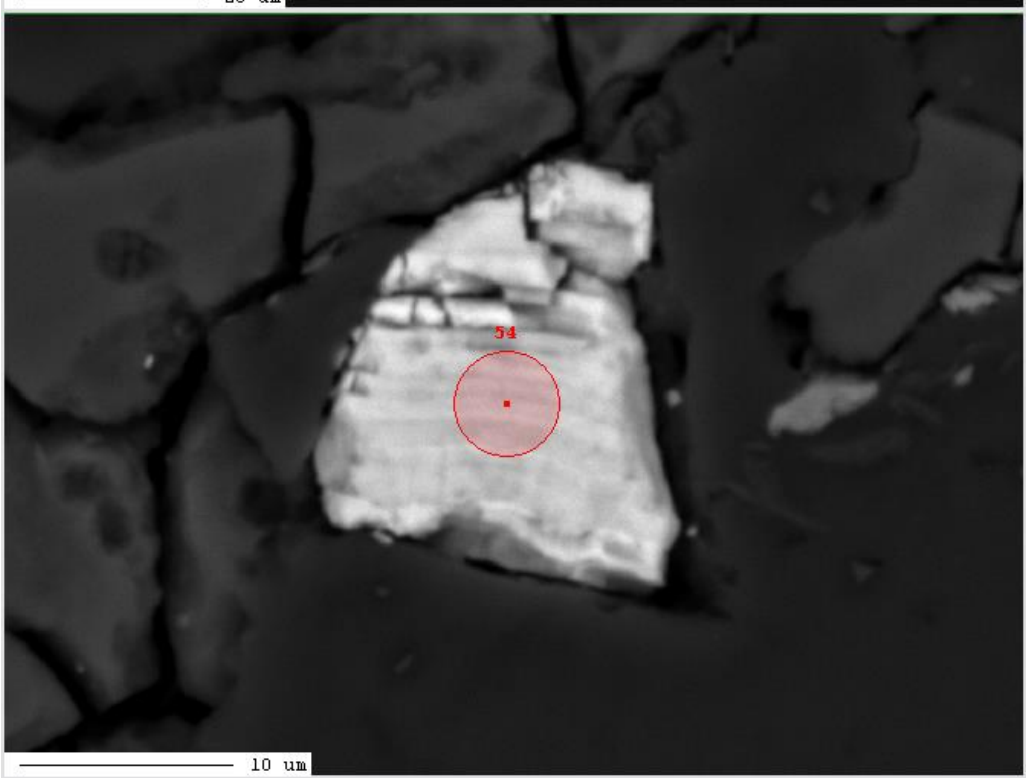
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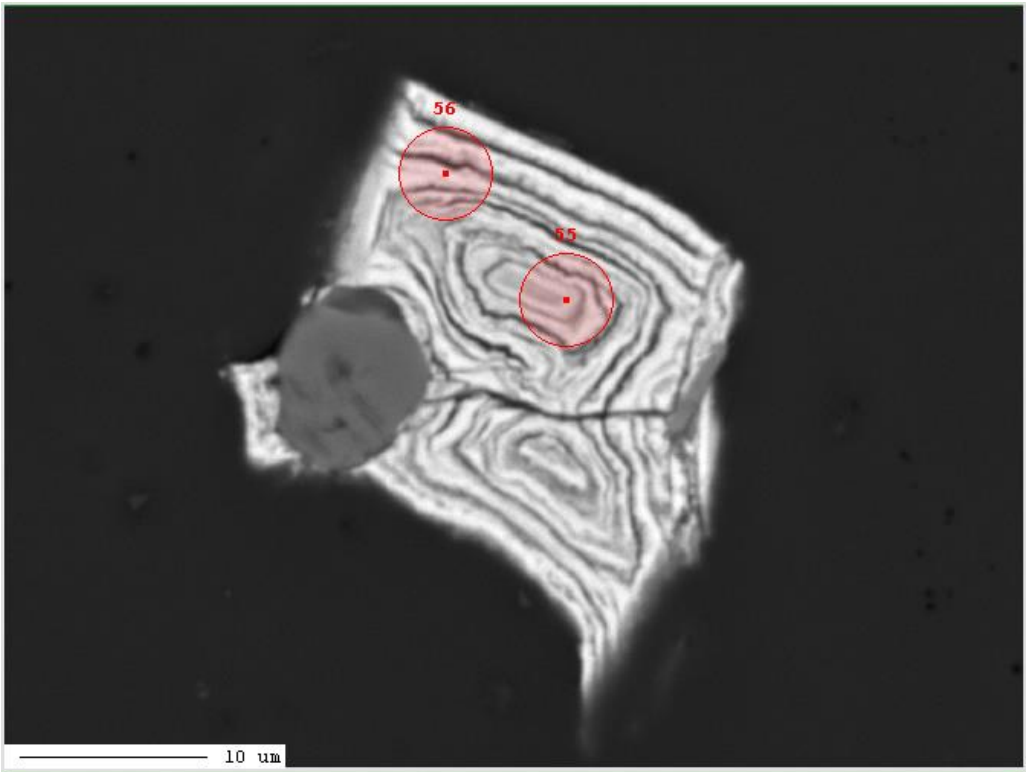
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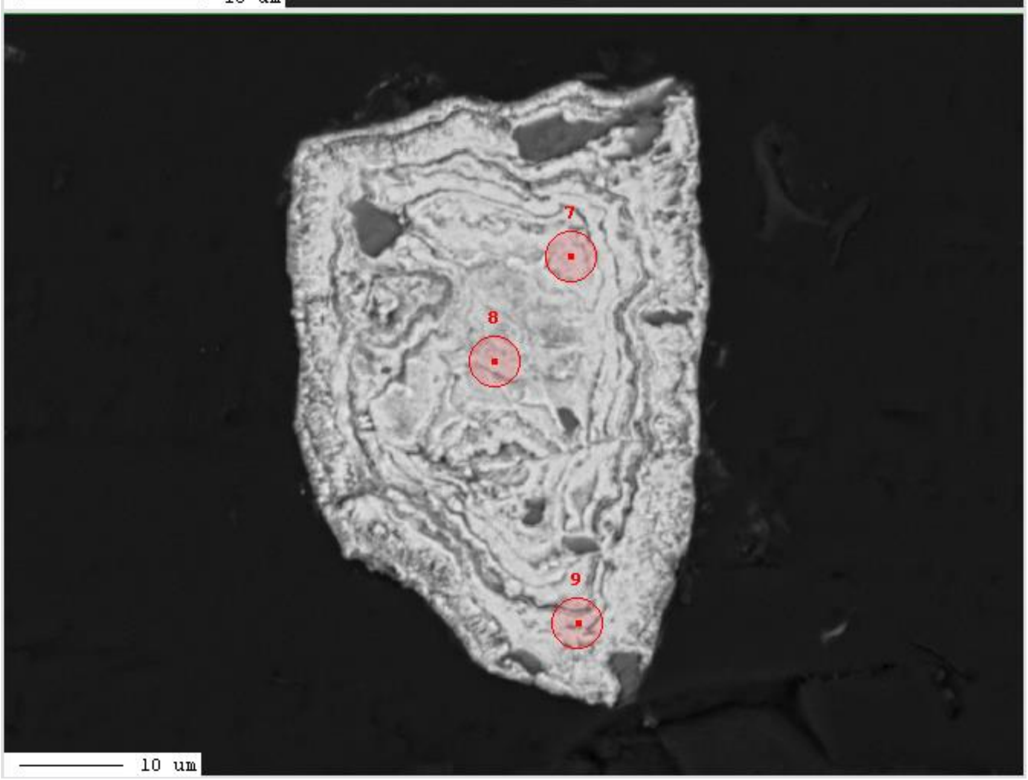
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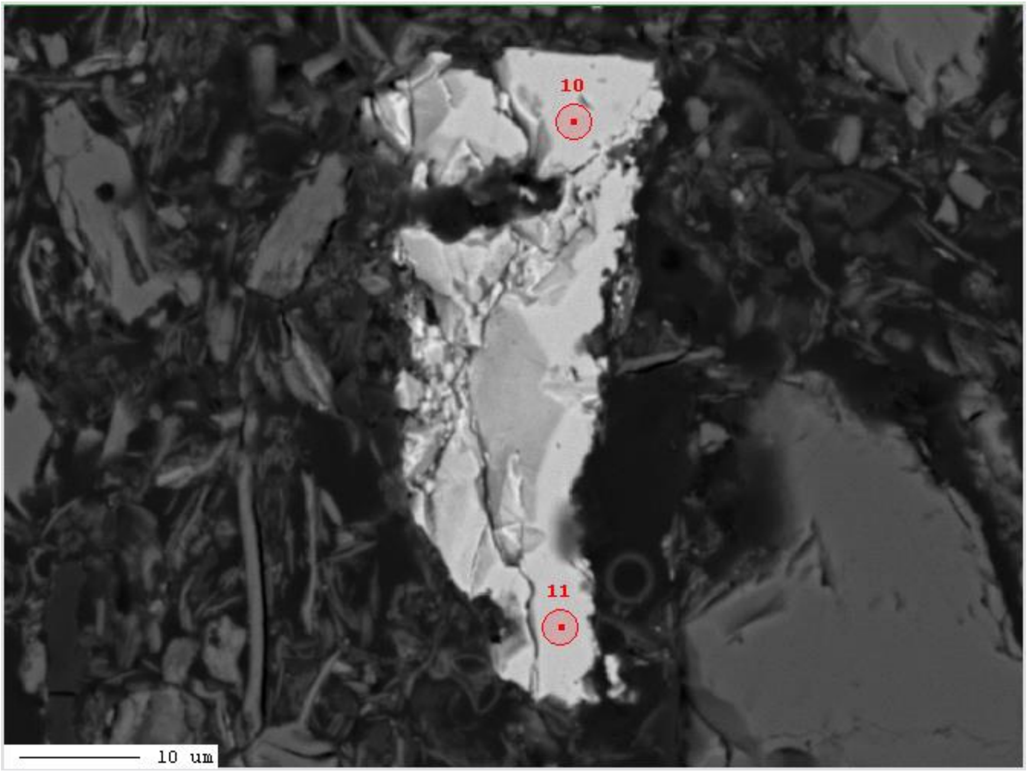
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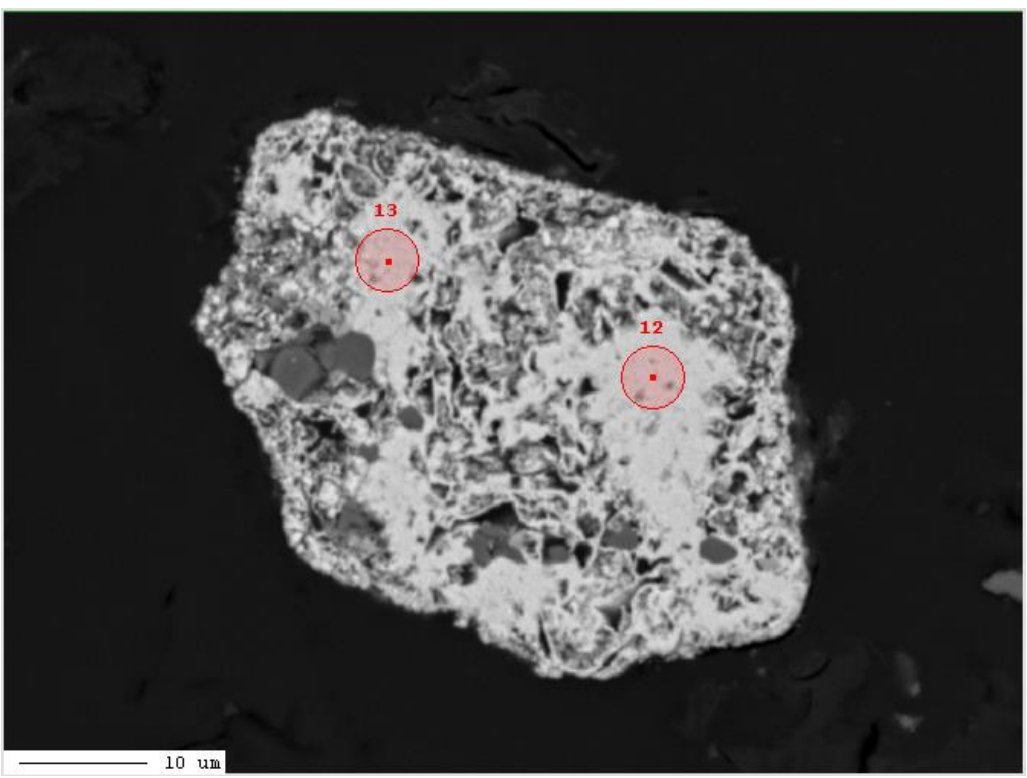
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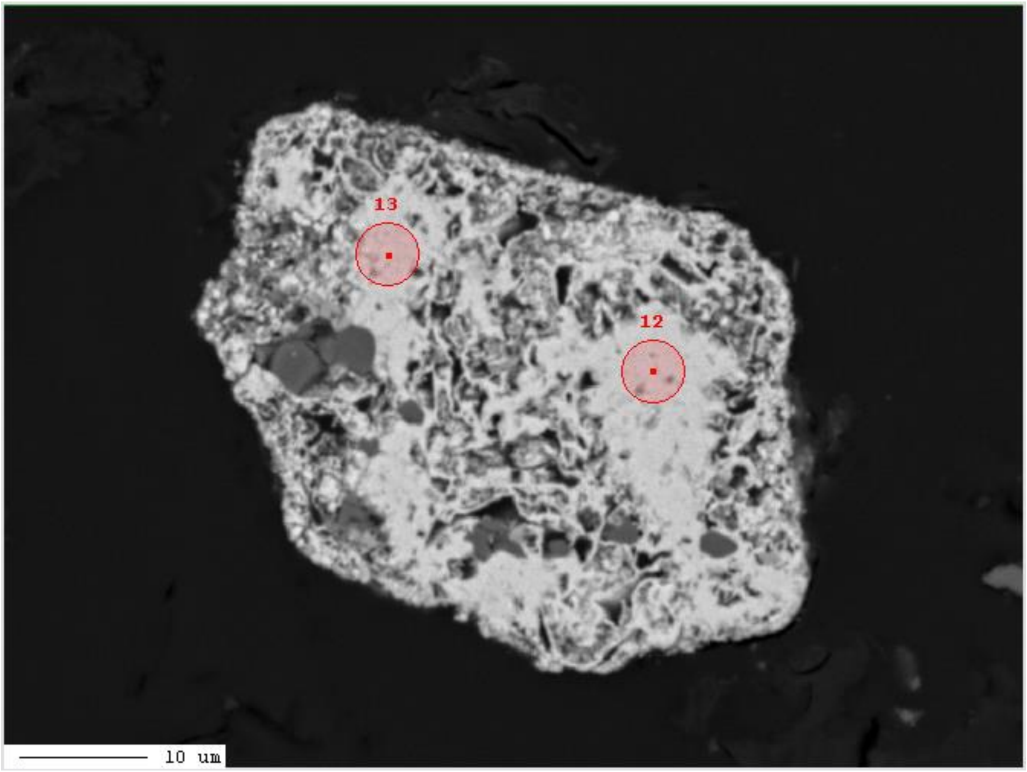
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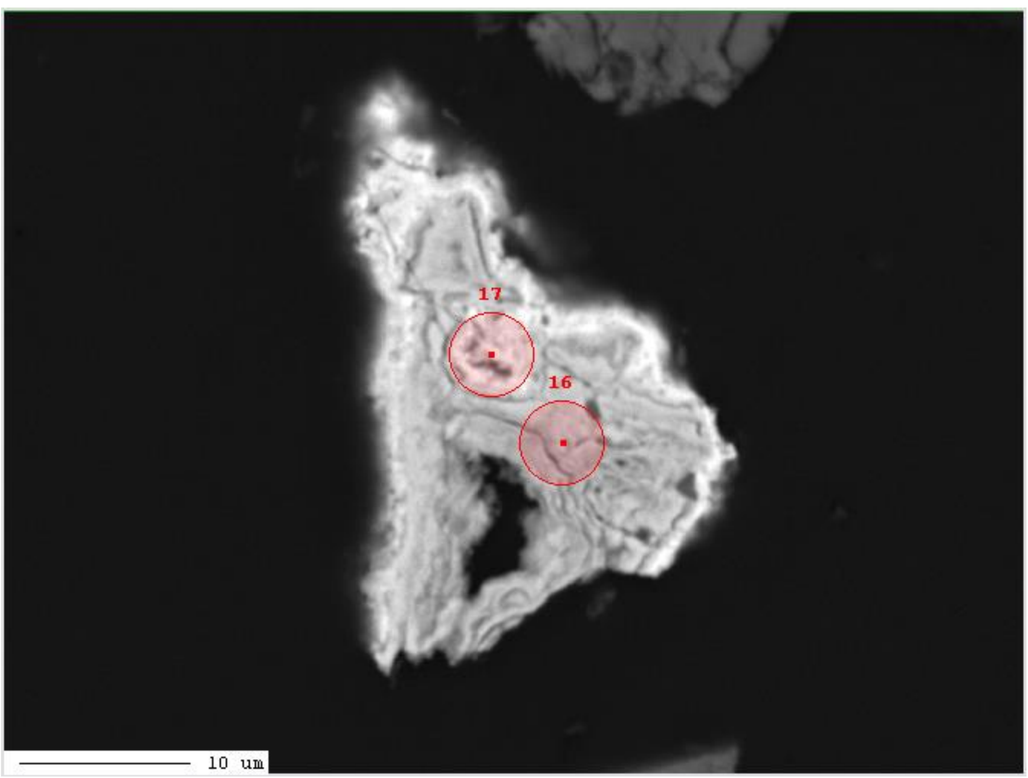
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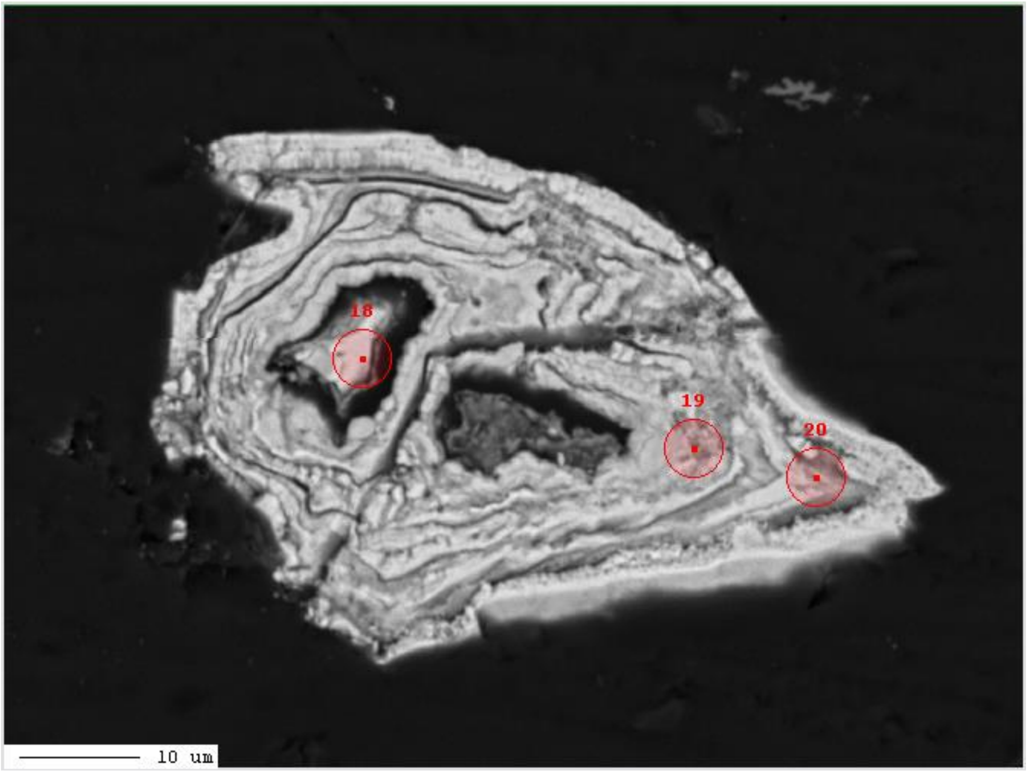
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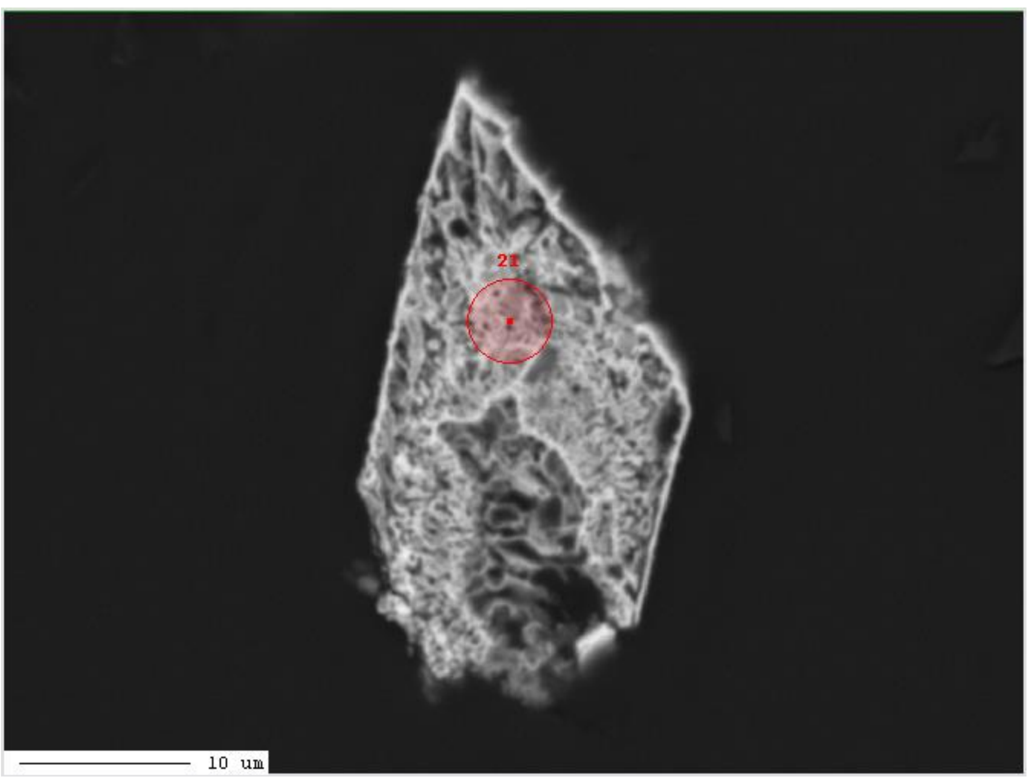
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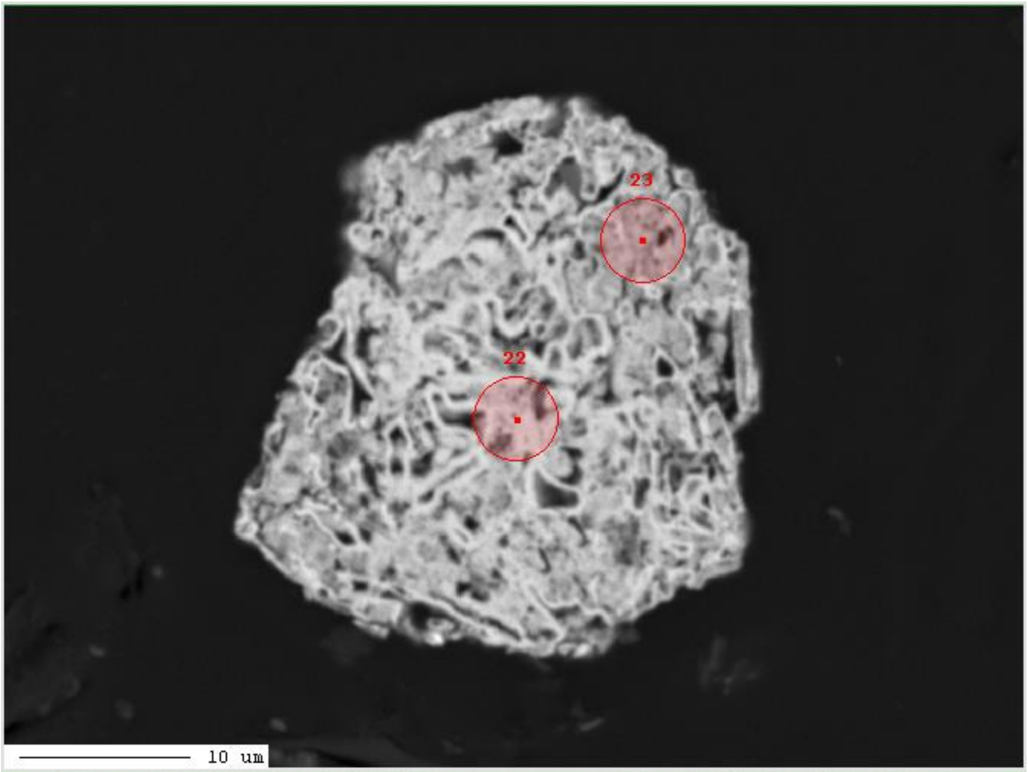
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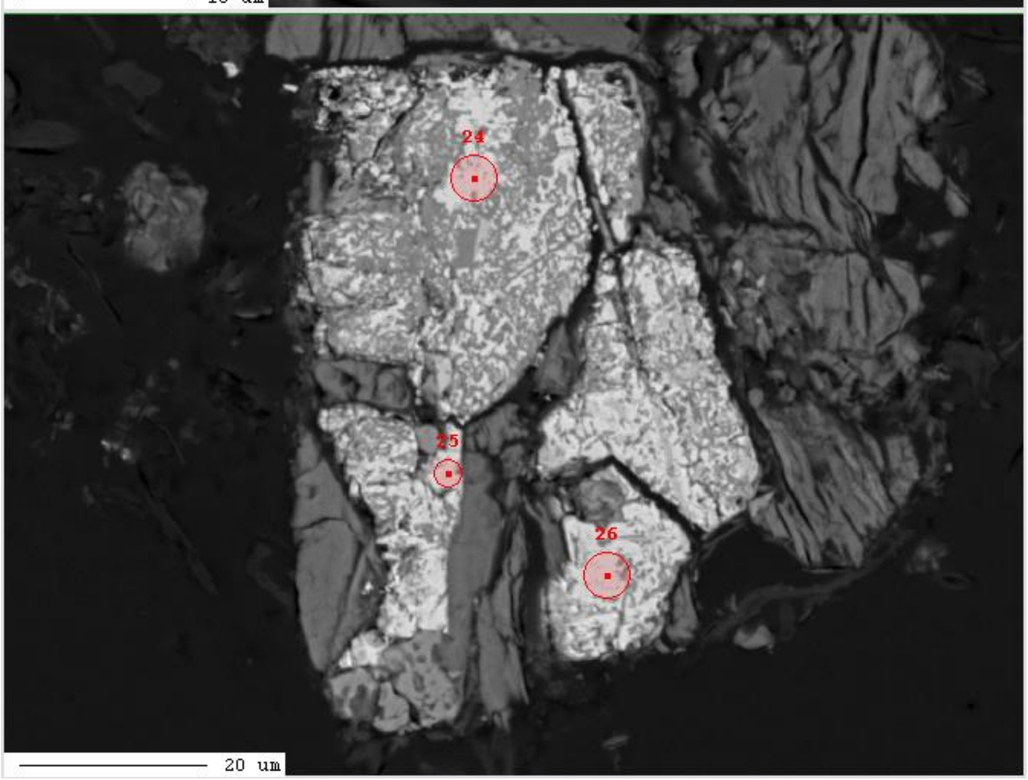
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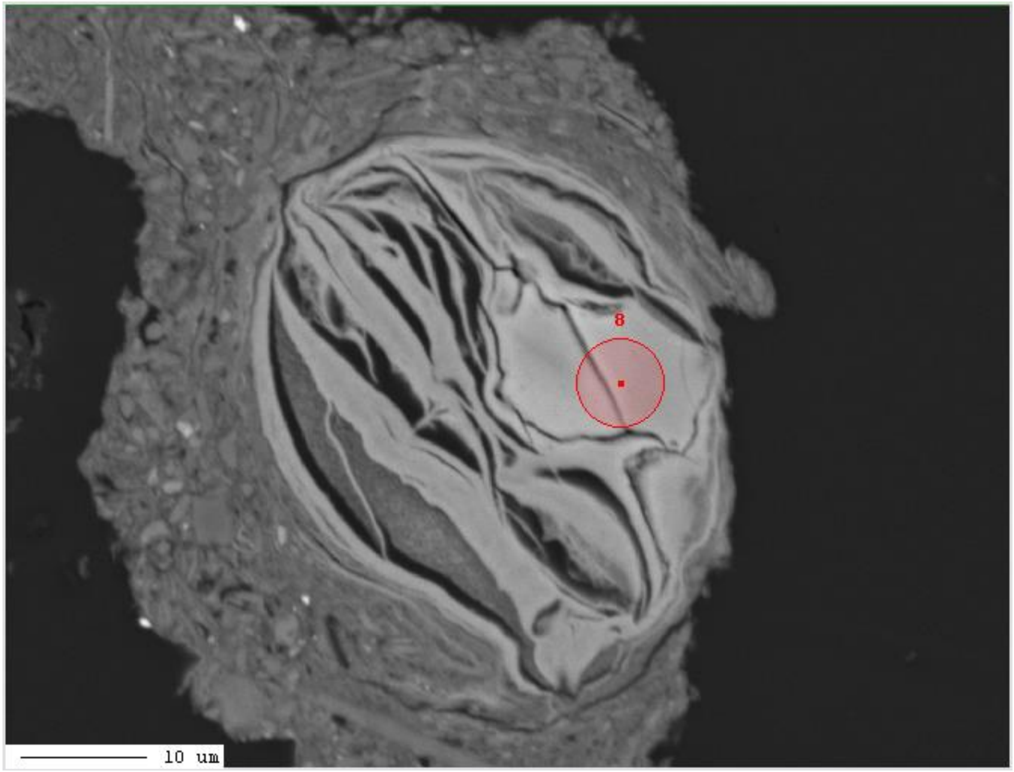
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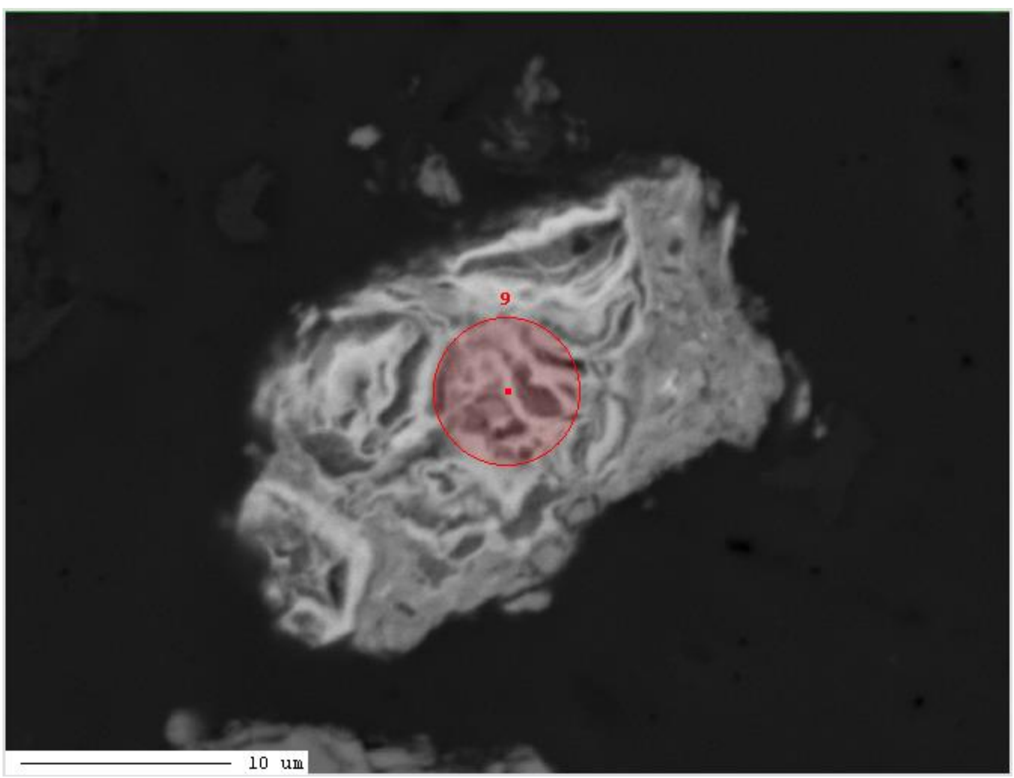
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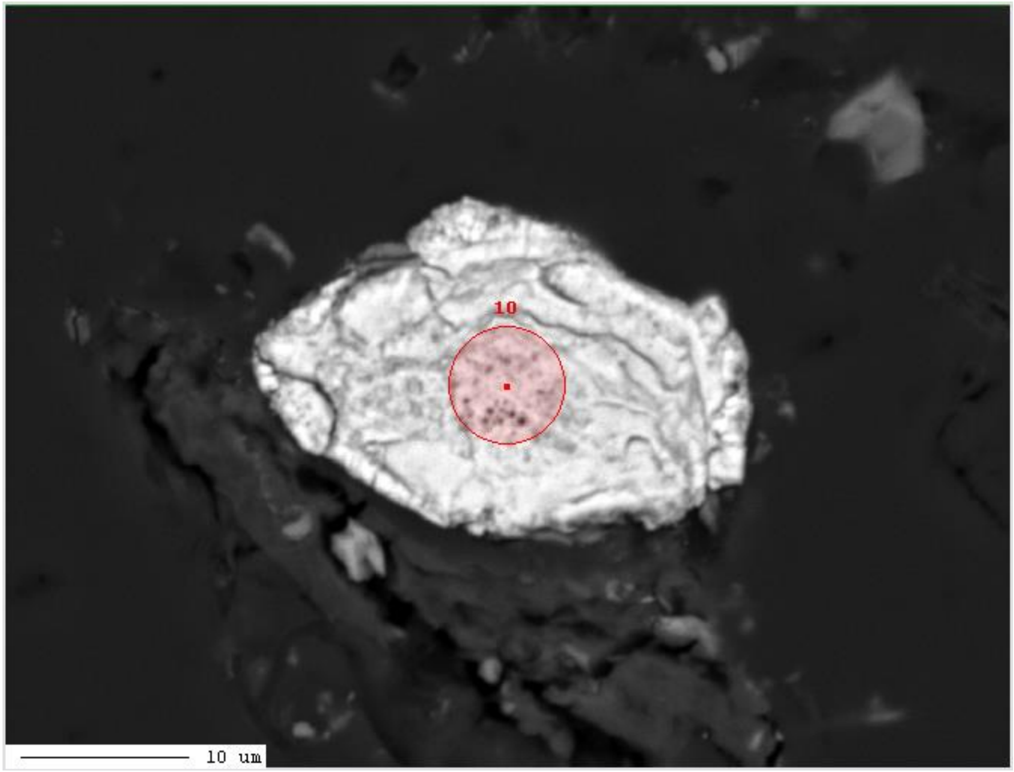
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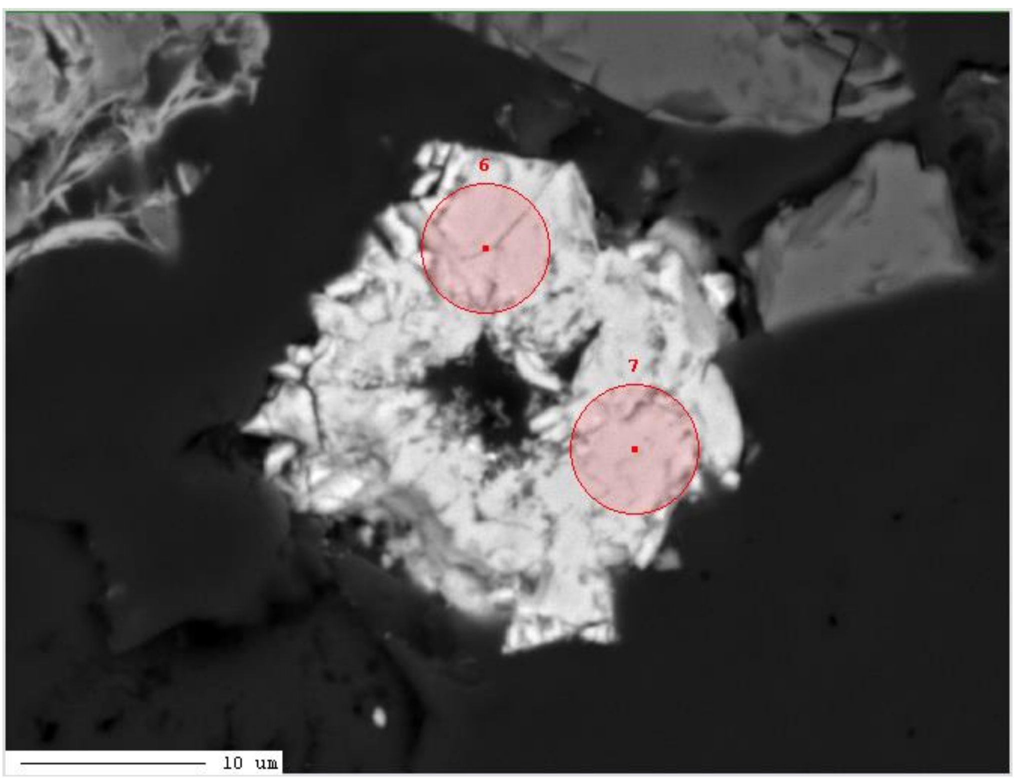
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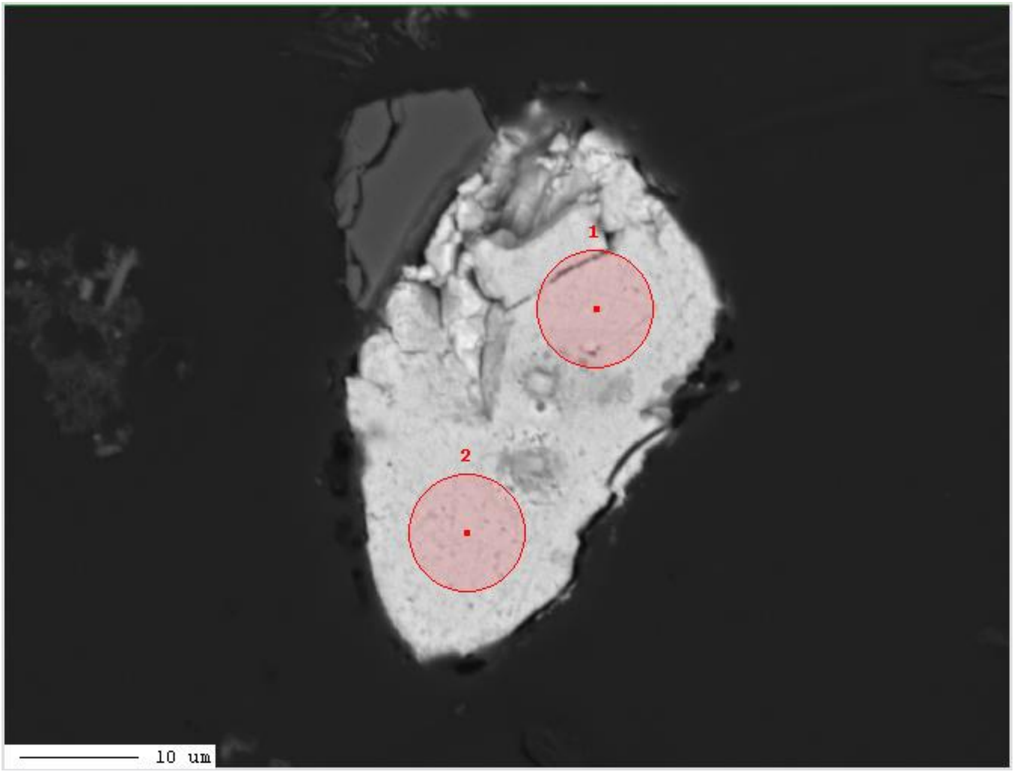
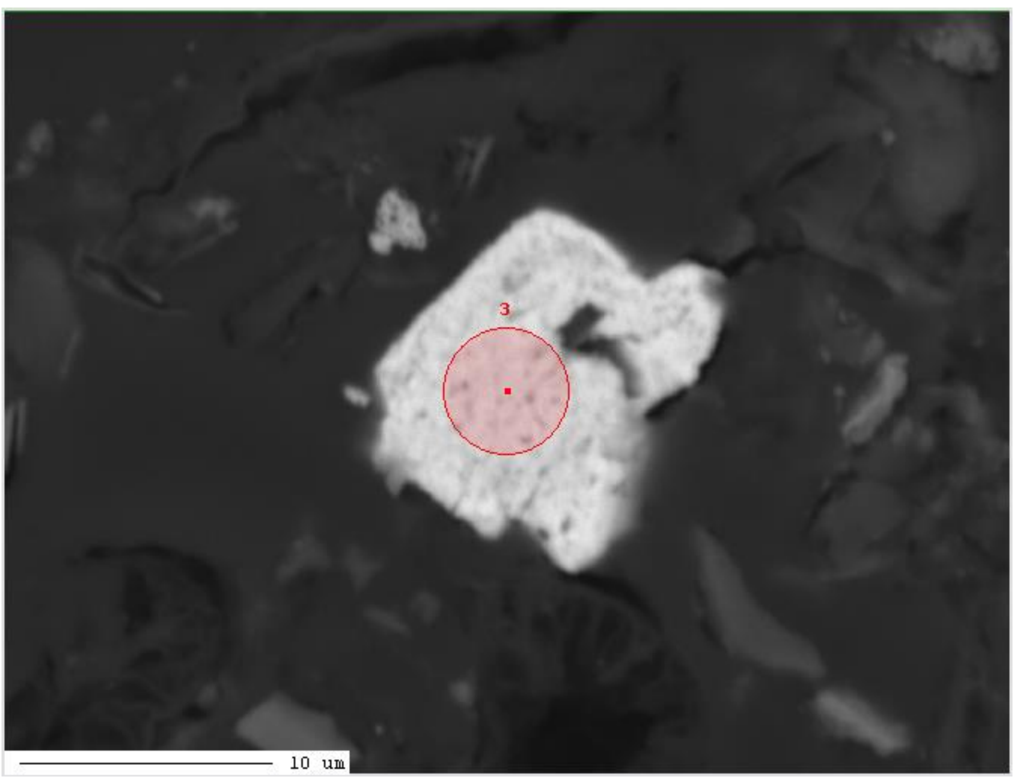
Table 2: EMPA data for iron oxides and arsenic trioxide from near Giant Mine, and arsenic trioxide and scorodite from near Con Mine. Scan# corresponds to the iron oxide figures shown below, in order of Sample ID. Data presented as weight percent.

Scan #	Sample	Al_2O_3	As_2O_3	CaO	CuO	Fe_2O_3	K_2O	MgO	MnO	PbO	Sb_2O_3	SiO_2	SO_3	TiO_2	ZnO	Total
1	G-WGM-23 arsenolite 1 1	0.029	100.7	0		0.0714	0	0.1972	0	0	0	0.0797	0.0113	0	0.0076	101.0962
2	G-WGM-23 arsenolite 1 2	0.0392	103.96	0		0.0882	0.0056	0.2021	0.0318	0	0.0342	0.0422	0	0.0136	0.0969	104.5138
3	G-WGM-23 arsenolite 2	0	96.88	0.0392		0.1111	0.0047	0.2311	0	0	0	0	0.0494	0.0518	0	97.3673
4	G-WGM-23 arsenolite 3 1	0.0098	103.04	0		0.1451	0.0064	0.2245	0.0117	0	0.0012	0	0.0186	0.0296	0	103.4869
5	G-WGM-23 arsenolite 3 2	0.0755	94.07	0		0.2639	0	0.2888	0.0337	0.057	1.69	0.1864	0.0967	0.0024	0.0284	96.7928
62	CM-08 arsenolite 1	0	100.31	0	0	0.0892	0	0.2351	0.0001	0.0602	0.6529	0	0	0.0482	0	101.3957
59	CM-18 arsenolite 1	0.111	99.04	0.0248	0.0012	0.1284	0.0084	0.227	0.0086	0	0.3981	1.0477	0.0639	0	0.0392	101.0983
60	CM-18 arsenolite 2	0	94.96	0	0	0.0815	0.0174	0.2145	0.0121	0.0714	1.76	0.2118	0	0.0507	0	97.3794
63	CM-22 arsenolite 1	0.0196	87.66	0.0264	0.0322	0.1883	0.0046	0.195	0	0.0448	0.5128	0.1417	0.1722	0	0	88.9976
64	CM-22 arsenolite 2 1	0.0435	98.35	0.0505	0.0909	0.0636	0.0121	0.2104	0.0215	0.0643	0.0799	0.1099	0.0032	0.0247	0.0468	99.1713
65	CM-22 arsenolite 2 2	0.0436	99.82	0.0402	0.0437	0.0355	0.0183	0.1063	0.0523	0.0001	0.0942	0.2025	0.0077	0	0	100.4644
66	CM-22 arsenolite 3 1	0.0054	97.65	0	0	0.04	0.0077	0.225	0	0.0454	0.7717	0	0.0155	0.0161	0	98.7768
67	CM-22 arsenolite 3 2	0.0077	95.7	0	0	0.018	0.0023	0.2082	0	0	1.0789	0.0438	0.0194	0.0149	0	97.0932
61	CM-23 arsenolite 1	0.1766	90.19	0.0941	0	0.1667	0.018	0.2581	0	0	0.1623	0.4617	0	0	0	91.5275


1
2
10 um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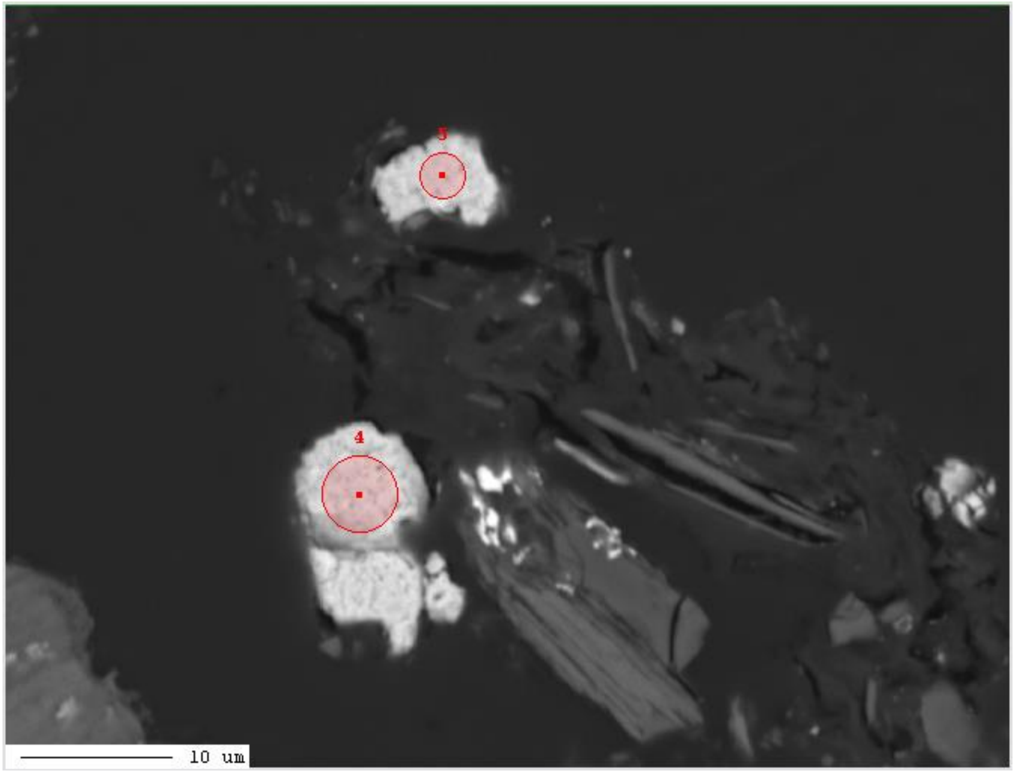
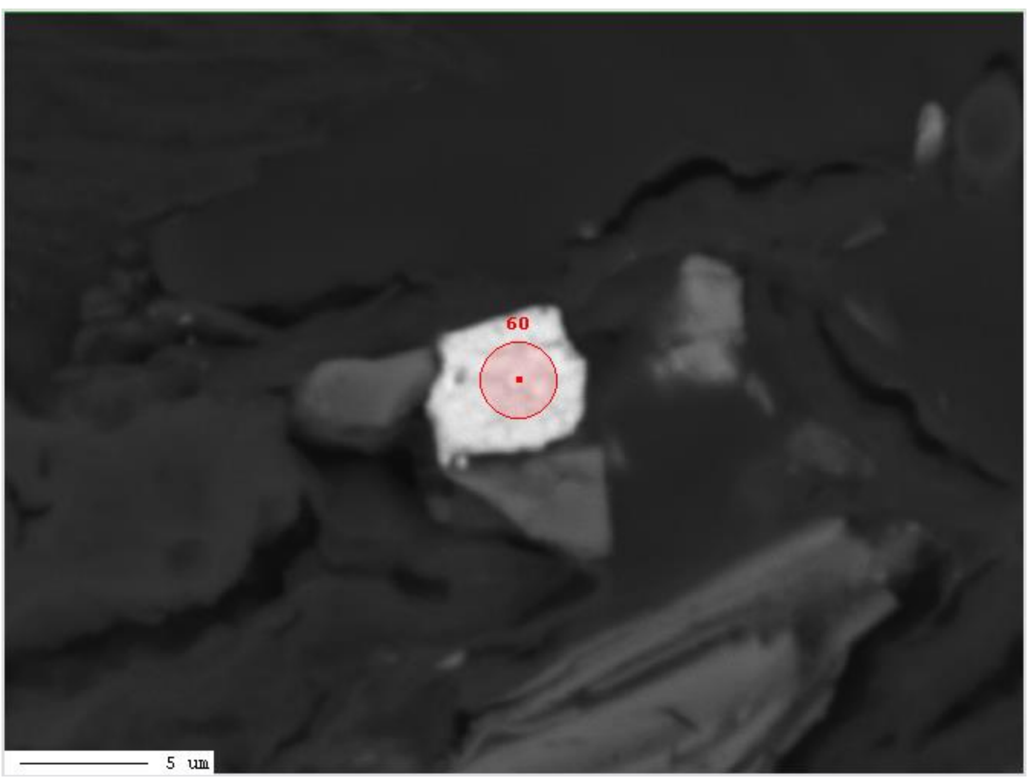

3
4
10 um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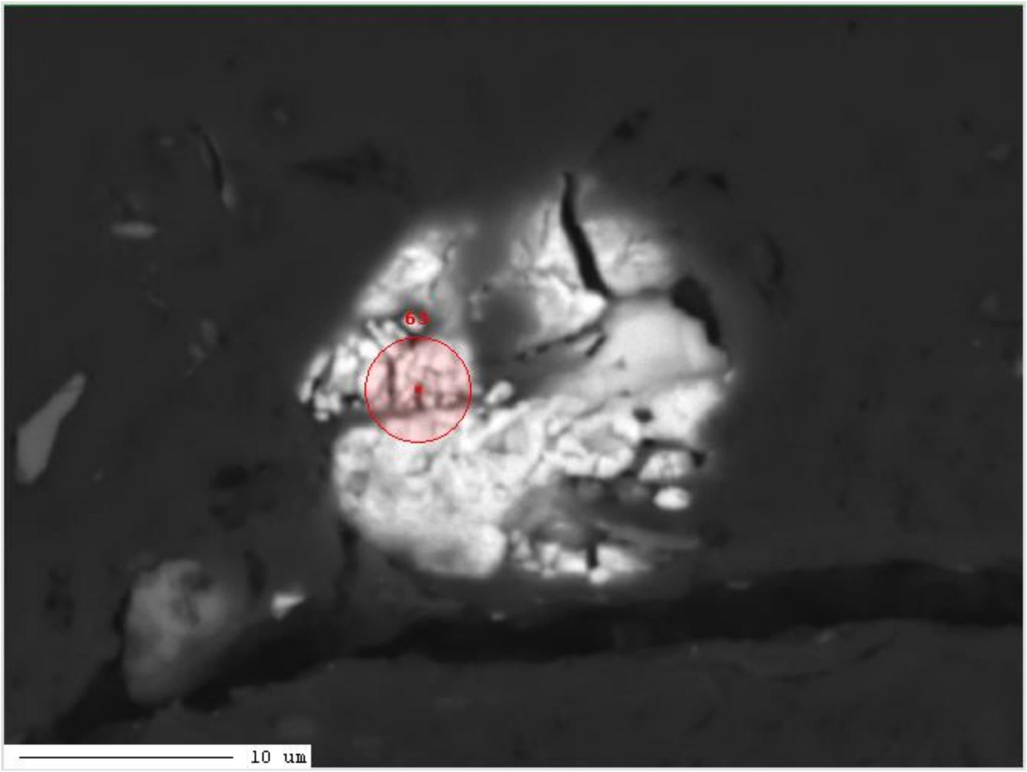
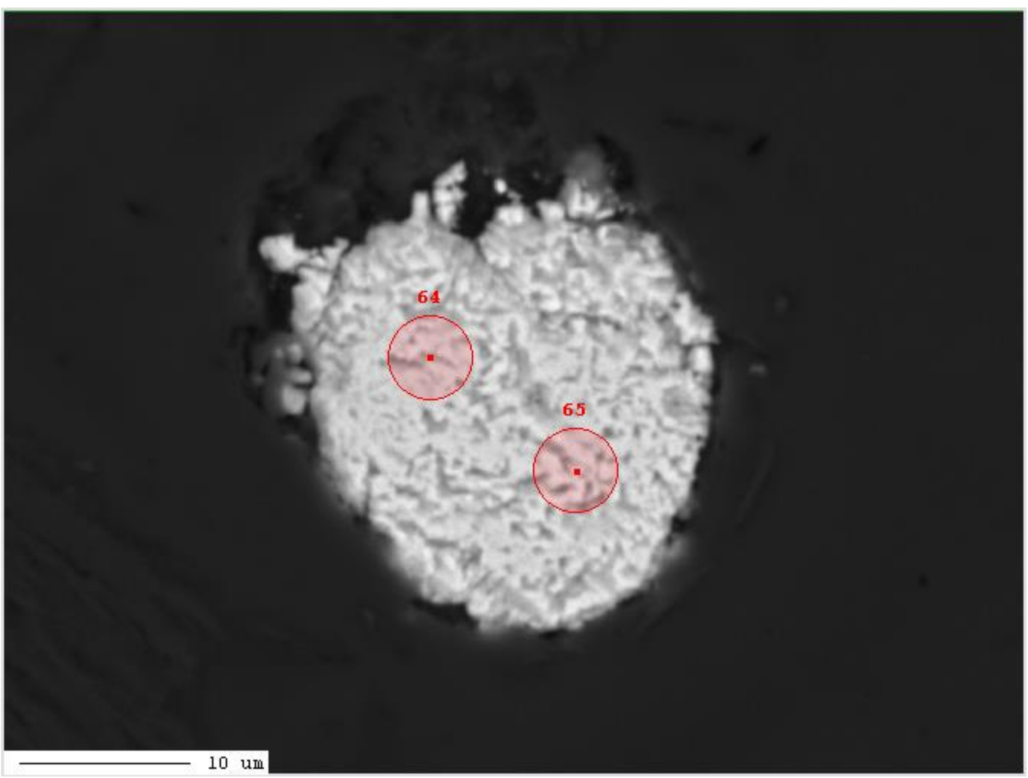
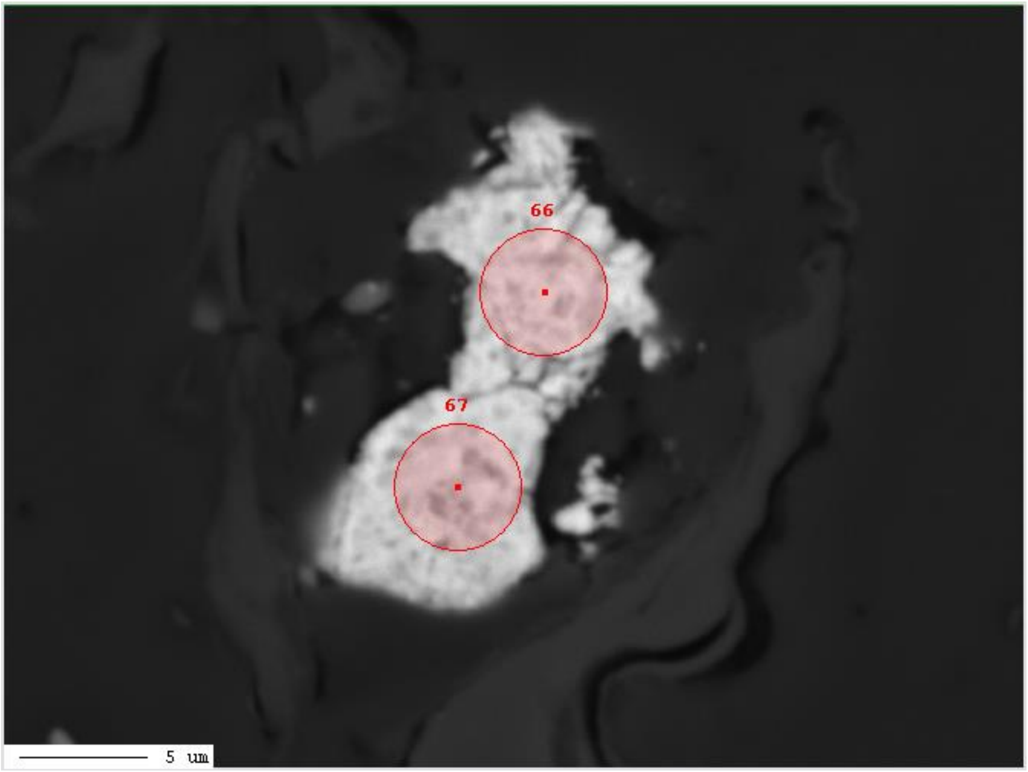
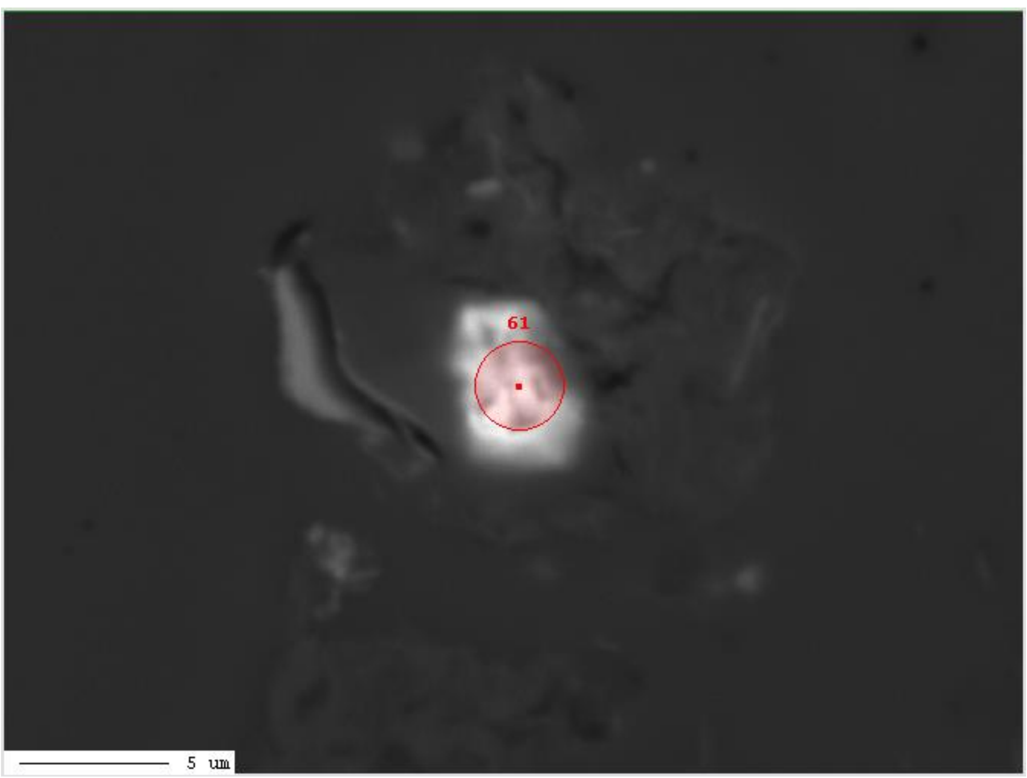

63
10 um


64
65
10 um

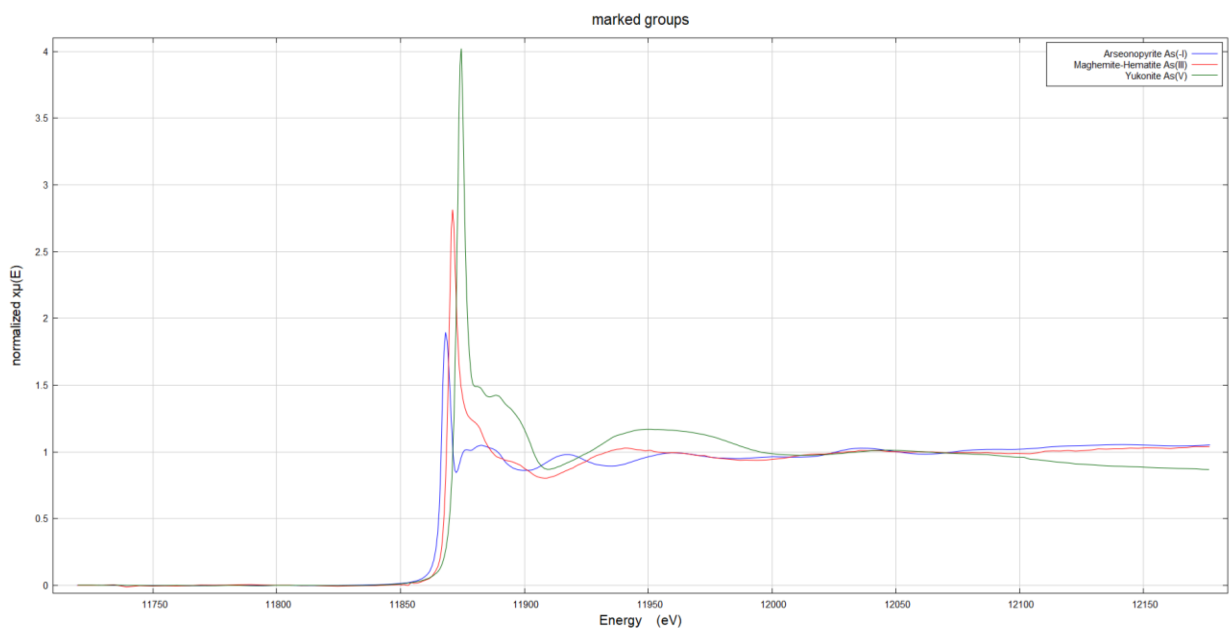

66
67
5 um


61
5 um

Appendix L

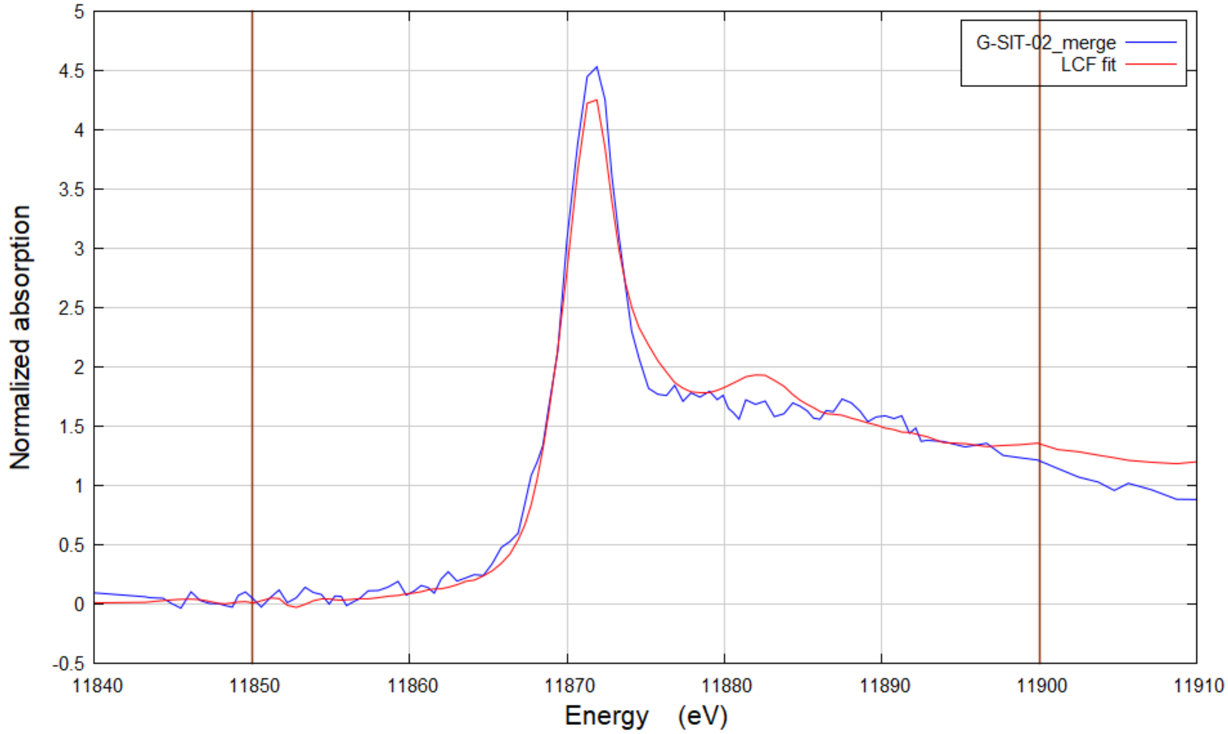
Synchrotron-based Bulk XANES Results

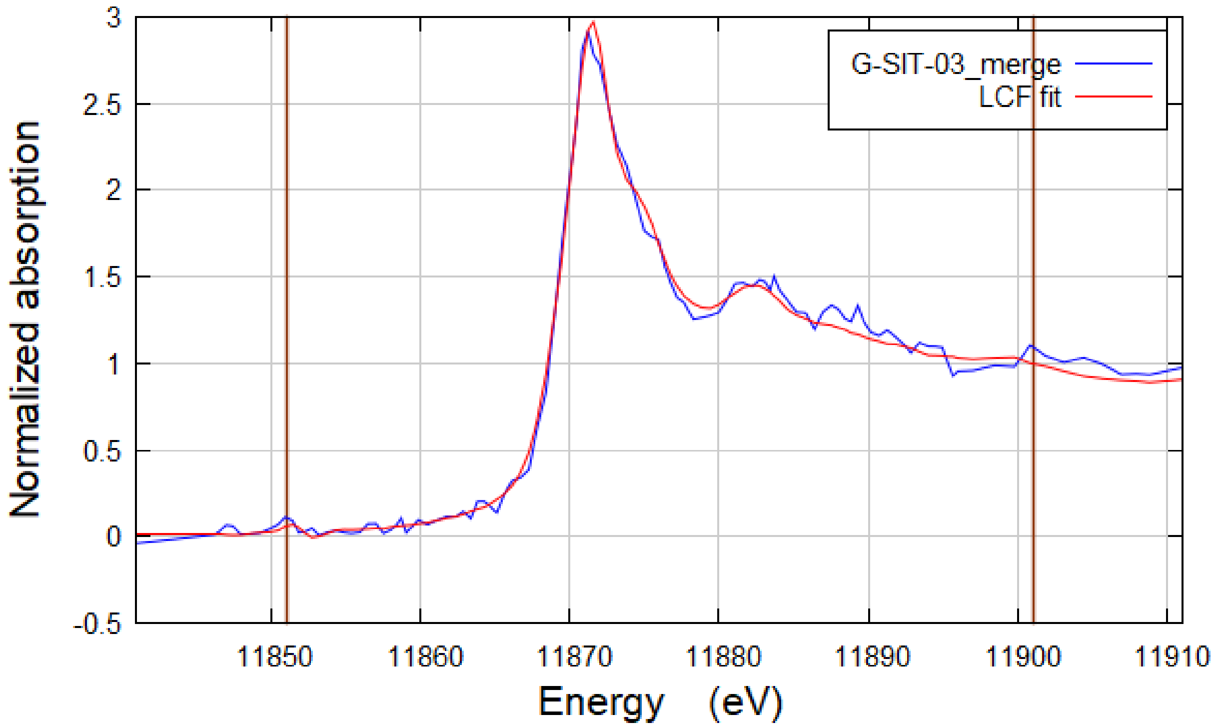
Bulk XANES transmission data and linear combination fitting (LCF) plots for soil samples collected in the PHL near Fred Henne Territorial Park and Long Lake. For each LCF plot, the following conditions remained the same: the weights of standards sum to 1; all weights were forced between 0 and 1; e0 was not shifted, and no noise was added to the data. Primary standards used for LCF analysis is shown below, followed by the quantitative results (Table K-1) and the corresponding plot for each sample.

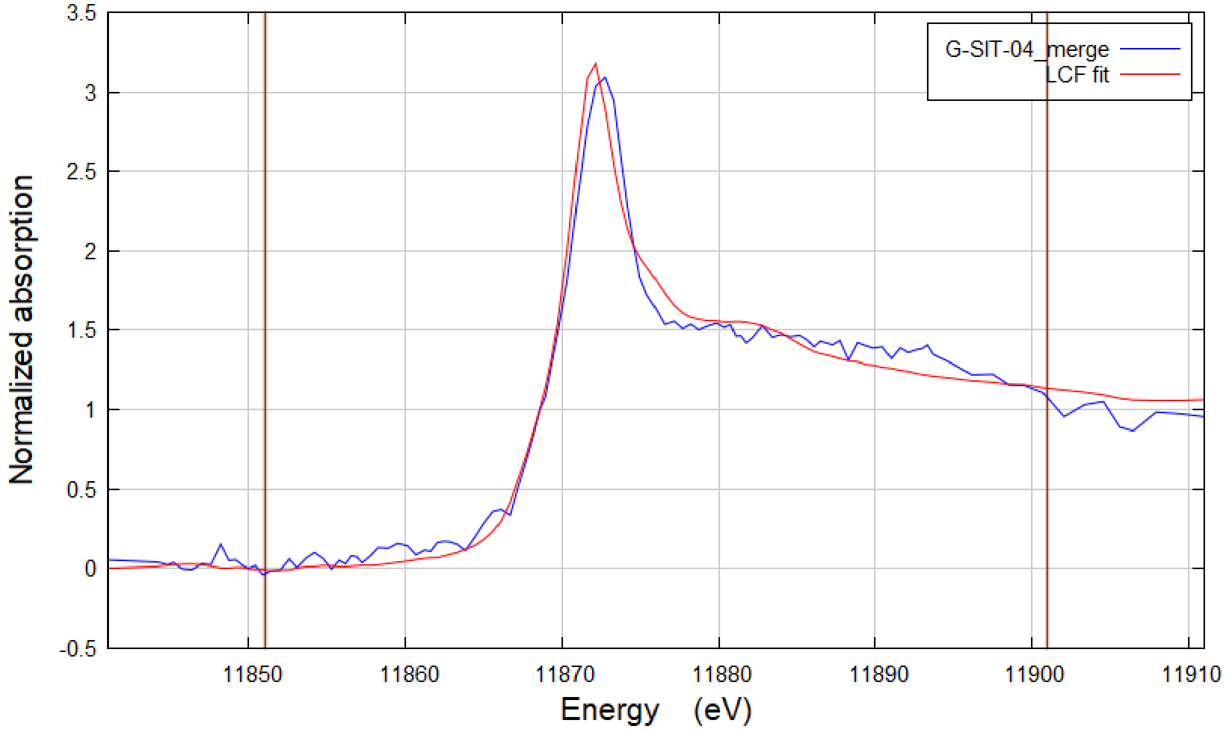


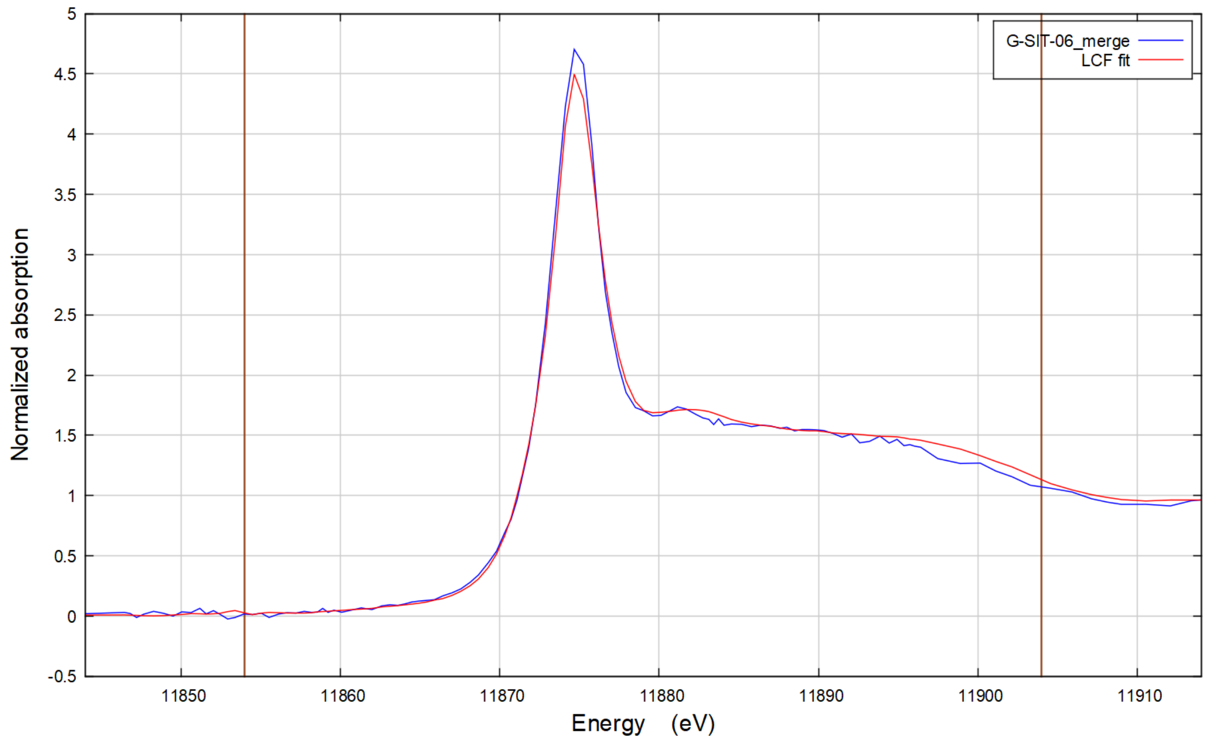
Primary standards used for LCF analysis.

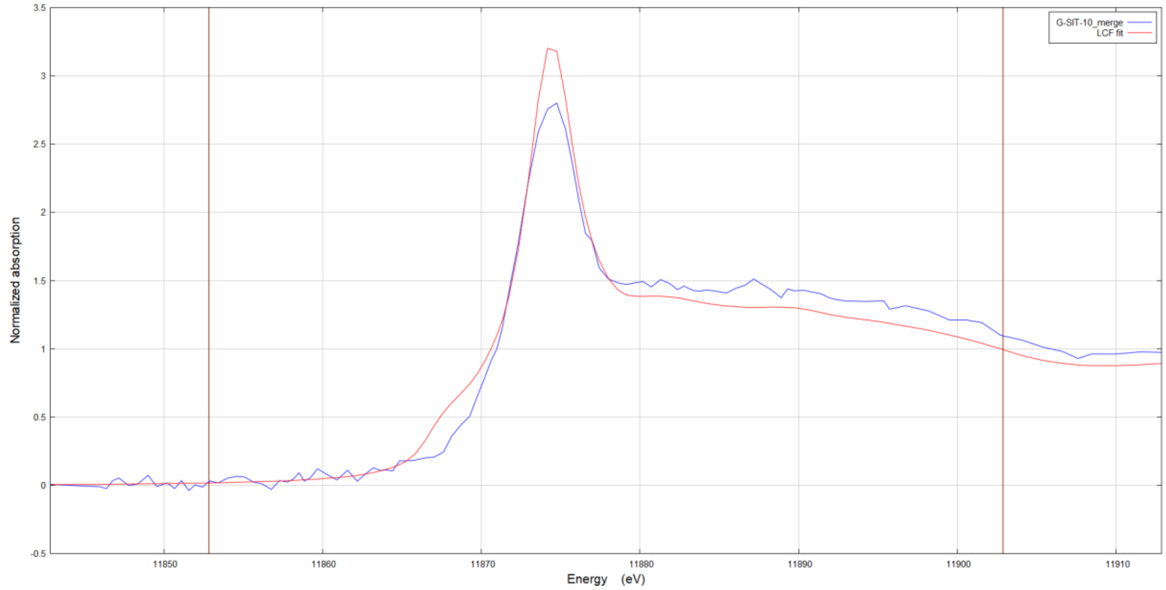
Sample ID	R-factor	Reduced Chi-square	Chi-square	Arsenolite			Arseonopyrite			GoethiteAs(III)			Mag_HemAs(III)			Mag_HemAs(V)			Scorodite			Tooeleite			Yukonite			Total	
				weight	error	percent	weight	error	percent	weight	error	percent	weight	error	percent	weight	error	percent	weight	error	percent	weight	error	percent	weight	error	percent	Sum	Count
G-SIT-02	0.02	0.02	1.77	0.52	0.15	41%				0.32	0.20		0.00	0.23								0.44	0.04	34%				1.28	4
G-SIT-03	0.01	0.00	0.34	0.51	0.02	53%										0.10	0.01	11%				0.34	0.02	36%				0.96	3
G-SIT-04	0.02	0.01	1.12				0.25	0.03	20%	0.25	0.21	20%	0.71	0.28	57%	0.04	0.02	3%										1.26	4
G-SIT-06	0.00	0.00	0.38							0.05	0.00	4%				1.00	0.00	91%	0.06	0.00	5%							1.10	3
G-SIT-10	0.01	0.01	0.68	0.00	0.08	0%				0.15	0.07	13%				0.99	0.01	87%										1.14	3
G-SIT-14	0.01	0.01	1.27							0.15	0.21	14%	0.00	0.32	0%	0.43	0.03	40%				0.50	0.04	46%				1.08	4
G-SIT-20	0.01	0.00	0.37	0.31	0.06	31%	0.23	0.03	23%				0.31	0.07	31%	0.15	0.01	15%										0.99	4
G-SIT-20-Dup	0.02	0.01	0.46	0.02	0.08	3%	0.19	0.03	27%	0.09	0.06	13%				0.09	0.01	12%				0.32	0.03	45%				0.70	5
G-SIT-26	0.02	0.02	2.30							0.24	0.03	19%				0.99	0.05	81%	0.00	0.33	0%				0.00	0.32	0%	1.23	4
G-SIT-27	0.00	0.00	0.21	0.00	0.02	0%										0.66	0.02	64%	0.36	0.01	36%							1.02	3
G-SIT-36	0.00	0.00	0.01													0.23	0.01	23%	0.77	0.01	77%							1.00	2
G-SIT-37	0.00	0.00	0.23	0.03	0.02	2%				0.02	0.02	1%				0.46	0.10	40%	0.10	0.14	9%				0.55	0.10	48%	1.15	5
G-SIT-43	0.01	0.01	0.83							0.37	0.03	32%				0.35	0.03	31%				0.25	0.02	22%	0.17	0.03	15%	1.14	4
G-SIT-45	0.02	0.02	2.04							0.22	0.02	19%				0.91	0.02	81%										1.13	2
G-SIT-47	0.07	0.04	3.22							0.07	0.31	6%	0.96	0.39	86%	0.00	0.06	0%							0.10	0.06	8%	1.12	4
G-SIT-53	0.03	0.02	1.56	0.01	0.13	1%							0.22	0.15	22%	0.03	0.05	3%							0.72	0.04	73%	0.98	4
LL-01	0.04	0.02	1.51	0.08	0.13	8%							0.41	0.15	44%	0.07	0.02	7%				0.38	0.03	41%				0.94	4
LL-02	0.03	0.03	2.26				0.02	0.04	2%	0.83	0.31	66%	0.40	0.40	32%													1.26	3
LL-04	0.01	0.01	0.70				0.00	0.03	0%							0.10	0.13	10%				0.00	0.02	0%	0.88	0.13	90%	0.98	4
LL-06	0.01	0.00	0.40	0.17	0.01	17%										0.08	0.02	8%	0.76	0.02	75%							1.01	3
LL-07	0.01	0.02	1.87			0%				0.11	0.00		0.00	0.00		1.00	0.00	78%	0.17	0.00	13%							1.29	4

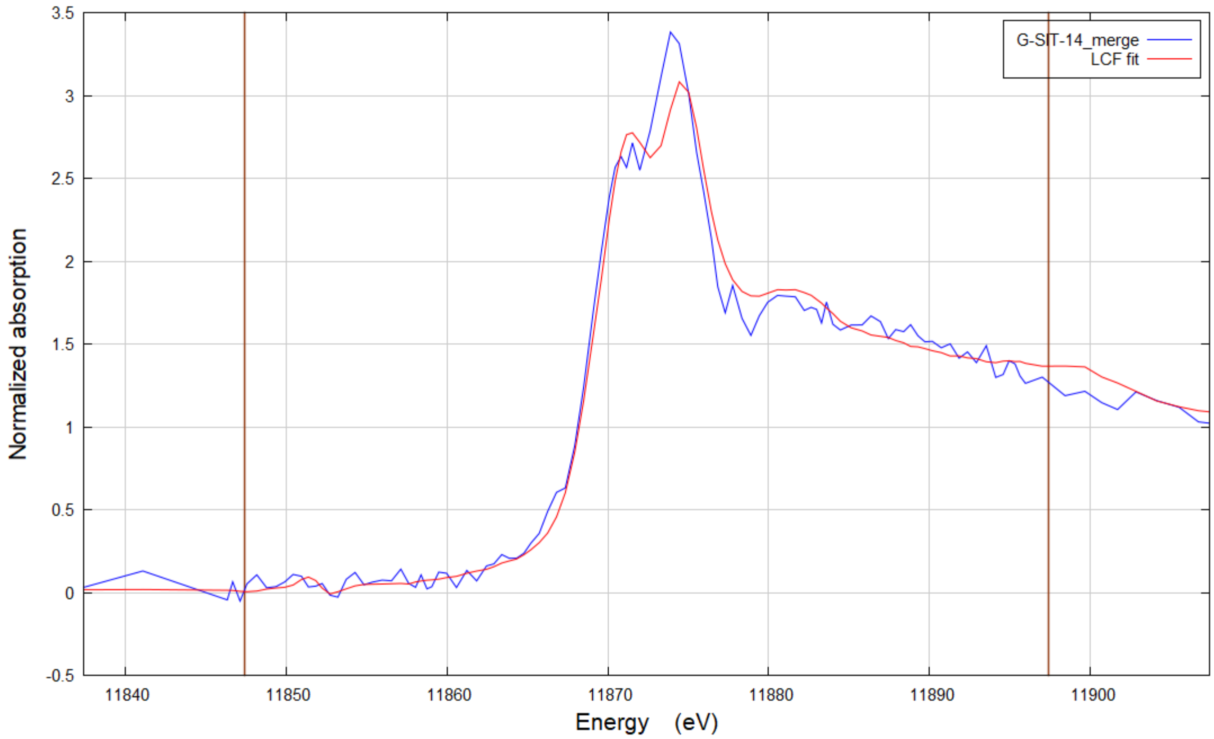

G-SIT-02_merge
LCF fit
Normalized absorption
Energy (eV)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
11840
11850
11860
11870
11880
11890
11900
11910


G-SIT-03_merge
LCF fit
Normalized absorption
Energy (eV)
3
2.5
2
1.5
1
0.5
0
-0.5
11850
11860
11870
11880
11890
11900
11910

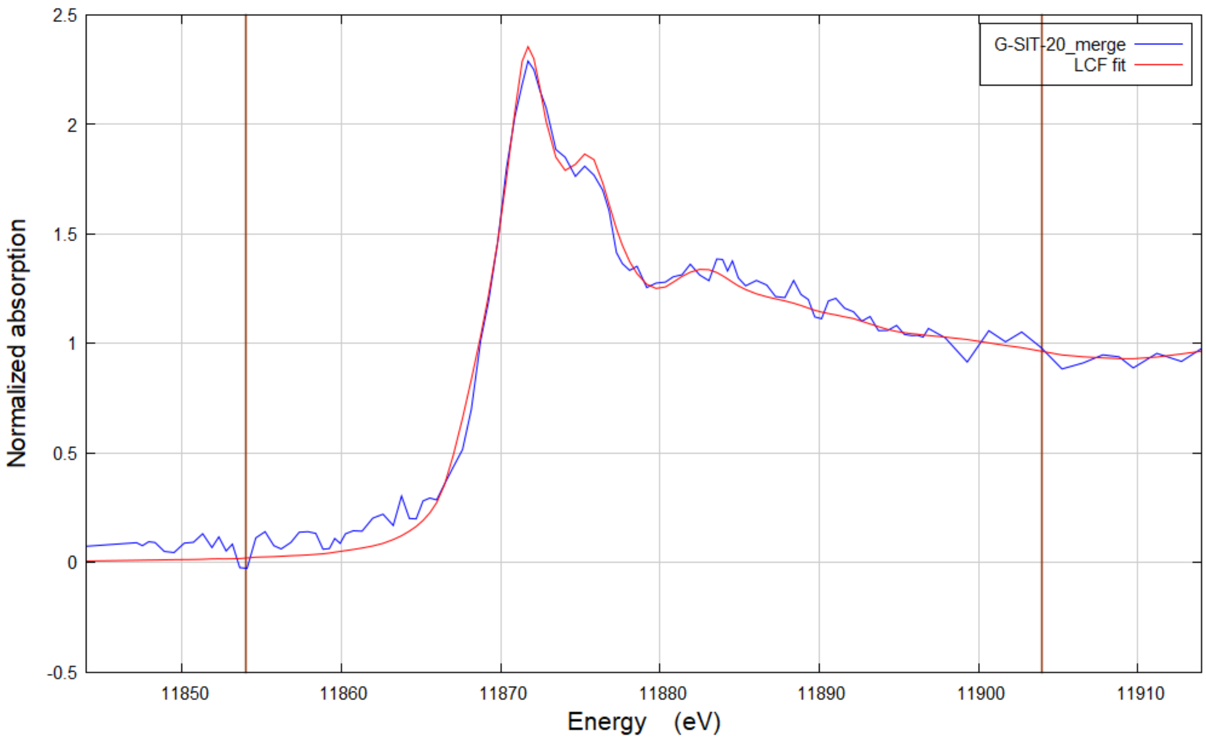

G-SIT-04_merge
LCF fit
Normalized absorption
Energy (eV)


G-SIT-06_merge
LCF fit
Normalized absorption
Energy (eV)

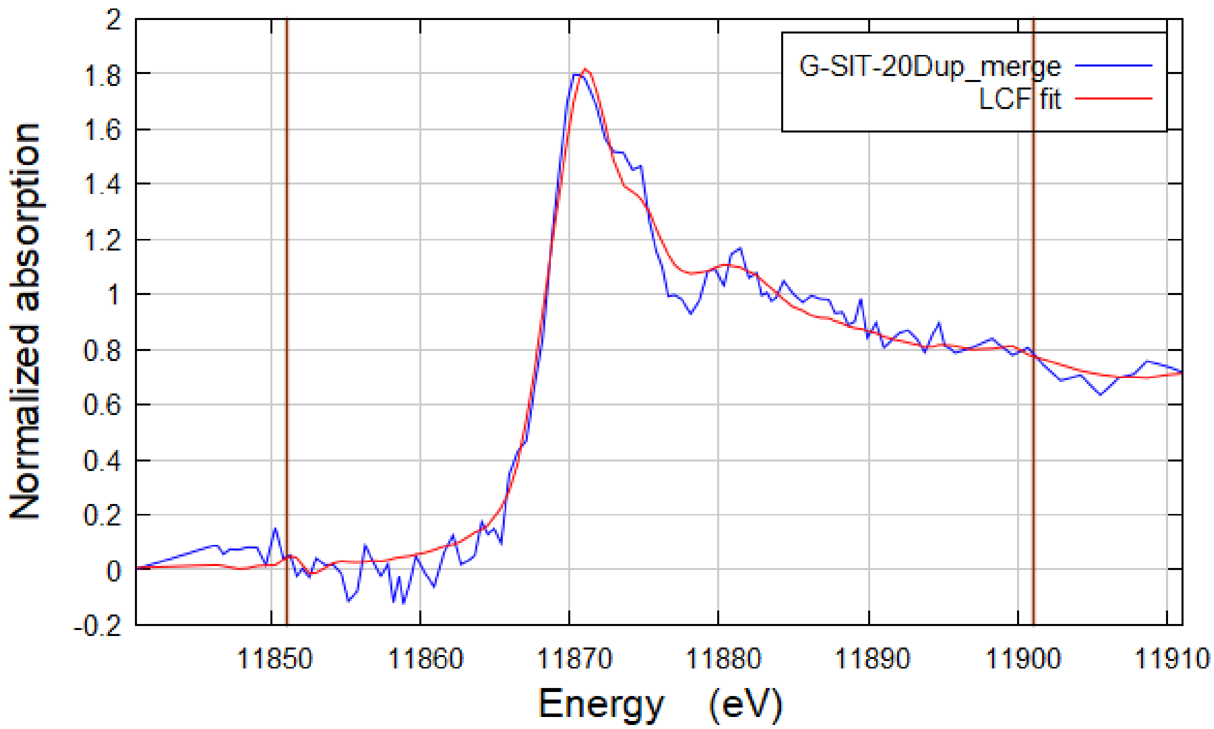

G-SIT-10_merge
LCF fit
Normalized absorption
Energy (eV)


G-SIT-14_merge
LCF fit
Normalized absorption
Energy (eV)

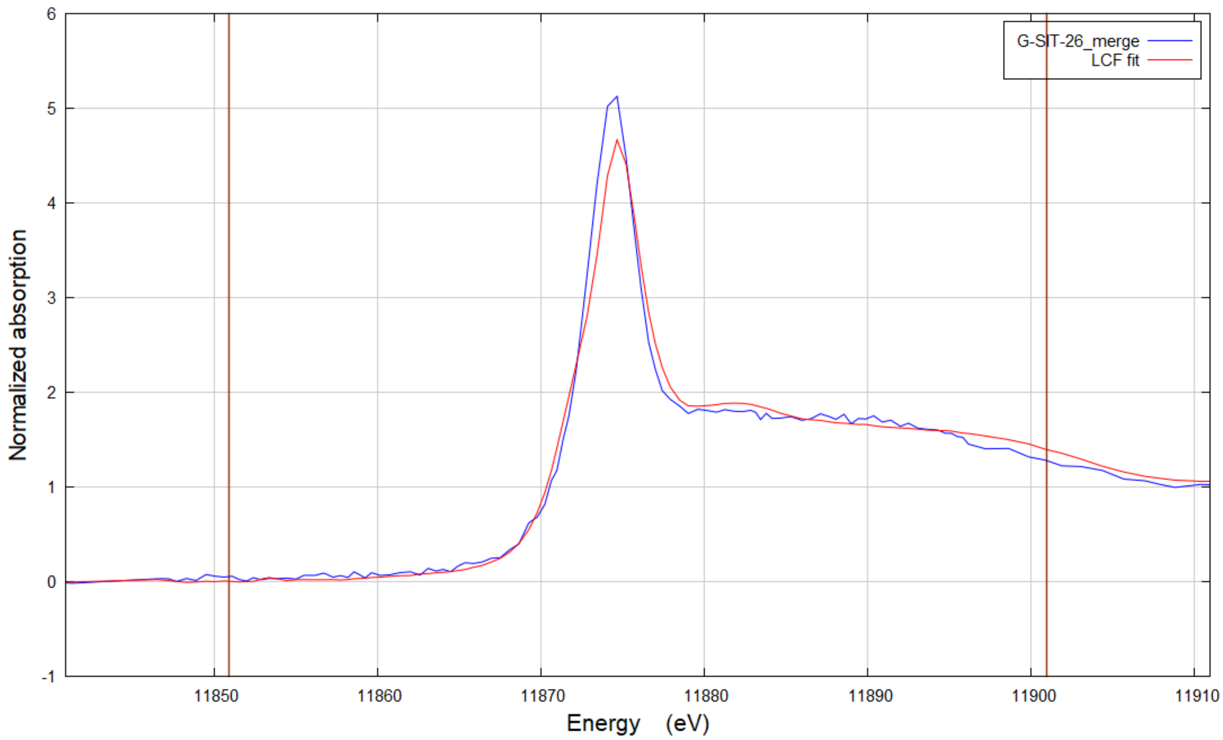
\

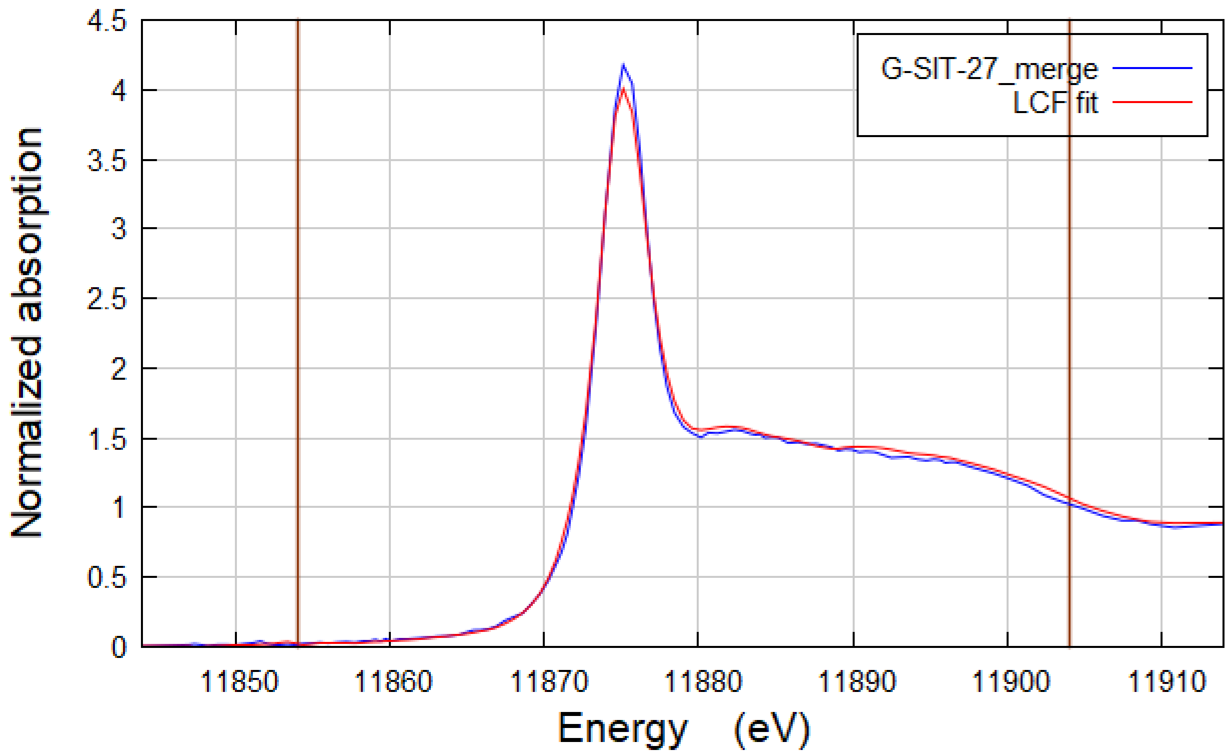


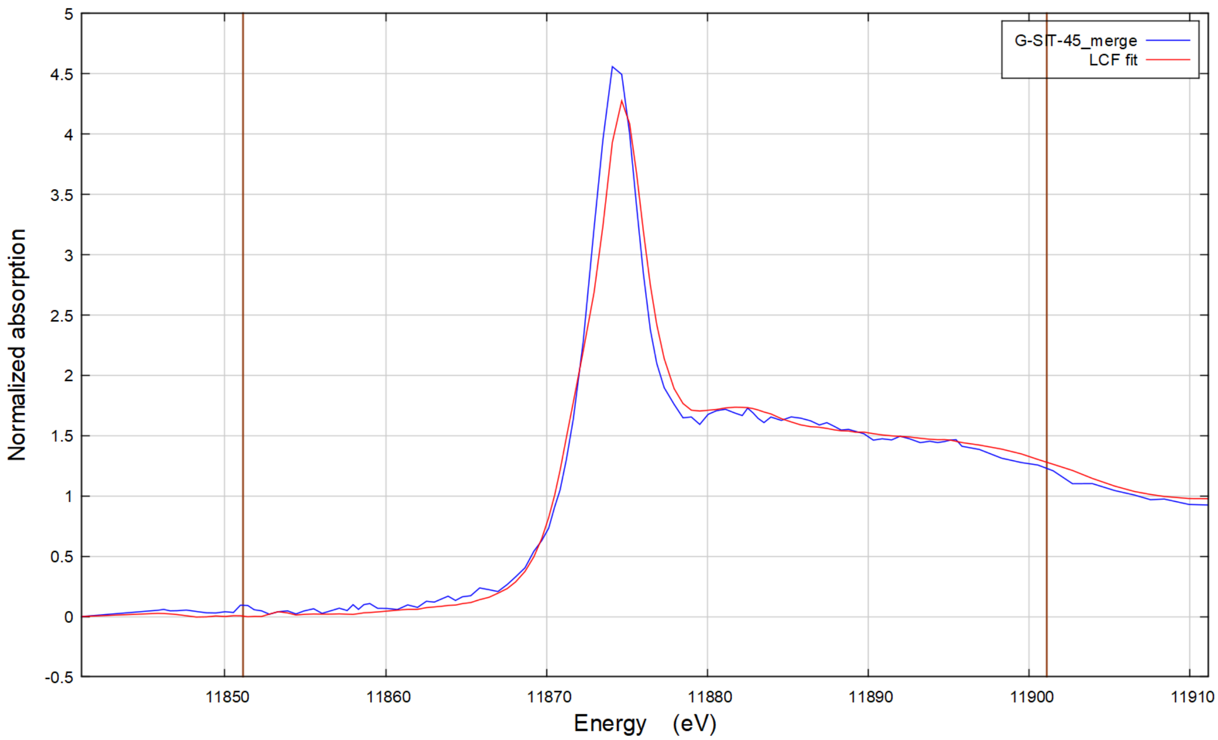
G-SIT-20_merge
LCF fit
Normalized absorption
Energy (eV)
2.5
2
1.5
1
0.5
0
-0.5
11850
11860
11870
11880
11890
11900
11910

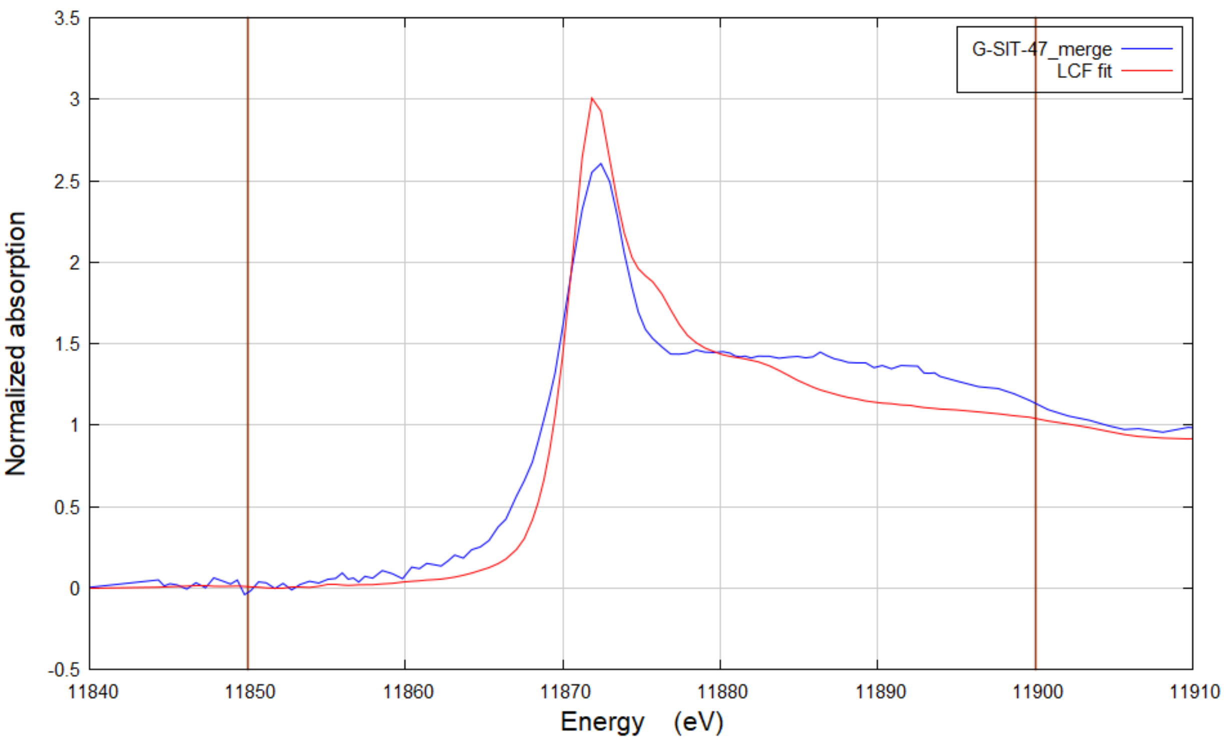


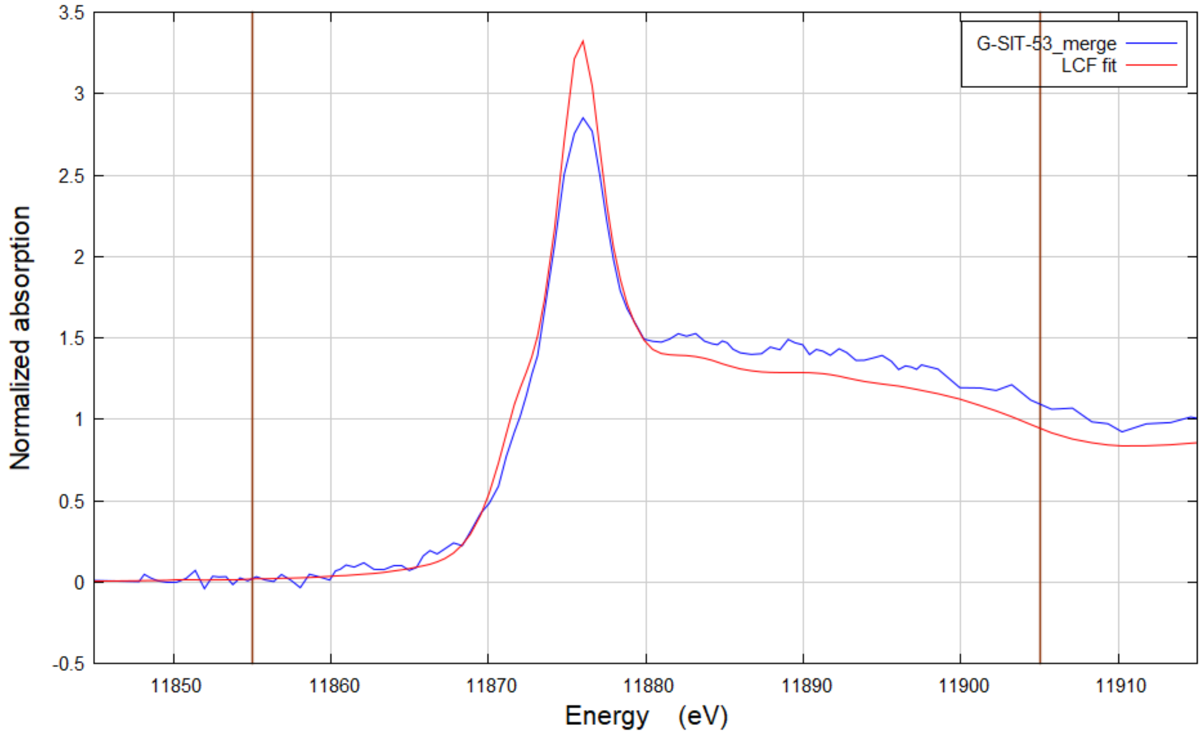
G-SIT-20Dup_merge
LCF fit
Normalized absorption
Energy (eV)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
11850
11860
11870
11880
11890
11900
11910

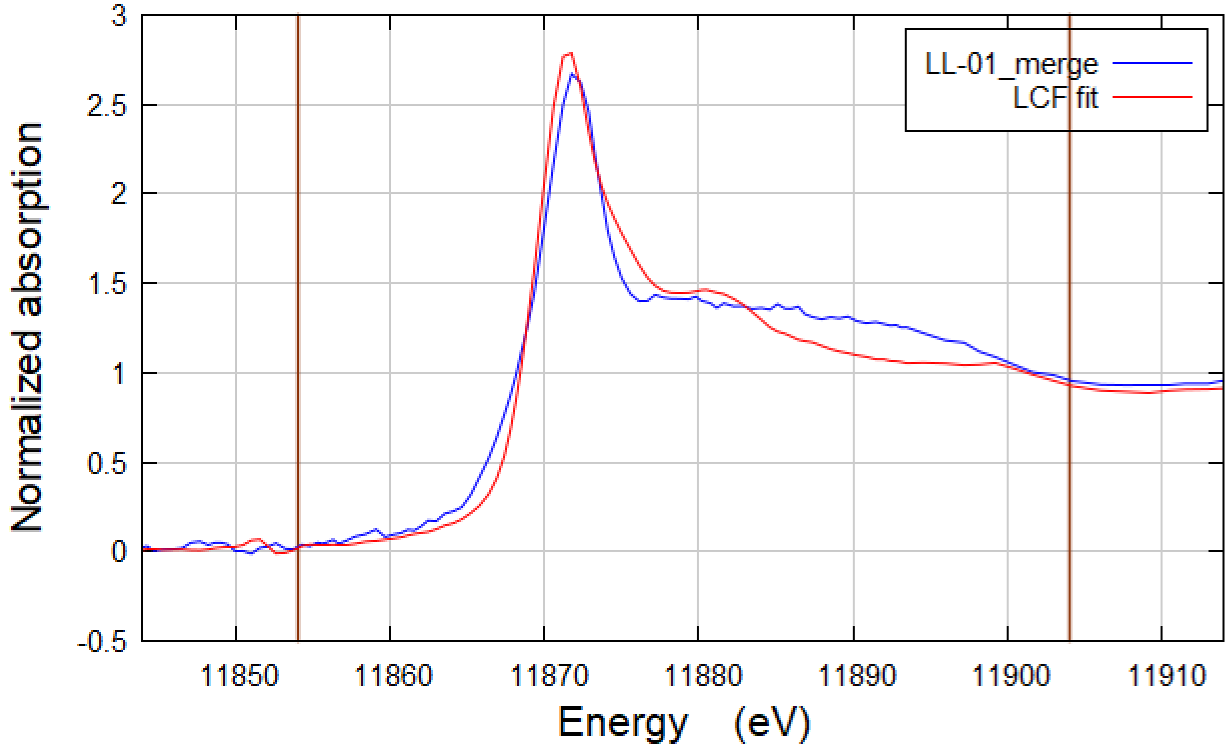

G-SIT-26_merge
LCF fit
Normalized absorption
Energy (eV)
6
5
4
3
2
1
0
-1
11850
11860
11870
11880
11890
11900
11910

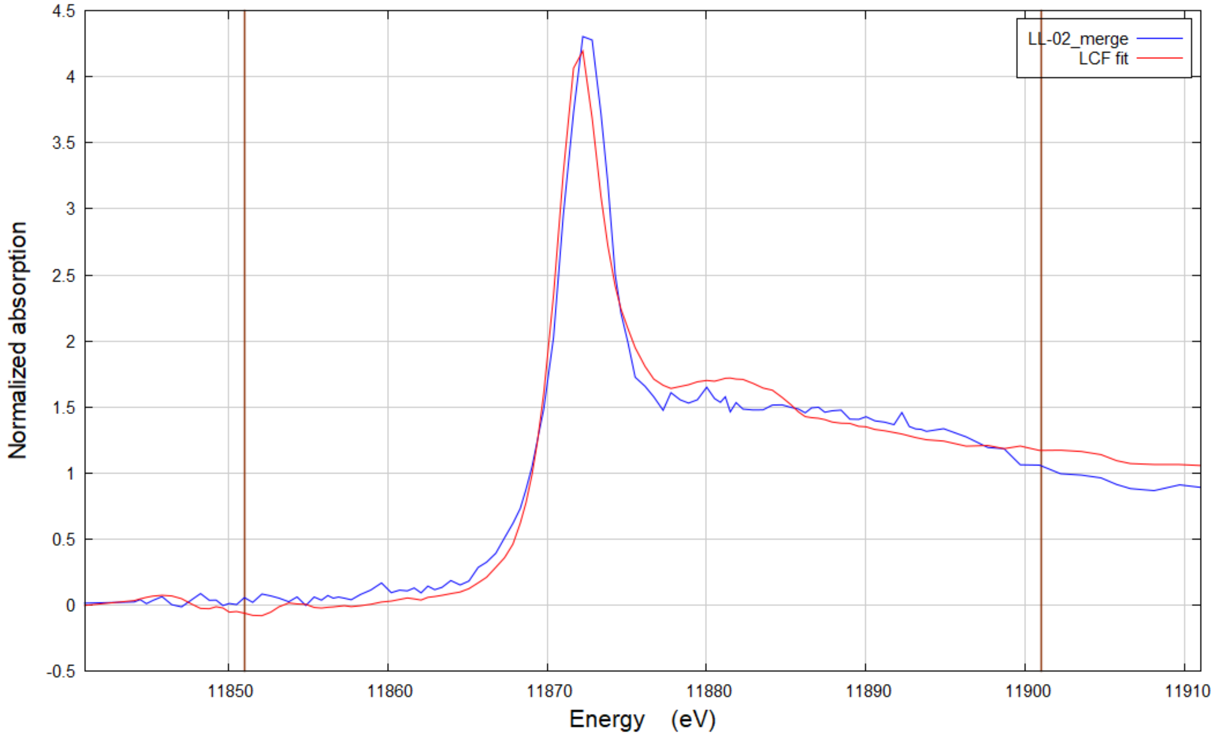

G-SIT-27_merge
LCF fit
Normalized absorption
Energy (eV)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
11850
11860
11870
11880
11890
11900
11910


G-SIT-45_merge
LCF fit
Normalized absorption
Energy (eV)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
11850
11860
11870
11880
11890
11900
11910

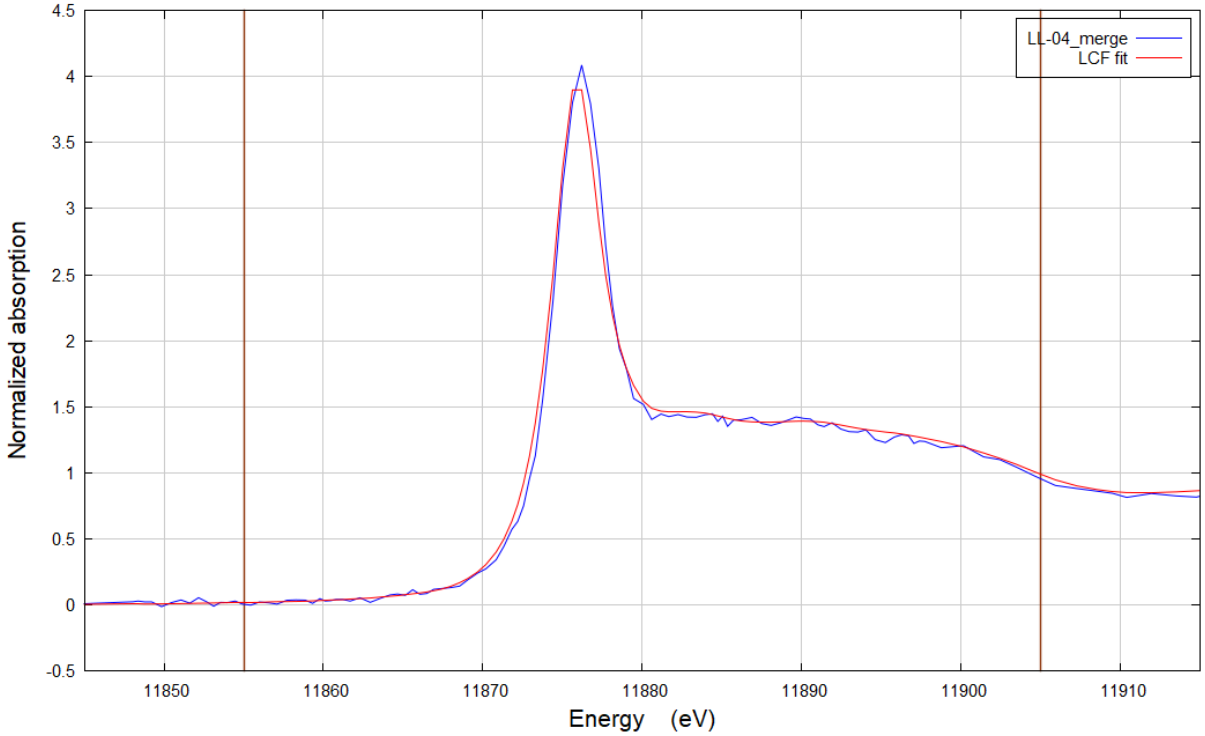

G-SIT-47_merge
LCF fit
Normalized absorption
Energy (eV)
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
11840
11850
11860
11870
11880
11890
11900
11910


G-SIT-53_merge
LCF fit
Normalized absorption
Energy (eV)
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
11850
11860
11870
11880
11890
11900
11910

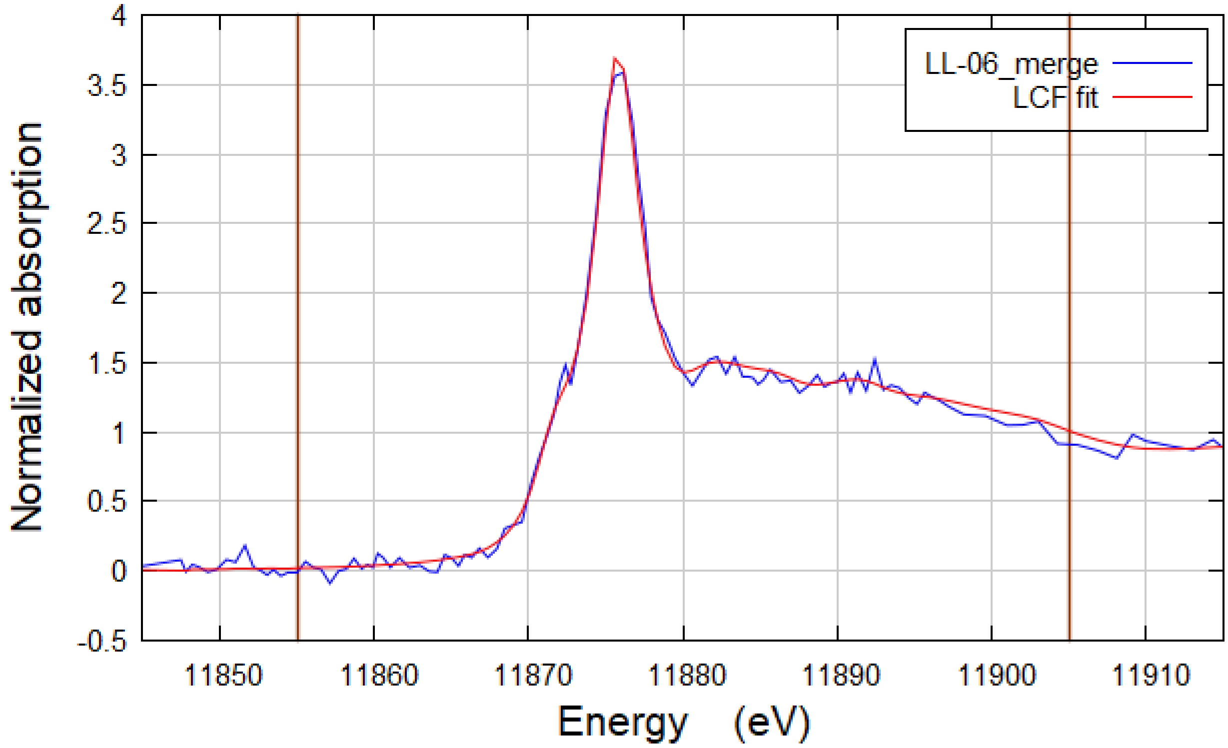

LL-01_merge
LCF fit
Normalized absorption
Energy (eV)
3
2.5
2
1.5
1
0.5
0
-0.5
11850
11860
11870
11880
11890
11900
11910

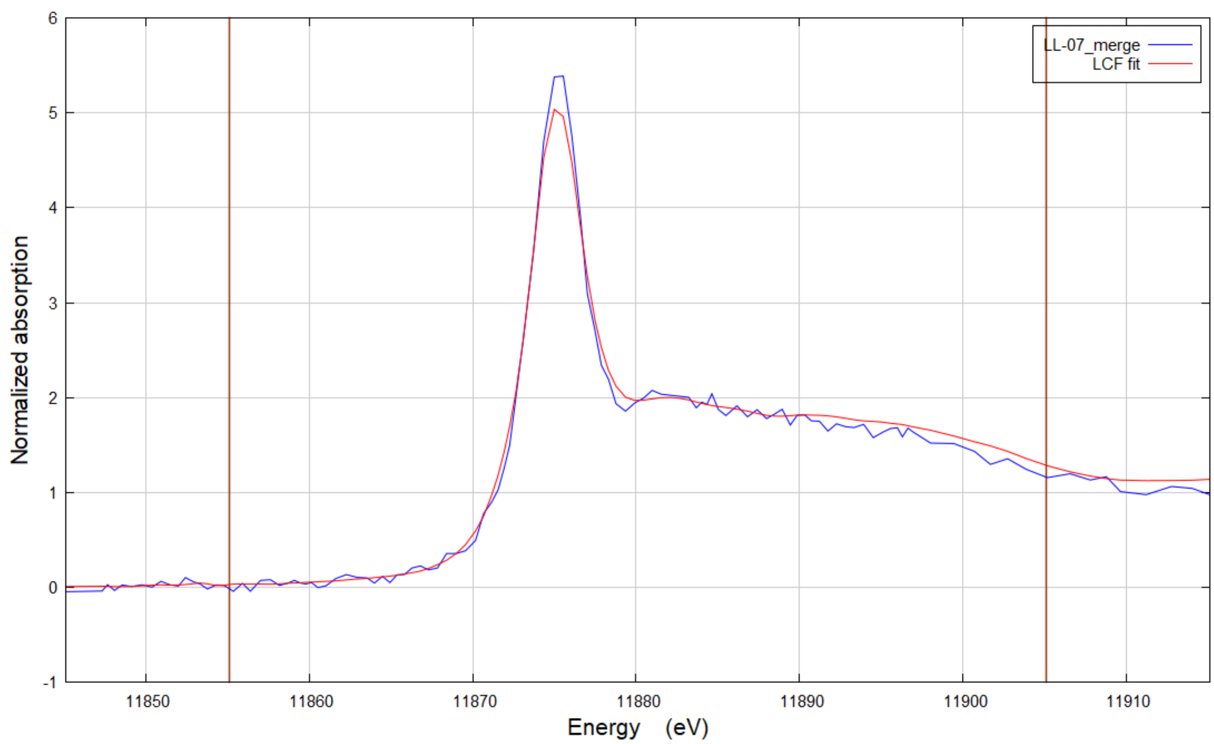


LL-02_merge
LCF fit
Normalized absorption
Energy (eV)



LL-04_merge
LCF fit
Normalized absorption
Energy (eV)


LL-06_merge
LCF fit
Normalized absorption
Energy (eV)
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
11850
11860
11870
11880
11890
11900
11910


LL-07_merge
LCF fit
Normalized absorption
Energy (eV)
6
5
4
3
2
1
0
-1
11850
11860
11870
11880
11890
11900
11910