Arsenic concentrations and solid phase speciation in soils in the Yellowknife region

By

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Abstract

Roasting of gold-bearing arsenopyrite (FeAsS) ore at mines around Yellowknife resulted in the release of arsenic trioxide (As_2O_3) via airborne emissions. Previous studies highlighted a persistent elevated arsenic (As) in local lake sediments and surface waters 50 years after the bulk of these emissions were released. The objectives of this research are to: 1) characterize regional concentrations of As in Yellowknife area soils; 2) identify factors that explain regional patterns of distribution; and 3) distinguish between natural and anthropogenic As sources in undisturbed soils.

Total element analyses were completed for 125 Public Health Layer (PHL) (top 5 cm of cored soil samples), 43 grab samples and 37 samples taken from greater depths in cores, or down core (DC) samples. Total As concentrations ranged from 1.5 to 4900 mg/kg in PHL samples, 12 to 930 mg/kg in grab samples, and 1.6 to 1200 mg/kg in DC samples. The most significant factors on As concentrations in PHL samples include the distance and direction from former mine roasters, soil depth, and terrain unit.

Fifty samples were selected for scanning electron microscopy and automated mineralogy (SEM/AM) to identify the solid species of As present within soil units. Anthropogenic sources of As are characterized by the presence of As_2O_3 and distinctive As-bearing Fe-oxides derived from roaster stack emissions. The most common As-bearing phases identified in soils throughout the study area included: As-bearing Fe-oxides/Fe-oxide mixes (present in 98% of samples), organic Fe-oxide mixes with As (98% of samples), As_2O_3 (82%), and As-bearing Mn-oxides (60% of samples).

Findings from this thesis suggest that previously estimated background levels for As ranging from 0 to 300 mg/kg are too high; median total As-concentrations decrease from 130 mg/kg to 22.5 mg/kg and finally 8.1 mg/kg for samples collected at distances of 0 – 10 km, 10 – 20 km and 20 – 30 km from the Giant roaster. Additional sampling initiatives need to target soils at further distances to determine an appropriate total As background concentration that can be used to help guide future risk assessment recommendations for the Yellowknife area.

Co-Authorship

This study was completed in conjunction with another thesis project at Queen's University in the Department of Geological Sciences and Geological Engineering, undertaken by Jonathan Oliver (Oliver 2018). Arsenic results from this study and the study completed by Oliver (2018) were combined and published in NWT Open File 2017-03 (Jamieson *et al.* 2017) aimed at bringing awareness to the arsenic concentrations in near surface soils around the City of Yellowknife.

The thesis study was developed under the supervision of Heather Jamieson (Queen's University) and Mike Palmer (formerly with the Government of the NWT, currently completing a PhD at Carleton University). Heather Jamieson acted as a supervisory role for the duration of this project, taking on the task of primary reviewer, and assisting with the interpretation of results. Heather also assisted with the initial design of the project and provided support while preparing for the field program. Mike Palmer assisted in the design of the project, was a reviewer of results, provided field assistance, and aided in the statistical analysis of the obtained results.

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List of Abbreviations

AM	Automated Mineralogy
ASU	Analytical Services Unit
BSE	Back-Scatter Electron
CCME	Canadian Council of Ministers of the Environment
CM&S	Consolidated Mining and Smelting
DC	Down Core
EDS	Energy-Dispersive X-ray Spectroscopy
ESP	Electrostatic Precipitator
FCOSC	Forested Canopy Outcrop Soil Core
FCOSG	Forested Canopy Outcrop Soil Grab
FCSC	Forested Canopy Soil Core
FCSG	Forested Canopy Soil Grab
FEG	Field Emission Gun
HB	High Boreal
ICP	Inductively Coupled Plasma
INAC	Indigenous Northern Affairs Canada
LD	Lab Duplicates
mASL	Metres Above Sea Level
MESS	Marine Sediment Reference Material for Trace Metals and Other Constituents
MLA	Mineral Liberation Analysis
MS	Mass Spectrometry
NA	Not Applicable
NWFAR	Northwest Far (sample area)
NWT	North West Territories
OES	Optical Emissions Spectrometry
OSC	Outcrop soils
OSG	Outcrop Soil Grab
PH	Public Health
PHL	Public Health Layer
PSC	Peat Soil Core
PSG	Peat Soil Grab
QAQC or QA/QC	Quality Assurance and Quality Control
RPD	Relative Percent Difference
SEM	Scanning Electron Microscopy
SPL	Sparse Phase Liberation
SS	Split Samples
TOC	Total Organic Carbon
YGB	Yellowknife Greenstone Belt
YK	Yellowknife
YKDFN	Yellowknife's Dene First Nation
Sample Areas	
BERRY	Berry Hill (TerraX Northbelt)
BPR	Bypass Road

CHAN	Chan Lake
DETR	Dettah Road
DUCK	Duck Lake
DUF	Duckfish Lake
HOML	Homer Lake
HW3	Highway 3
INGT	Ingraham Trail
LL	Landing Lake (TerraX Northbelt)
MASL	Mason Lake
MIR	Mirage Islands
ML	Martin Lake
NDILO	Ndilǫ
SW3	Southwest 3
TX	TerraX Northbelt
VL	Vital Lake (TerraX Northbelt)
YK67	YK67 Lake
Elements	
As	Arsenic
Au	Gold
Cd	Cadmium
Cr	Chromium
Fe	Iron
Mn	Manganese
Ni	Nickel
Pb	Lead
S	Sulphur
Sb	Antimony

Chapter One: Introduction and Background

1.1 Introduction

From 1938 to 2004, mining and ore processing activities within and around the City of Yellowknife resulted in significant terrestrial and aquatic contamination (Hocking *et al.* 1978, Hutchinson *et al.* 1982, Kerr 2006, St. Onge 2007, Andrade *et al.* 2010, Jamieson 2014, Schuh *et al.* 2018, Van den Berghe *et al.* 2018, Bromstad *et al.* 2017). Mineral exploration in the 1930s and 1940s around Yellowknife Bay led to the development of two long-operating gold mines, Giant and Con, in addition to establishing the City of Yellowknife. The Yellowknife Greenstone Belt was one of the most productive and profitable gold districts in Canadian history, with Giant and Con Mine producing approximately 13 million ounces of gold and generating over $5 billion in revenue (Moir *et al.* 2006, Bullen and Malcolm 2006). Both the Giant and Con deposits contained refractory “invisible” and free-milling “metallic” forms of gold mineralization (Siddorn *et al.* 2006).

The production of this gold resulted in the generation of arsenic (As)-bearing waste. The refractory, gold-bearing arsenopyrite (FeAsS) ore was roasted as a pretreatment for cyanidation, creating arsenic trioxide (As_2O_3) dust, which was released into the surrounding environment through roaster emissions (Jamieson 2014). Poor emission controls at Giant Mine in the early years of mining resulted in the release of approximately 20,000 tonnes of As-bearing dust, with 85% of emissions released prior to 1958, before the installation of more efficient emission capturing technologies (Wrye 2008, Jamieson 2014, Bromstad *et al.* 2017). Most of the As-bearing dust produced at Giant (237,000 tonnes) was captured and is currently being stored in underground, thermally regulated chambers. Previous work has demonstrated that As from roaster emissions persists in near surface soils on the Giant Mine property and can be distinguished from natural As using mineralogical tools - scanning electron microscopy (SEM) coupled with automated mineralogy, synchrotron and microprobe methods (Wrye 2008, Bromstad 2011, Bromstad *et al.* 2017). The extent and characteristics of roaster emissions beyond the Giant mine property are not well understood. Total As concentrations have been determined for more limited sample sets in earlier studies conducted by Hocking *et al.* (1978), Hutchinson *et al.* (1982), and Kerr (2006), however no systematic regional study with a substantial number of samples that might elucidate the factors controlling As concentrations has been completed in the areas surrounding Yellowknife, Giant, and Con Mine. The mineralogical tools that were applied to the soils on the Giant property (Bromstad *et al.* 2017), have not yet been applied to samples collected in the broader surrounding regions. This work has been influential in identifying the forms of As present in near surface soils outside the mine lease properties, in areas that have not yet been targeted for environmental remediation yet continue to be used by locals in various capacities. Knowing the type of As persisting in near surface soils in the Yellowknife region will help local officials in planning and with the prevention of risks associated with As exposure.

For this thesis, a regional geochemical soil survey (174 samples in total) was implemented over the summer of 2015 to help characterize the extent of total As persisting in near surface soils within 30 km of Yellowknife. Regional surveys are useful in defining background conditions, exploring drivers of variability in soil geochemistry and determining the zone of influence from past industrial activity (M. Palmer, personal communication, January 2016). The primary research objectives for this thesis include:

1. Characterization of the regional distribution of total As in near surface soils. This will be achieved by observing total As concentrations in the Public Health Layer (PHL) of soils collected during the 2015 regional soil survey. The PHL has been defined by Health Canada as the top 0 to 5 cm of soil and is considered as such because people in the environment have the greatest probability of encountering contaminants contained within this depth interval (Rencz *et al.* 2011). The study will look at undisturbed soil sample sites; undisturbed sites were targeted as a means of avoiding post depositional changes that may have occurred from anthropogenic activities that have taken place in the area following the cessation of mining at Giant and Con.
2. Identification of factors affecting the regional distribution of As concentrations in soils. Parameters including distance from the point sources of contamination (Con and Giant roaster stacks), location with respect to prevailing wind direction, elevation, total organic carbon concentrations, and terrain type will be investigated. It is hypothesized that these factors could play an important role in the distribution of As throughout the area.
3. Identification of the solid phases of As persisting in near surface soils. The presence or absence of As_2O_3 in a portion of the collected samples will be the primary target of investigation. Arsenic trioxide is indicative of anthropogenic contamination in the study area, as proven by past research (Wrye 2008, Bromstad 2011, Bromstad *et al.* 2017, Schuh *et al.* 2018, Van Den Berghe *et al.* 2018. Arsenic trioxide and other As-hosting phases will be identified using scanning electron microscopy coupled with automated mineralogy. Based on previous work (Bromstad *et al.* 2015, Schuh *et al.* 2018, Van Den Berghe *et al.* 2018) other As-hosting phases that may be present include but are not limited to arsenopyrite, pyrite with As, and Fe- oxides containing As.

1.2 Background

1.2.1 Physiographic Setting

The study area falls within the Taiga Shield High Boreal (HB) Ecoregion, which occupies the eastern third of the Taiga Shield in the Slave Province of the Northwest Territories. The ecoregion is characterized by undulating bedrock terrain, with jack pine and mixed spruce forests spread over rock outcrops, thin boulder-dominated, coarse-textured till, and outwash deposits. Pockets of peatlands and collapsed fenland (wetland) areas are dispersed throughout this hilly bedrock terrain, and cover less than 5% of the region. Fine textured, nutrient-rich, lacustrine deposits have accumulated in low-lying areas between bedrock exposures at lower elevations. Brunisols are the primary soils throughout the Great Slave Upland and Lowland ecoregions, with no soil development present on bare bedrock exposures. Organic Cryosols are found associated with peat plateaus. In addition, Regosols and Gleysols are present in wet depressions containing shore fens and floating fens (Ecosystem Classification Group 2008). The Taiga Shield HB Ecoregion can be subdivided into 5 smaller ecoregions - the Great Slave Upland, Great Slave Lowland, East Arm Upland, Rutledge Upland and Nonacho Upland (Ecosystem Classification Group 2008). All samples collected during the regional soil survey in 2015 belong to the Great Slave Upland and Great Slave Lowland ecoregions (Figure 1-1) (Ecosystem Classification Group 2008).

Over the last glaciation, 8000 to 12,000 years ago, Glacial Lake McConnell covered a large portion of the study region. The boundary of Glacial Lake McConnell marks the separation between the Great Slave Lowlands and Great Slave Uplands ecoregions. Following the retreat of the Laurentide Ice Sheet, the expanding Glacial Lake McConnell and ancestral Great Slave Lake resulted in the deposition of silts and clays throughout the Great Slave Lowlands (Wolfe and

Morse 2015). The boundary between the lowland and upland ecoregions falls at an elevation of 205 mASL. Above this elevation, elevated permafrost mounds (elevated peat), or lithalsas, are no longer present, and the terrain consists primarily of bedrock containing isolated glaciolacustrine and glaciofluvial deposits. Beneath an elevation of 205 mASL, 70% of the Great Slave Lowlands are covered with fine silts and clays (Wolfe *et al.* 2014).

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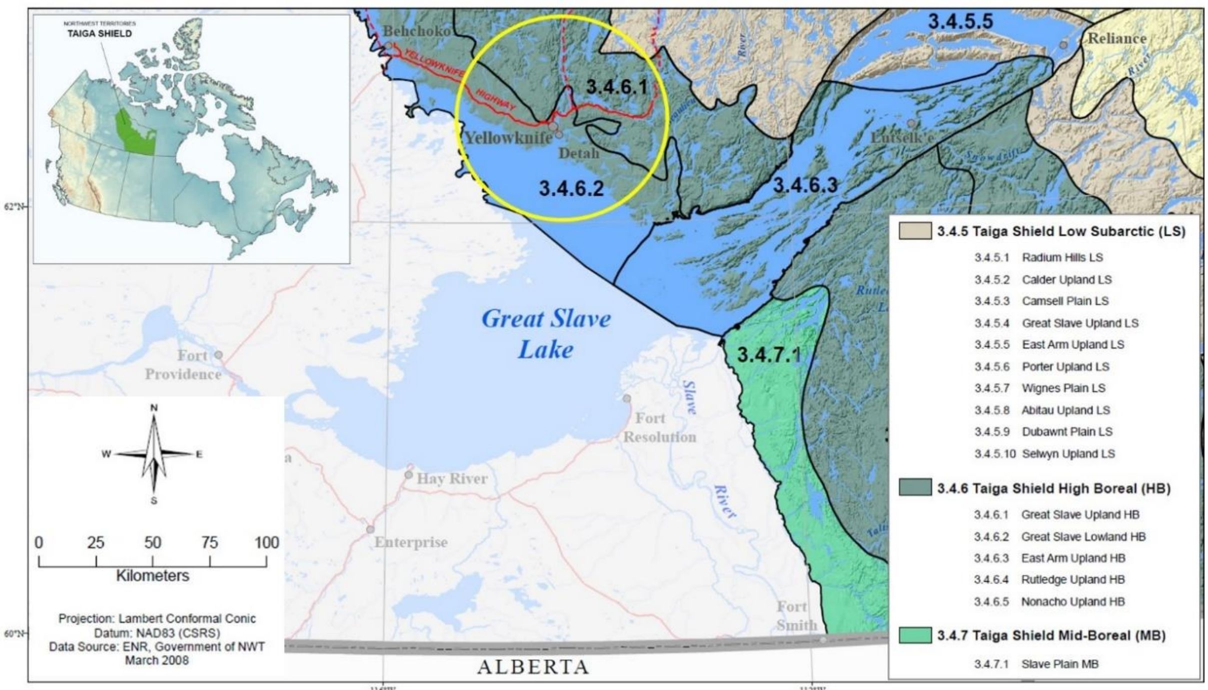

Figure 1-1 Taiga Shield High Boreal Ecoregion. Figure modified from (Ecosystem Classification Group 2008)

Climate data collected from the Yellowknife station for the Taiga Shield HB Ecoregion indicate mean annual temperatures range from -3 to -6^{o}C. Average annual precipitation for the ecoregion is between 280 to 360 mm (Ecosystem Classification Group 2008). In Figure 1-2A below, 10 years of climate data was plotted to illustrate the annual temperature fluctuations in Yellowknife and show the months during which snowfall occurred. From this figure it is evident that for 8 to 9 months of the year snowfall is present in the study area. For 6 to 7 of these months it can be assumed that snow cover persists on soils, with reported mean temperatures for these months falling below 0°C. Although this research is not primarily aimed at risk assessment, the presence of snow cover on soils is important when considering the probability of exposure to contaminants persisting in near surface soils. For the ten years of data provided, mean minimum temperatures in January ranged from -22 to -34 °C, and mean maximum temperatures in July ranged from approximately 19 to 24 °C (Government of Canada 2017).

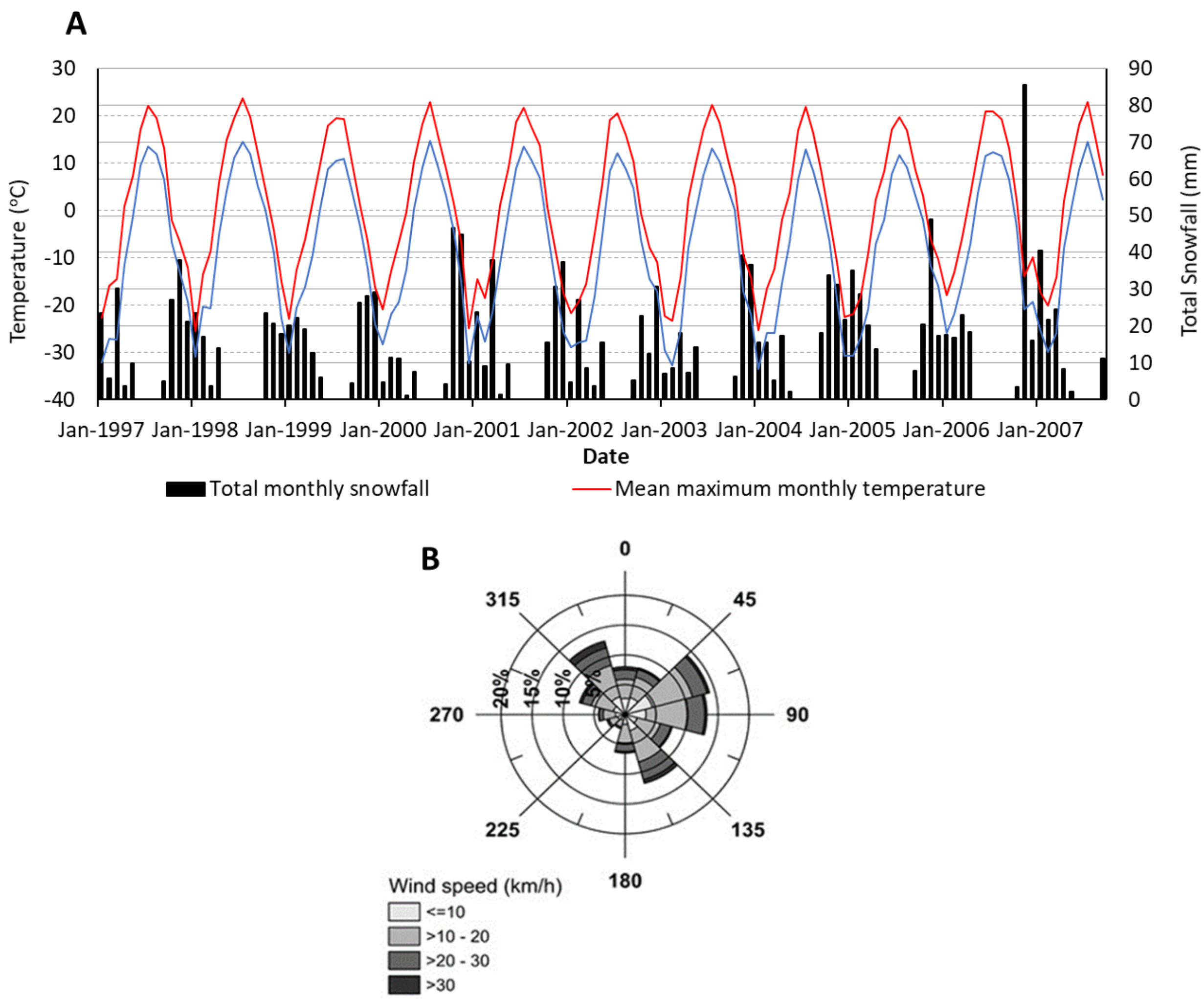

Figure 1-2 A:Monthly climate data plotted over a 10-year period from January 1997 to September 2007. The red line indicates the mean maximum monthly temperature recorded at the Yellowknife Airport weather station, whereas the blue line indicates the mean minimum monthly temperature recorded. Total monthly snowfall measurements are also shown, indicating that for 8 to 9 months of the year snowfall is present in the area. In most years it can be assumed that snow cover persists for 6 to 7 months (temperatures below 0°C)
B:Wind rose diagram created from hourly measurements at the Yellowknife Airport weather station between 1953 and 1999 (years of ore roasting). Created by Mike Palmer.

Prevailing wind directions and wind speeds are expected to have contributed to the distribution of roaster emissions throughout the study area. Wind measurements taken at the Yellowknife airport indicate the dominant wind direction is from the east, while smaller wind components exist from the south-southeast, and from the northwest (Pinard *et al.* 2008). Figure 1-2B shows wind speed and frequency of direction plotted from hourly measurements at the Yellowknife airport from 1953-1999. This range was chosen because the measurement record began in 1953 and all roasting activities at Yellowknife area mines ceased in 1999. East winds dominate all months, except June, July, and August when winds blow regularly from the South (Environment Canada 2017).

1.2.2 Geologic Setting

This study area covered regions located within the Yellowknife greenstone belt (YGB); one of many small greenstone belts exposed in the southern region of the Canadian Shield Slave Structural Province (Canam 2006). The belt is a linear, north-south-trending formation located between the Western Plutonic Complex of the Defeat Plutonic Suite to the west, and the Duncan Lake Group metaturbidite basin that conformably overlies the YGB to the east (Hubbard *et al.* 2006, Siddorn *et al.* 2006). A map illustrating the occurrence of these simplified rock units throughout the study region can be found in Figure 1-3. The YGB consists of a northeast striking, southeast dipping and facing homocline of mafic volcanics and intrusives belonging to the Kam Group (2.72 – 2.7 Ga), intermediate metavolcanics and intrusives of the Banting Group (2.66 Ga), as well as conglomerates and sandstones of the Jackson Lake Formation (2.6 Ga) tectonically emplaced between the two former groups (Hubbard *et al.* 2006, Siddorn *et al.* 2006).

A series of gabbro dykes crosscut the Kam and Banting Groups, but do not intrude the Jackson Lake Formation. The preservation of their steeply dipping stratigraphy within the southeast dipping Kam Group, suggest the dykes were emplaced following the tilting of the Kam and Banting Groups, prior to the deposition of the Jackson Lake Formation (Siddorn *et al.* 2006).

Two distinct phases of granite intrusion occurred in the Yellowknife region following the deposition of the Duncan Lake Group east of the YGB. West of the YGB the Western Plutonic Complex, belonging to the Defeat Plutonic Suite, is characterized by massive to foliated homogeneous porphyritic biotite-trondhjemite-granodiorite-granite plutons (~2.62 to 2.63 Ga). The metamorphic grade of the YGB decreases from amphibolite facies in the west, where in contact with the Defeat Plutonic Suite, to greenschist facies in the east along the shores of Yellowknife Bay. Continuing further east, the medium to coarse grained muscovite-biotite granite plutons of the Prosperous Granite (~2.59 Ga) intrude the metaturbidites of the Duncan Lake Group (Siddorn *et al.* 2006).

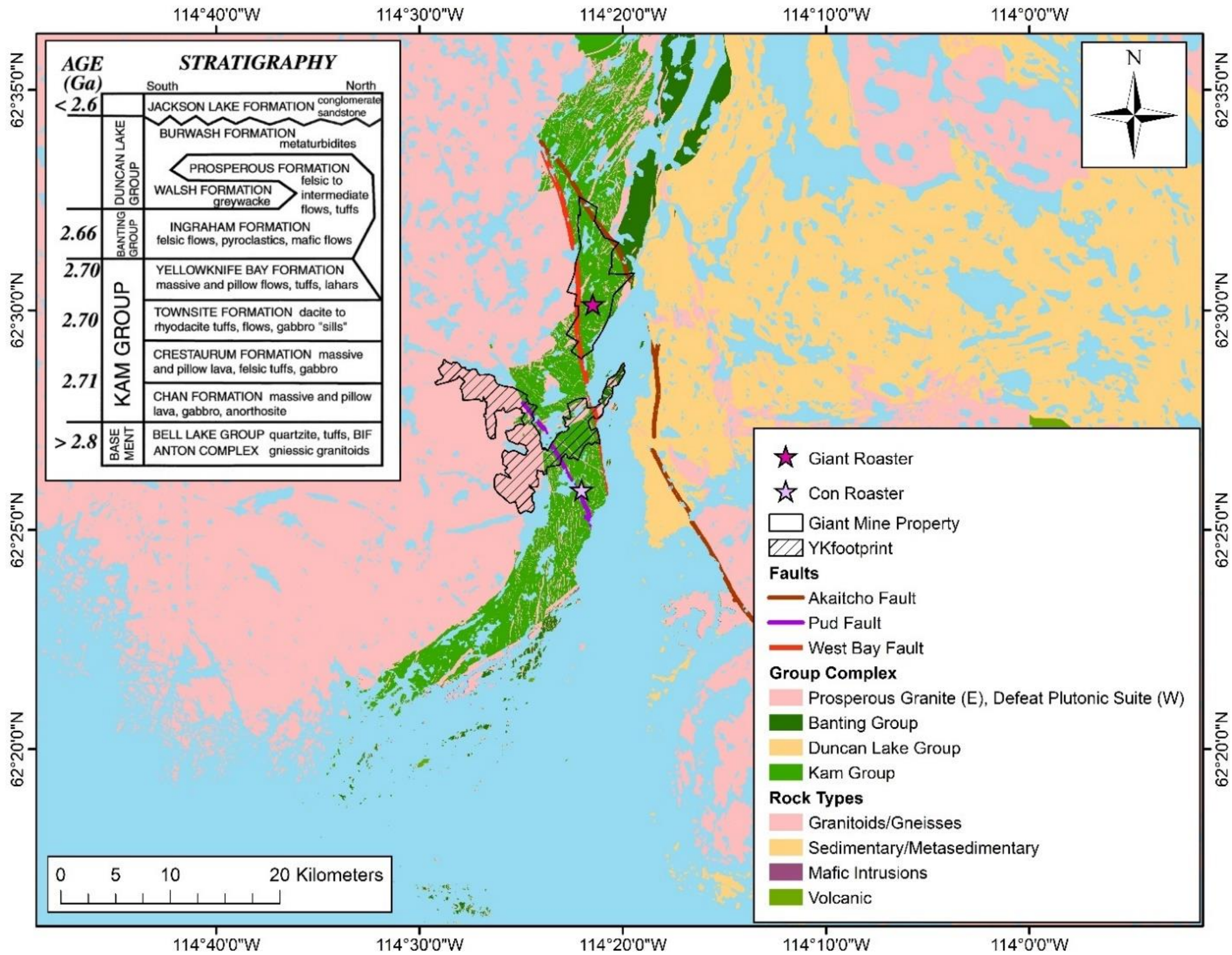

Figure 1-3 Geological map of study area, with stratigraphy inset from (Cousens 2000).

Archean deformation zones crosscut all but one of the YGB formations. These major brittle-ductile shear systems, consisting of hydrothermally altered and deformed sericite- or chlorite-rich rocks within the Kam Group are host to the Giant and Con gold deposits (Hubbard *et al.* 2006, Siddorn *et al.* 2006). Late-stage north-northwest-trending Proterozoic diabase dykes crosscut all lithologies within the YGB, including all orebodies at Giant and Con, and were the only units not affected by the deformation zones across the region (Siddorn *et al.* 2006).

The Kam Group occupies the eastern half of the Giant Mine Property and consists of sub-vertically to vertically dipping, southeasterly facing formations. In ascending order, these formations include: the Chan Formation (basaltic flow, dykes, and sills), the Crestaurum Formation (dacitic to rhyodacitic tuffaceous layers, dominated by pillow basalts, massive flows and sills), the Townsite Formation (dacitic and quartz-feldspar flows crosscut by gabbroic sills and calcalkaline porphyritic intrusions), the Yellowknife Bay Formation (pillowed basalts and massive flows) and the proposed Kamex Formation (sills and tuffaceous units) (Hubbard *et al.* 2006). The Yellowknife Bay Formation hosts the majority of the mineralized zones at Giant and Con mine (Canam 2006, Hauser *et al.* 2006).

All YGB stratigraphy and associated gold deposits were offset by late stage north-north-west trending sinistral Proterozoic faults. This faulting resulted in the north-south alignment of fault-bound blocks in the YGB, in addition to an offset of the Giant and Con gold deposits on either side of the West Bay Fault (Figure 1-3) (Siddorn *et al.* 2006). The Con gold deposit is situated south of Yellowknife between the West Bay and Pug faults, while the Giant gold deposit occurs north of the city between the West Bay and Akaitcho faults (Siddorn *et al.* 2006).

1.2.2.1 Con Mine Geology

The Con Mine is hosted in massive and pillow tholeiitic basalts of the Yellowknife Bay Formation. Shear structures, including the Campbell, Con and Rycon-Negus shears, strike northerly, crosscutting stratigraphy, and dip moderately to the west. Gold mineralization at Con occurs within quartz-ankerite-sericite veins enclosed in variable amounts of sericite-ankerite schist. These sericite-ankerite alteration zones are the most intense and widest in the upper areas of the Campbell shear zone, and in the refractory mineralized zones in the Con shears (Hauser *et al.* 2006).

Two distinct ore types exist at Con Mine: free milling ore (gold is independent or intergrown with sulphides) and refractory ore (submicroscopic particles within arsenopyrite).

Free milling ore could be recovered using conventional cyanidation methods; in contrast the refractory ore was collected in a sulphide concentrate and the sulphide minerals were oxidized to release the gold (Hauser *et al.* 2006).

1.2.2.2 Giant Mine Geology

The gold at Giant Mine is hosted in a complex system of linked quasi-planar alteration-deformation zones up to 500 m wide. The width of individual deformation zones varies between 30 and 60 m. In map view, the deformation zones form a simple north-east trending braided pattern, but below the surface the geometry of the zones is much more complex with intersecting zones dipping vertically, northwest, and southeast (Siddorn *et al.* 2006).

The mineralized zones are bound in the north by the Akaitcho Faults, in the east by the Jackson Lake Formation and Banting Group, and in the south and west by the West Bay Fault (Figure 1-3). Bands of quartz and sulphides alternating with sericite-carbonate schist define the orebodies. A typical ore zone at Giant contains 30% to 90% quartz and up to 15% sulphides and sulphosalts. Colman (1957) suggested that the sulphide and sulphosalt minerals were deposited during three periods of mineralization; 1) pyrite and arsenopyrite, 2) sphalerite, chalcopyrite, and pyrrhotite, and 3) sulphides and sulphosalts containing antimony and lead (Canam 2006). The gold at Giant is most commonly associated with very fine grained arsenopyrite formed during the first stage of mineralization. It occurs as a refractory phase in fractures within the arsenopyrite, or as thin coatings on crystals (Coleman 1957, Canam 2006). Some gold is associated with pyrite mineralization, and quartz absent of sulphides to a lesser extent than its association with arsenopyrite (Canam 2006). Gold was also observed with sulphides and sulphosalts containing antimony and lead, yet textural relationships indicate the gold had precipitated prior to the formation of these minerals (Coleman 1957, Canam 2006). The total sulfide content in the ore units is typically less than 10%. Roasting was required to treat the refractory Au that was microscopically enclosed within the arsenopyrite. The process of roasting transformed the sulfides into porous iron oxides of maghemite and hematite, volatized As and Sb, and produced a gold-rich calcine high in As, Sb, Cu, Pb and Fe concentrations (Walker *et al.* 2015, Bromstad *et al.* 2017).

1.2.3 History of Mining – Yellowknife, NT

The largest gold deposits within the Slave Structural Province, Giant and Con, can be found in the Yellowknife Greenstone Belt. The Giant Mine, located roughly 5 km north of the City of Yellowknife, was the largest gold producer in the Slave Structural Province, followed by the Con, Lupin, Discovery and Colomac mines (Canam 2006). From 1938 to the late 1990's, the City of Yellowknife was an active gold mining community (Bullen and Malcolm 2006, Moir *et al.* 2006), with Giant and Con mine operations being strong economic drivers in the development of the area.

This long history of mining in Yellowknife has led to a complex legacy of contamination in the surrounding environment. As mentioned in sections 1.2.2.1 and 1.2.2.2, much of the gold at Giant, and to a lesser extent Con, was hosted submicroscopically within arsenopyrite. Roasting was required to extract the gold, leading to the production of SO_2 emissions and As-rich vapors, which precipitated to form As_2O_3 dust upon release into the atmosphere (Walker *et al.* 2015). Roasting of gold ore is a thermal oxidation process that breaks down or decomposes sulfide minerals (ie. pyrite and arsenopyrite) into porous iron oxides including hematite, maghemite or magnetite, to make the ore yielding to cyanidation (Walker *et al.* 2005). Equation 1-1 below outlines the process in which arsenopyrite is oxidized to form iron oxides, As_2O_3 and SO_2 emissions.

$$2FeAsS + 5O_2 = Fe_2O_3 + As_2O_3 + 2SO_2$$

Equation 1-1 Formation of arsenic trioxide (As_2O_3) and sulphur dioxide (SO_2) as a result of roasting the gold-bearing arsenopyrite ore (FeAsS).

A brief history of operation at the two long-running mines in the study area can be found outlined in Table 1 below. The table was created to highlight some of the more significant events that happened over the life of the mines, and a more detailed description of mine operations at Con and Giant can be found in sections 1.2.3.1 and 1.2.3.2.

Table 1-1 A brief outline of significant events occurring in the Yellowknife mining district.

1935	Geological Survey of Canada's Dr. A. W. Jolliffe leads a mapping party of undergraduate students to Yellowknife Bay. Student Norman Jennejohn, along with a group of prospectors (Vic Stevens, Don Mclaren and Ed McLelland) discover visible gold in quartz veins on the west side of Yellowknife Bay. Jolliffe and Jennejohn make a public announcement on September 30, 1935 and a staking rush ensues (Moir *et al.* 2006). In July 1935, C.J. Baker and H. Muir stake the GIANT mineral claims on the west side of Yellowknife Bay after discovering and claiming the gold-bearing quartz veins on the RICH property to the east of Yellowknife Bay (Moir *et al.* 2006). After the announcement made by Jolliffe, a group of geologists working for Consolidated Mining and Smelting (CM & S) stake mineral claims on the west of Yellowknife Bay that would later become the core of Con Mine (Moir *et al.* 2006).
1937	Consolidated Mining and Smelting purchase claims surrounding the Con property (Moir *et al.* 2006).
1938	Con-Rycon Mine begins production (Moir *et al.* 2006).
1939	Negus Mine production begins (Negus merged with Con Mine in 1953) (Moir *et al.* 2006).
1942	Roasting facility constructed at Con and the roasting of gold-bearing arsenopyrite ore begins. The roaster was in operation from April to November 1942 (Moir *et al.* 2006).
1943	Frobisher Explorations acquire 100,000 shares of the Giant property from Giant Yellowknife Gold Mines Ltd. An extensive drilling program run by Frobisher Exploration begins on the Giant property (Moir *et al.* 2006). Con Mine stops production due to wartime restrictions (Moir *et al.* 2006).
1946	Postwar production resumed at Con in August 1946 (Moir *et al.* 2006).
1948	Giant Mine begins gold production with the first gold brick being poured on August 24, 1948 (Moir *et al.* 2006).

	Milling and stockpiling of flotation concentrates begins at Giant in May 1948 (Silke 2013).
1948 to 1951	For the first three years of operation at Giant, tailings were discharged onto the shores of Yellowknife Bay at the tailings beach site. Following 1951, tailings were discharged into Bow Lake (a small lake on the mine property), and other low-lying areas, which evolved into the north, central and south tailings ponds currently existing on the property (Walker *et al.* 2015).
1949	A flat-hearth autogenous roasting facility is opened at and roasting commences in January 1949. A scrubber is installed at Con to reduce emissions (Walker *et al.* 2005, Silke 2009, Silke 2013)
1949 to 1952	Over 8700 tonnes of As is estimated to have been emitted by both the Giant (approximately 7900 tonnes) and Con (approximately 850 tonnes) roasters between 1949 and 1952 (Hocking *et al.*1978, Walker *et al*. 2005). By 1951 an estimated 7400 kg of As is emitted by the Giant roaster each day (Silke 2013).
April 1951	Yellowknife Dene First Nations child dies after ingestion of snow, which lead to acute As poisoning (Sandlos and Keeling 2012).
June 1951	Government and Giant Mine officials meet to discuss pollution controls. A recommended safety threshold value for As in drinking water of 0.05 ppm is established (Sandlos and Keeling 2012). [1]
October 1951	Cottrell Electrostatic Precipitator (ESP) installed at Giant Mine to help with emission controls (More and Pawson 1978).
1952	Arsenic trioxide dust recovered at Giant Mine is put underground as a means of storage (Walker *et al.* 2005). A second roaster (two-stage slurry Dorrco unit) is installed at Giant Mine, allowing the mill to increase its rate from 400 to 700 tons per day (Moir *et al.* 2006, Silke 2013).
1952 to 1956	Giant Mine roaster emissions decrease from 7,400 kg As / day to 2,900 kg As / day (Silke 2013).
1958	The installation of a baghouse at Giant Mine increases As recovery leading to a decrease in As emissions after 1958. A third roaster (larger Dorrco two stage flu-solids roaster) is installed at Giant Mine to increase Au recovery (Silke 2013).
1959	Giant Mine roaster emissions decrease to approximately 200 to 300 kg As / day with some days as low as 52 kg As / day (INAC 2018)
1965	Concern over As levels is renewed after high concentrations found on local vegetables and in local water sources (Sandlos and Keeling 1978).
1968 to 1969	The City of Yellowknife relocates its water intake source from Yellowknife Bay to the Yellowknife River (AECOM 2017).

[1] Current guidelines for Canadian drinking water quality list the maximum acceptable concentration for As in drinking water as 0.01 ppm. This guideline was established in 2006 (Health Canada 2017).

1969 to 1975	Numerous studies published between 1969 and 1975 highlighting the extent and risk of As contamination around Yellowknife due to mining activities increases public concern, prompting the Government of Canada to conduct further environmental surveying (Hocking *et al.*1978).
1977	Mill employee surveys conducted by the government through the collection of hair and urine samples in 1975 and 1976 showed that As exposure was not severe, despite the occurrence of skin rashes due to contact with the As (Silke 2013).
1981	Giant Mine tailings effluent treatment plant is constructed and begins operating (INAC 2018).
1991 to 1993	Territorial government studies sulphur dioxide and As emissions from Giant, in response to a request by the NWT Environmental Rights Act. Conclusions report airborne As concentrations fall below Ontario standard (Sandlos and Keeling 2012).
1990s	Initiation of studies regarding mine closure options related to the permanent storage of As_2O_3 dust underground (Sandlos and Keeling 2012).
1995	Testimony by Yellowknives Dene elders at hearings on behalf of the Canadian Environmental Protection Act (Sandlos and Keeling 2012).
1999	Royal Oak Mines Ltd. (Owner of Giant property since 1990) files for bankruptcy. Roasting and treatment of ore ceases at Giant Mine; ore is processed at Con (Silke 2013). Giant Mine was placed into receivership in April 1999; after no purchasers were identified, control of Giant Mine was transferred to Indian and Northern Affairs Canada (INAC) on December 13, 1999. (Moir *et al.* 2006, Jamieson 2014, INAC 2018). On December 14, 1999 the assets of Giant Mine were sold to Miramar Giant Mine Ltd from the federal government of Canada. The federal government would still retain the responsibility for the pre-existing state of the property (Moir *et al.* 2006).
November 2003	Underground operations cease at Con Mine (Moir *et al.* 2006)
2004	Miramar continue to mine Au ore at Giant until July 2004; ore was processed at Con Mine property (Moir *et al.* 2006, Silke 2013).
2007	INAC submits a Remediation Plan and water license application to the Land and Water Board (INAC 2018).
2008	The Land and Water Board conclude the Remediation Plan is not likely to be the cause of adverse environmental impact or public concern. The City of Yellowknife refers project to environmental assessment. The Review Board initiates an environmental assessment (INAC 2018).
August 2014	Official Giant Mine remediation plan is approved by the Canadian federal government (INAC 2018).
Present Day	Remediation and monitoring efforts on-going at both sites.

1.2.3.1 Con Mine Operations

After early prospecting and development of the Con claims in 1936, a construction program was initiated in July 1937, the same summer sinking of the main production shaft was started. By the summer of 1938 the shaft was 250 feet (76 m) deep and two levels were being mined at depths of 125 (38 m) and 250 feet. When Con Mine milling operations began in 1938, ore was produced at a rate of 100 tonnes per day. By 1939 the mill capacity was increased to 175 tonnes per day due to the addition of extra grinding and filtering equipment (Silke 2009). Free gold in the Con deposit was quickly depleted, and arsenopyrite became the main source of ore at the mine. In 1942, roasting of the gold-bearing arsenopyrite ore began as it was more economical than continued efforts to extract free gold from the deposit. By 1942, production increased to 300 tonnes per day through the addition of the Edwards-Type roaster, a Hadsill Mill, and cyanidation, flotation and filtration equipment (Egil and MacPhail 1978). By the end of 1955, production was increased to 465 tonnes per day due to the replacement of the Hadsill mill by a CAC ball mill. 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).

Roasting operations at Con Mine lasted from 1942 to 1970 and produced roughly 2500 tonnes of As_2O_3 emissions (Hocking *et al.* 1978). The roasting process consisted of two heating stages; the first stage was completed at 500^oC under a slightly reducing environment to volatize arsenopyrite, remove As from the ore and produce As_2O_3 gas, while the second stage of roasting was completed at 550 ^oC under an oxidizing environment, which converted pyrite to hematite and magnetite (Miramar Con Mine, Ltd 2007, Walker *et al.* 2015). As_2O_3 gas emissions were released to the environment up until 1948 when a baghouse scrubber was installed (Miramar Con Mine, Ltd 2007). Con Mine produced fewer As_2O_3 emissions and different calcine chemistry than what was produced through roasting at Giant Mine, which may have been a result of slightly different roasting methods (Walker *et al.* 2015).

After Cominco sold Con Mine to Nerco Minerals in 1986, the C1 headframe was replaced, increasing operational capacity to 1200 tonnes of ore per day, and the pressure-oxidation (autoclave) treatment for gold ores was installed. Autoclave construction began as a replacement for ore roasting technology and was used in the reclamation of old As wastes. The autoclave used high temperature and pressure to liberate gold from refractory ore and was used to process As_2O_3-bearing waste by converting As_2O_3 into stable iron arsenates as shown by the reaction in Equation 1-2 below (SRK 2002, MCML 2007, Silke 2009).

$$2FeS_2 + 8.5O_2 + 6H_2O + As_2O_3 \rightarrow 2FeAsO_4 \cdot 2H_2O + 4H_2SO_4$$

Equation 1-2 Reaction produced through use of the autoclave to process gold-bearing refractory ore.

Scorodite was likely the stable iron arsenate produced through this reaction, with hematite also being produced during the autoclave process (MCML 2007).

Mining operations at Con Mine ceased on November 28, 2003 and milling of the refractory stockpiles continued into early 2004. Fifteen tonnes of As_2O_3 waste was treated per day using the autoclave. Processing of the As sludges stopped temporarily in 2005 but began again in 2006 after all the locations of As wastes had been identified, and the waste stockpiled into one location (Silke 2009). In 2007 the autoclave was decommissioned once all As-bearing sludges had been treated (MCML 2007). Over the life of Con Mine 12,071,642 tonnes of ore was produced at a 0.48 ounces of gold per tonne for a total of 5,801,303 ounces of gold (MCML 2007).

1.2.3.2 Giant Mine Operations

Giant Mine was one of the most productive gold mines in Canada's history, producing more than 7 million ounces of gold over 55 years of operation (Bullen and Robb 2006). The first gold brick was poured at Giant in 1948, and ore processing operations ceased in 1999 when the mine went into receivership. At this time remediation of the site became the responsibility of the federal government and Giant Mine was transferred to Indigenous and Northern Affairs Canada (INAC), who became responsible as caretaker for the pre-existing environmental liabilities on the property (INAC 2018). INAC sold the assets of the mine to Miramar Giant Mine Ltd. who continued with underground operations until 2004.

Roasting of ore at Giant began in 1949 and lasted until 1999, however a cold Cottrell electrostatic precipitator (ESP) was not installed until October 1951, thus roasting continued for almost 3 years without any form of emission controls (More and Pawson 1978). The roasting of the refractory gold ore associated with arsenopyrite created a calcine product and gas stream. The calcine product contained a mixture of Au-bearing Fe-oxides and some residual sulphides, which were amenable to cyanidation (MCML 2007). The gas stream consisted primarily of As_2O_3, sulphur dioxide (SO_2), and iron oxide bearing fine dust (More and Pawson 1978). Early roasting between 1949 and 1951 resulted in the release of approximately 7.3 tonnes per day (tpd) of airborne As_2O_3 containing emissions, amounting to over 7,900 tonnes of As_2O_3 dust being released to the surrounding environment (Wrye 2008). In 1951, emissions dropped to 5.5 tpd with the implementation of the cold Cottrell ESP (Wrye 2008, INAC 2018). ESP dust was collected and leached to extract additional Au, and beginning in 1952, As_2O_3 dust was stored in underground stopes and chambers (Walker *et al.* 2005).

By 1952, production increased to 700 tpd, almost doubling the production of that at Con Mine, with the implementation of a Dorrco fluosolids roaster to work in parallel with the flat hearth roaster (More and Pawson 1978, Moir *et al.* 2006). This roaster was a prototype for the two-stage fluosolids roasting, which commenced at Giant in 1958 and continued until the end of operations (More and Pawson 1978). The two-stage fluosolids roasting consisted of a fine-grained slurry mixture with a higher surface area and efficiency than the Edwards-type hearth roasting (Thomas and Cole 2005). During this time Giant processed between 1000 and 1200 tpd (Canam 2006).

In 1958 a Dracco baghouse facility was also constructed to collect roaster emissions, and the As_2O_3 dust being released. Following the installation of the bag house and the addition of two hot ESP's connected in series with the two-stage fluosolids roaster (1963), As_2O_3 emissions decreased to a range of 0.01 and 0.9 tpd between 1959 and 1999 (Wrye 2008). Over the life of the mines in the Yellowknife area it is estimated that over 20,000 tonnes of As_2O_3 was released across the surrounding landscapes through roaster emissions (CPHA 1977, Wrye 2008).

Dust collected in the baghouse was deposited underground, where it remains today in a total of 9 chambers and 5 stopes as part of INAC's remediation plan to freeze the As_2O_3 dust in place (INAC 2010, INAC 2018b). This method was chosen largely due to the removal of the As_2O_3 dust from the underground cavities being too dangerous, and as it was deemed the most appropriate method by an Environmental Assessment (INAC 2010, INAC 2018b). The frozen block method is a passive, self-sustaining system which continuously removes heat from underground and transports cold air below using thermosyphons (INAC 2013).

1.3 Arsenic in the Mine Waste Environment

Arsenic is commonly associated with many types of ore deposits, and hydrothermal gold deposits are often enriched in As (Jamieson *et al.* 2015). Arsenopyrite and As-bearing pyrite are often the primary forms of As in such ore deposits. When these minerals are exposed to oxidizing environments, a complex suite of secondary minerals may occur, including arsenate minerals or iron oxides with adsorbed arsenite and arsenate. In reducing conditions these oxidation products may become reductively dissolved and As may be released back into the environment (Jamieson *et al.* 2015).

Arsenic has the potential to become mobilized in the environment through a combination of natural processes such as weathering reactions, particularly changes in redox state, and biological activity, in addition to a variety of anthropogenic activities (Bowell *et al.* 2014). The mobility, toxicity and bioavailability[2] of As are dependent on the oxidation state of As (Fawcett and Jamieson 2011). The geochemical behavior of As in the surficial environment is characteristic of oxyanion-forming metalloids, as As is mobile at relatively natural Eh and pH values in soil and groundwater (pH values of 6.5 to 8), and can exist in both oxidizing or reducing environments (Bowell *et al.* 2014). Arsenic can occur in the environment in several oxidation states, but most commonly occurs in natural groundwaters and soil pore waters as trivalent arsenite (As(III)) or pentavalent arsenate (As(V)). In anaerobic soils or sediments arsenite ($As^{III}O_3^{3-}$) is the dominant species and is typically found combined with sulphur, where

[2] Bioavailability: measurement of the ability of a toxin to be dissolved in gastric fluid and become available for absorption into the body. A bioavailable compound is that which is freely available to cross an organism's cellular membrane and be transported to a site of toxic action (Semple *et al.* 2004, Plumlee and Morman 2011).

as in aerobic soils or sediments arsenate ($As^{V}O_4^{3-}$) is the predominant species (Bowell *et al.* 2014). Conversely, As_2O_3 (As(III)) persists in the near surface aerobic environment in soils throughout the study area.

Ore roasting at Giant and Con mines increased the solubility, toxicity and bioaccessibility[3] of As through the conversion of sulfide-hosted As to oxide-hosted As (Equation 1-1) (Jamieson 2014). Figure 1-4 below outlines the degree of bioaccessibility exhibited by various phases of As (Plumlee and Morman, Mine Wastes and Human Health 2011). Plumlee and Morman (2011) also report that organic soil carbon may reduce As(V), which is more readily sorbed onto particulates in the intestines, to As(III), which is less readily sorbed. Giant mine is considered to be the largest contributor of bioaccessible As in the study region, as Con

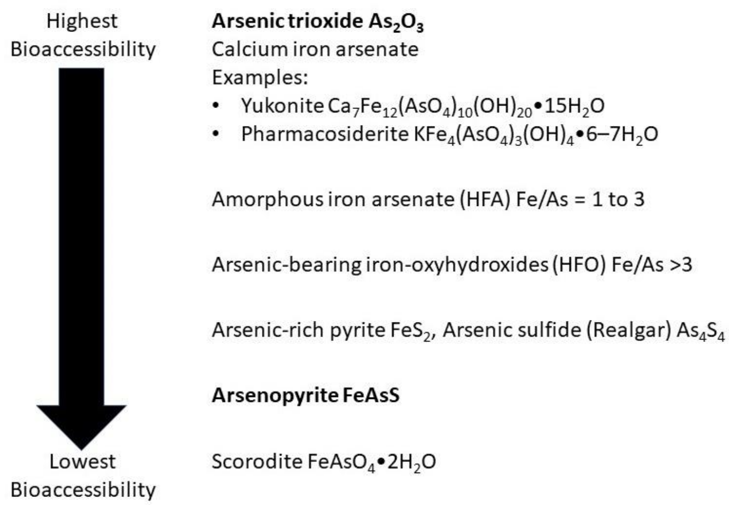

Figure 1-4 Bioaccessibility of arsenic phases adapted from a figure originally created by Heather Jamieson. The order of decreasing bioaccessibility was determined via gastric and intestinal extraction tests reported by (Plumlee and Morman, Mine Wastes and Human Health 2011).

[3] Bioaccessibility: measurement of how readily a toxin is released into the body's fluids from a contaminated medium and are available for uptake (or become bioavailable); the compound's bioaccessibility may be decreased by physical removal or occlusion (ie. the compound is physically restrained) (Semple *et al.* 2004, Plumlee and Morman 2011).

mine was able to cease roasting due to the presence of less refractory ores, and the conversion to pressure oxidation in the late 1980s (Jamieson 2014).

1.3.2 Arsenic in Lake Waters and Sediments in the Yellowknife Region

Several studies have recently been completed in the Yellowknife area to observe the persisting impacts of past roasting activities on the surrounding environment. Palmer *et al.* (2015) sampled 98 lakes within a 30 km radius from the City of Yellowknife, and discovered that concentrations of As, Sb and SO_4 were elevated in lakes up to 17.5 km from Giant Mine when compared to lakes beyond this distance. Palmer *et al.* (2015) also found that As concentrations were highest in smaller lakes (less than 100 ha), in locations downwind and proximal to the former Giant roaster. Within 12 km of the roaster, As concentrations in lakes exceeded the federal drinking water guideline for As (10 µg/l), and in some instances were 60 times greater than this guideline limit. Houben *et al.* (2016) also reported aquatic As concentrations well above drinking water guidelines with concentrations ranging up to 136 ug/L in lakes within 4 km of Giant Mine, to 2.0 ug/L in lakes 24 km away.

In a study completed at the same time as Palmer *et al.* (2015), Galloway *et al.* (2015) sampled near-surface sediments in lakes and found that 71% of all sediment samples collected (149 of the 211 samples) contained As concentrations that exceeded the Canadian Council of Ministers of the Environment (CCME) Interim Freshwater Sediment Quality Guideline of 5.9 mg/kg. This study also found that 54% of samples (114 of 211) exceeded the CCME Probable Effect Level of 17 mg/kg. The highest concentrations of As in near-surface sediments were found in lakes nearest to the City of Yellowknife, and are expected to indicate a combination of anthropogenic and geogenic input (arsenopyrite rich rocks within YGB).

Martin Van Den Berghe, a MSc graduate from Queen's University, sampled lake sediments from 3 lakes, downwind and proximal (< 5 km) to the sources of anthropogenic contamination; Handle Lake, BC-20, and Lower Martin Lake. Results from his thesis determined that the occurrence of As_2O_3 in lake sediments coincides with the onset of industrial activity in the area (Van Den Berghe 2016, Van Den Berghe *et al.* 2018).

Christopher Schuh, a current PhD candidate at Queen's University, has also been investigating the influence of legacy mining activities on lake sediments in the Yellowknife area. He collected deep water and shallow water sediment cores from two lakes downwind from Giant Mine, Long Lake and Martin Lake, and recently published a paper of his findings (Schuh *et al.* 2018). Four predominant solid phases of As-hosting minerals were identified in the sediments; anthropogenic As_2O_3, authigenic realgar, As-bearing Fe-oxyhydroxides and As-bearing framboidal pyrite. Contribution from arsenopyrite to the total sediment As concentrations was negligible, suggesting elevated concentrations are likely anthropogenic in origin (Schuh *et al.* 2018).

1.3.3 Arsenic in Soils in the Yellowknife region

Arsenic concentrations in surface soils in the area surrounding Yellowknife, and on the Giant Mine property have also been investigated. Work completed almost four decades ago, during mining operations, reported elevated concentrations of As in near surface soils. Hocking *et al.* (1978) collected samples soil from 52 sites within 40 km from Giant and Con, in response to public concern over roaster stack emissions. Hocking *et al.* (1978) found that As concentrations were very high in topsoil layers and decreased with depth and distance from the sources of contamination. A comprehensive comparison between Hocking's results and the results from this regional sampling survey can be found in the discussion section in Chapter 3 of this thesis.

Hutchinson *et al.* (1982) found similar results in near surface soils (0 to 2, 2 to 4, and 4 to 6 cm depth intervals) within 15 km of the roasters in areas around the City of Yellowknife. Their study projected that As concentrations could range anywhere between 500 and 1500 mg/kg within the Yellowknife City limits at that time, and also reported a decrease of As concentrations with depth. This study also pointed to high As concentrations in surface soils as being a result of airborne stack emissions (Hutchinson *et al.* 1982).

Kerr (2006) completed a comprehensive study in till (10 to 70 cm depth), humus, and leaf litter in the Yellowknife area. This research determined that concentrations of As, Sb and Au were elevated in leaf litter and humus, while decreasing with depth; once again indicative of contaminant loading from airborne stack emissions (Kerr 2006). St. Onge (2007) also completed a soil sampling program in which, soil cores (0 to 30 cm depth) were collected form 12 sites up to 40 km from the former mines. Similar to other studies previously completed, this study determined that As concentrations decreased with increasing distance from the sources of contamination.

A thesis completed by Lori Wrye at Queen's University looked at distinguishing between natural and anthropogenic sources of As in soils surrounding Yellowknife. Wrye (2008) reported elevated As and Sb concentrations at the surface (As = 140 to 3300 mg/kg), with decreasing concentrations at depth (22 to 600 mg/kg). Wrye (2008) also found As_2O_3 in surface soils by using synchrotron and scanning electron microscopy methods. She suggested that the persistence of As_2O_3 was likely due to the association of Sb with the dust grains, a dry climate, and high organic concentrations in soils (Wrye 2008). The solubility of As_2O_3 being related to Sb content was explored in a study completed by Riveros *et al.* (2000) who found that using water leaches with temperatures <100^{o}C only low-Sb content As_2O_3 grains dissolved, leaving higher Sb- As_2O_3 in the remaining residue. Riveros *et al.* (2000) hypothesized that the Sb within the As_2O_3 dust was in solid solution within the As_2O_3 and that it resulted in lower aqueous solubility.

Mackenzie Bromstad investigated the impact of roaster emissions in soils collected on the Giant Mine property as part of her MSc thesis at Queen's (Bromstad 2011). Bromstad also completed a technical report for soil samples collected from the property for Golder Associates in 2015, and summarized the previous work in addition to Lori Wrye's work in Bromstad *et al.* (2017). Bromstad *et al.* (2017) found that near-surface, undisturbed, soils on the mine property contained up to 7700 mg/kg As, with the highest concentrations occuring in soil pockets on bedrock outcrops. It was also concluded that the most common As hosts in soils were As_2O_3 and roaster-generated Fe- oxides (maghemite and hematite) (Bromstad *et al.* 2017).

1.4 Community Concern regarding As in the Yellowknife Region

Gold mining and processing activities in and around the City of Yellowknife have sparked numerous discussions regarding the risk of exposure to airborne contaminants (As_2O_3 dust) within the surrounding environment. Prior to the development of mining, the Yellowknife's Dene First Nation (YKDFN) occupied the area, with the first land treaty being signed in Fort Resolution in 1900 (YKDFN 2017). Blankets of blueberries used to cover the areas where the mine sites now exist; the YKDFN used the areas around the current city limits and mine properties extensively as hunting, trapping and gathering grounds. Despite efforts to control emissions in later years, during the early stages of operation thousands of kilograms of As_2O_3 dust were released out of the roaster stacks daily. In 1951, a Dene child was killed by acute As poisoning in the community of Ndilǫ on Latham Island and reports were made of local livestock dying after drinking from water sources in the area (Sandlos and Keeling 2012).

Current concern regarding the sites are related to the underground storage of the 237,000 tons of As_2O_3 dust collected over the years of operation (Sandlos and Keeling 2012), and the potential for windblown dispersion of contaminants from onsite tailings facilities (F. Sangris, personal communications, summer 2015, Bailey 2017). Each year the YKDFN community members see dust blowing from the Giant Mine site, which causes them a great deal of concern (Quenneville 2015). Prior to work completed by Bailey (2017) there was no information available regarding the composition of the dust-sized fraction of the tailings. Bailey (2017) determined that As_2O_3 was mostly absent from the tailing dust, but that other dust particles (ex. calcium-iron arsenates) could still pose a risk.

Today the Yellowknives Dene First Nations have been forced to travel further from their homes in Ndilǫ and Dettah to engage in traditional hunting and gathering activities due to As contamination in the region (Sundberg 2015, F. Sangris, personal communication, July 2015). Remediation efforts in the area have begun, however some community members feel as though the mine sites should remain as the grey scar on the land that they currently are as a means of reminding future generations of the mistakes that were made in the past (J. Black, personal communication, July 2015). Mary Sundberg suggests that a story or legend will have to be constructed to teach future generations about the risk associated with the site and surrounding land today (Sundberg 2015).

When talking with other members of the Yellowknife community during the 2015 field season, it was made evident that not only the YKDFN have been affected by the legacy of contamination associated with mining in the area. Numerous other people expressed their concern regarding interacting with the land around their homes, whether by gardening, gathering, or recreational activities. Efforts are currently underway via a researcher from the University of Ottawa, in which toenail clippings, urine and saliva samples will be collected from Yellowknife and YKDFN community members as part of a Health Effects Monitoring Program to assess the levels of As in local citizens (Kyle 2017, M. Palmer, personal communications, 2017).

1.5 Thesis Organization

Chapter 2 of this thesis will outline the methods used throughout the course of the work leading to this final product; detailed descriptions regarding why various methods and pathways of analysis were used may be found in this chapter. Chapter 3 will be comprised of a manuscript outlining the results from this study, and will be submitted for publication, co-authored by Kirsten Maitland, Heather Jamieson, and Michael Palmer, who was a critical member in the planning and execution of this study. Chapter 4 will outline conclusions made from this study, reflections regarding the work completed, and outline recommendations for continued work in this topic.

Chapter Two: Field and Analytical Methods

2.1 Sampling Protocol

Sites for sample collection were chosen based on numerous factors, including distance from the source of contamination, direction from the point source with respect to prevailing wind direction, the location of past and present research sites, as well as the influence of on-going activities in the region. The aim was to acquire regional scale data representative of un-impacted areas.

Undisturbed sample locations were sought to decrease the likelihood of post-depositional changes to the environment. The idea of the study was to capture a picture of the extent of contamination, uninfluenced by current activities taking place within the Yellowknife area. Such activities could include, but are not limited to, citizens using the areas for recreational purposes, industrial operations, and traditional uses such as fur trapping routes, and the gathering of medicine plants from the region. When picking a sample location in the field, great care was taken to avoid areas that looked as though they may be disturbed. Samples were collected far from pathways and trails, and when possible taken in areas close to shrubs or brush, where access was more limited.

At some sample locations evidence of past use by residents was evident. Roasting operations ceased in 1999, thus 18 years have passed since the last emissions were released to the surrounding environment and areas within the study region may have undergone changes since then. For example, the Bypass Road was recently constructed in one of the most highly contaminated areas, directly west of the Giant Mine property. Despite the diligent effort to target only non-disturbed areas, it was impossible to determine if the areas had undergone absolutely no post-depositional changes since impacted by stack emissions.

Soil samples were collected within a 30 km radius from the City of Yellowknife, as Giant Mine emissions were expected to influence locations within approximately 20 km of the historic roasters. A regional lake survey of the study area found concentrations of As, Sb and SO_4, elevated in lakes within 17.5 km of Giant Mine, relative to lakes beyond this distance (Palmer *et al.* 2015). The location of these sample sites can be found in Figure 2-5A and Figure 2-5B below. Google Earth and topographic maps of the region were used to select sample locations representative of regional variation with respect to bedrock geology, surficial geology, land cover type, soil type and saturation, as well as distance to and direction from the roaster.

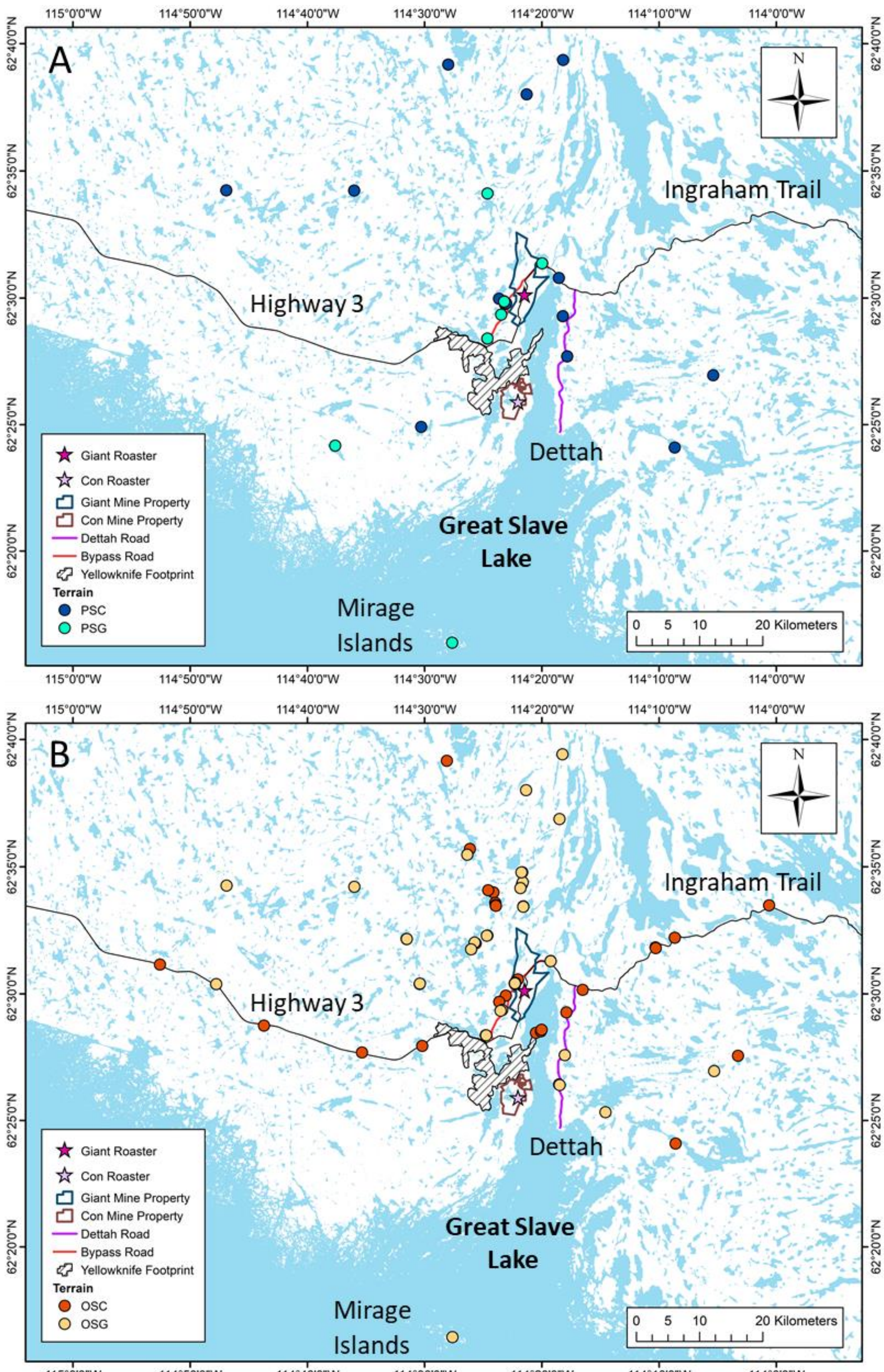

Figure 2-5A - Sample Location Map: Core and grab samples collected during the 2015 field season.
A: Locations for all peat soils cores (PSC) and peat soil grabs (PSG).
B: Locations for all outcrop soil cores (OSC) and outcrop soil grabs (OSG).

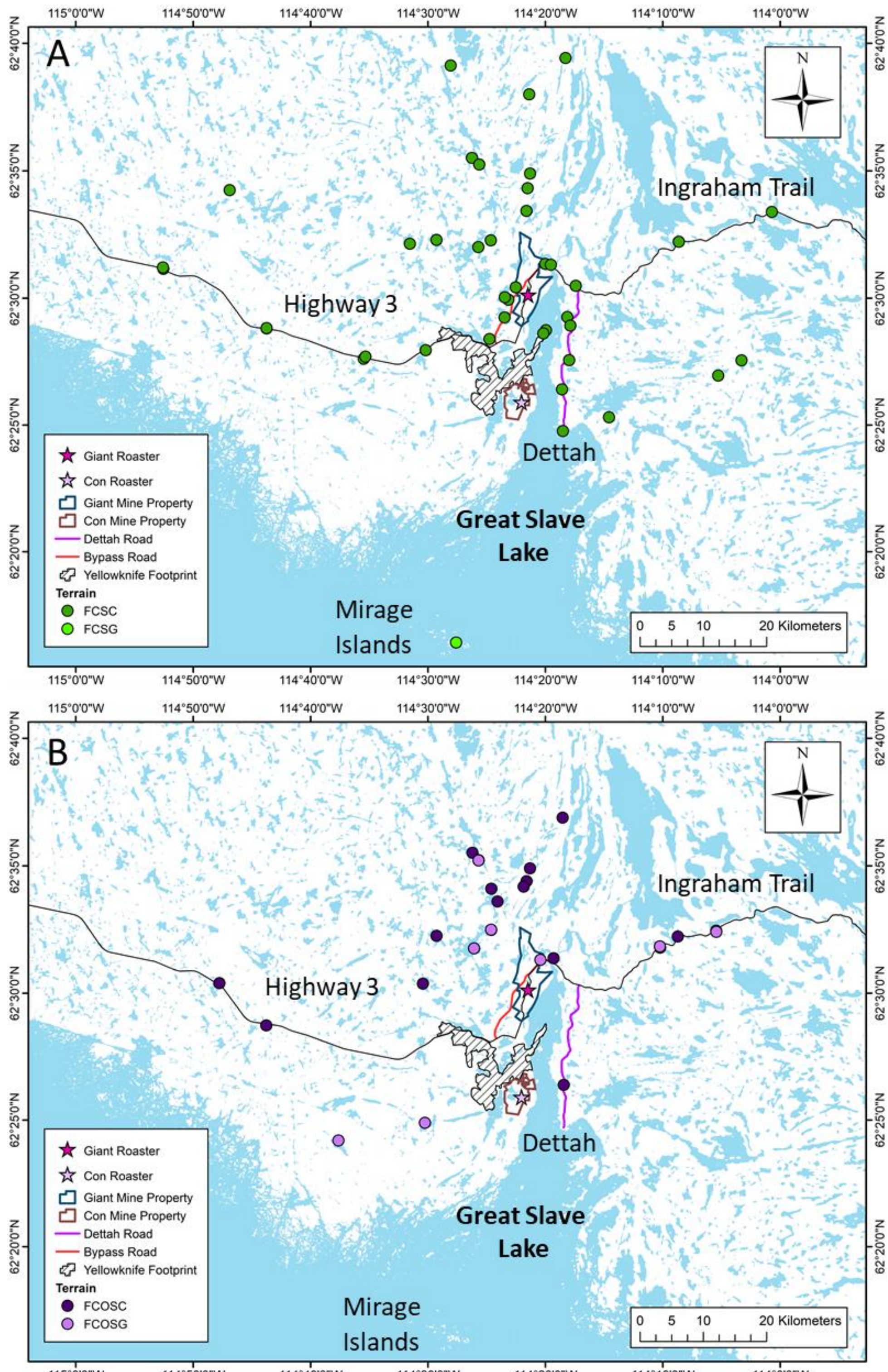

Figure 2-5B - Sample Location Map: Core and grab samples collected during the 2015 field season. A: Locations for all forested canopy soil cores (FCSC) and forested canopy soil grabs (FCSG). B: Locations for all forested canopy outcrop soil cores (FCOSC) and forested canopy outcrop soil grabs (FCOSG).

2.1.1 Terrain Units

Multiple terrain units were targeted to distinguish variations in soil geochemistry between the units. A broad classification scheme was used due to the high degree of variability between soils at different sample locations; allowing for comparisons to be made between the 4 distinct terrain units (Forested Canopy Outcrop, Outcrop, Forested Canopy, and Peat).

Forested canopy outcrop soils (FCOSC(G)) were collected from soil pockets located on exposed rock outcrops with significant canopy cover (Figure 2-6). These samples were often located at higher elevations and had numerous trees growing within the soil pockets. This category was created mid-way through the sampling program, due to the number of outcrop soil pockets with significant canopy cover. It was thought that forest cover may have influenced the distribution of roaster stack emissions, as the fallout of contaminants could have become trapped in the canopy, restricting the amount of arsenic and other contaminants that may have settled in these outcrop soil pockets.

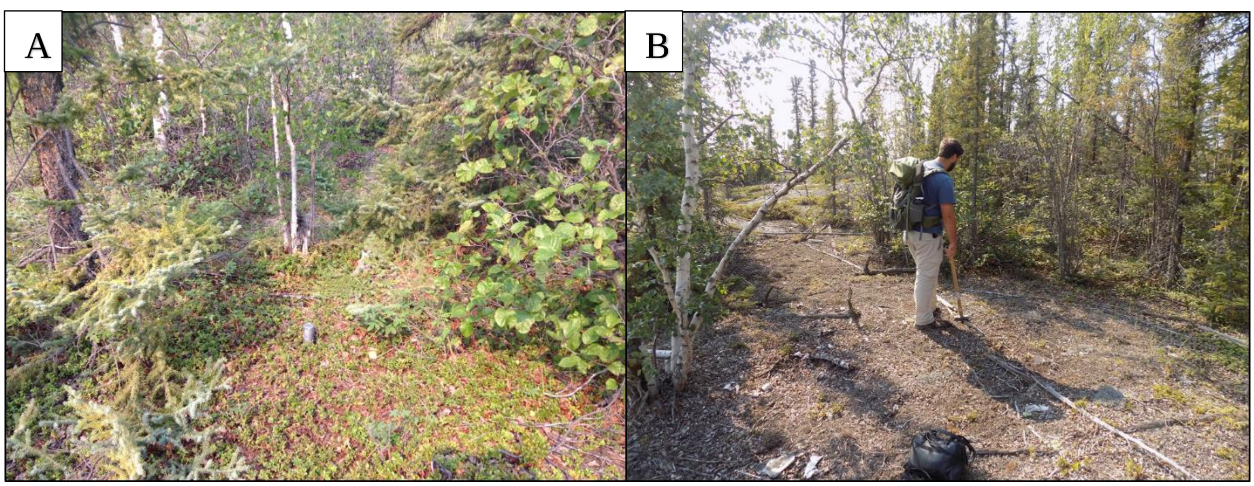

Figure 2-6 - A: Forested canopy outcrop sample collected on the Ingraham Trail. B: A different FCOSC sample site on the Ingraham Trail collected closer to Yellowknife and just north of the Giant Mine property.

Outcrop soils (OSC(G)) were defined as soil pockets with little to no canopy cover. These sample locations were also often located at higher elevations and would contain vegetation in the form of small willow trees, juniper bushes, or long grass. Outcrop soil pockets ranged in size from one to tens of meters in diameter and resided within larger areas of bare outcrop. Some examples of these outcrop soil pockets are shown in Figure 2-7 below.

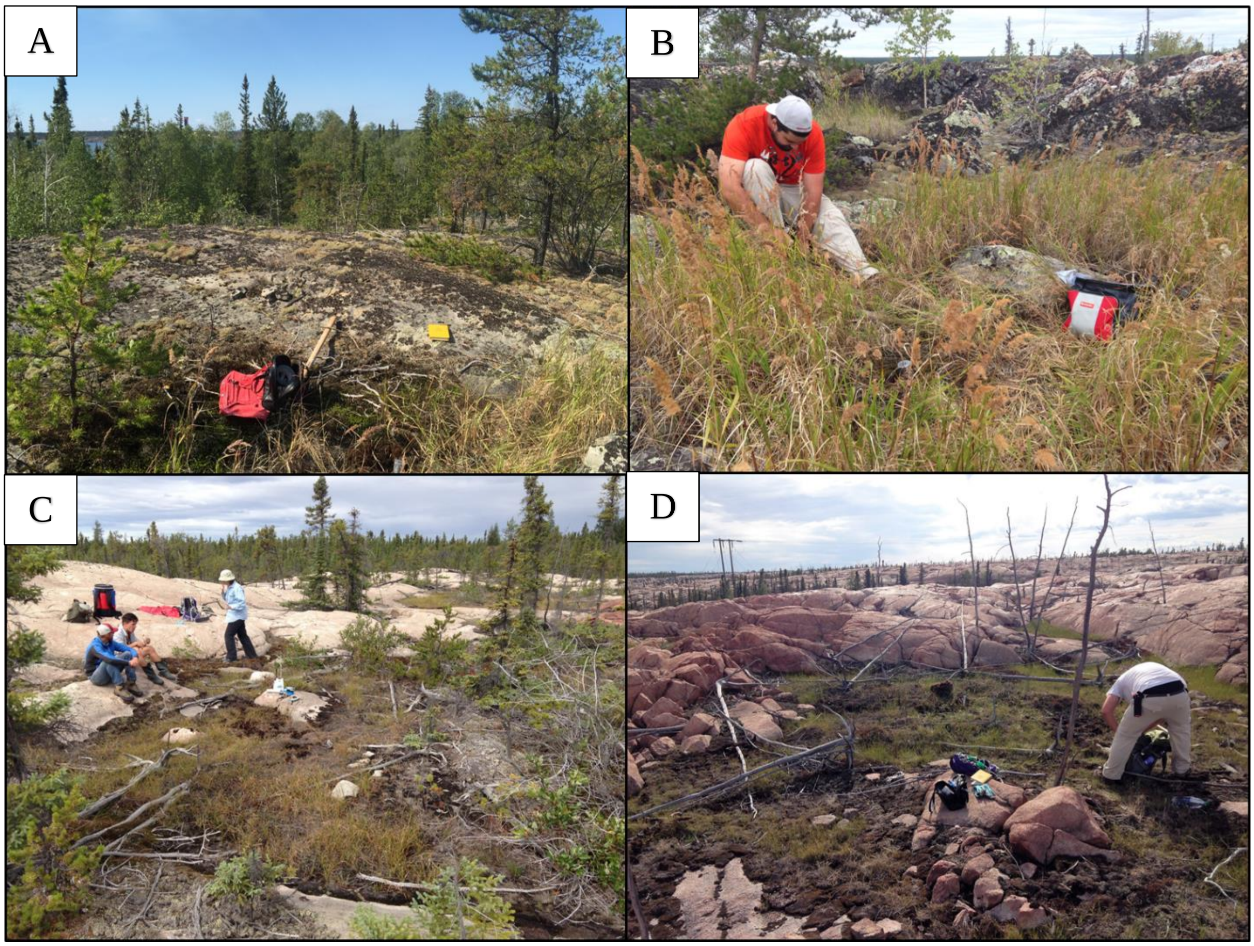

Figure 2-7 - A: Outcrop soil pocket off the Detah Road, with the Con Mine headframe visible in the distance. B: Field assistant, James Blanchard, in an outcrop soil pocket on Landing Lake, north of Yellowknife. From this location the Giant Mine headframe, and the City of Yellowknife were visible in the distance. C: First day of sampling on the Bypass Road with Mike Palmer, Trey Madsen, and Heather Jamieson. D: An outcrop soil pocket on the granites directly west of the Giant Mine property.

Forested canopy soils (FCSC(G)) were obtained from locations with dense canopy cover, often in lower lying areas. At these sample sites, the deepest cores were retrieved. Refusal was occasionally hit early due to dense root coverage, but most forest canopy cores consisted of well compacted silty sands, that were cold to the touch upon removal. Three different forested canopy sites are shown in Figure 2-8.

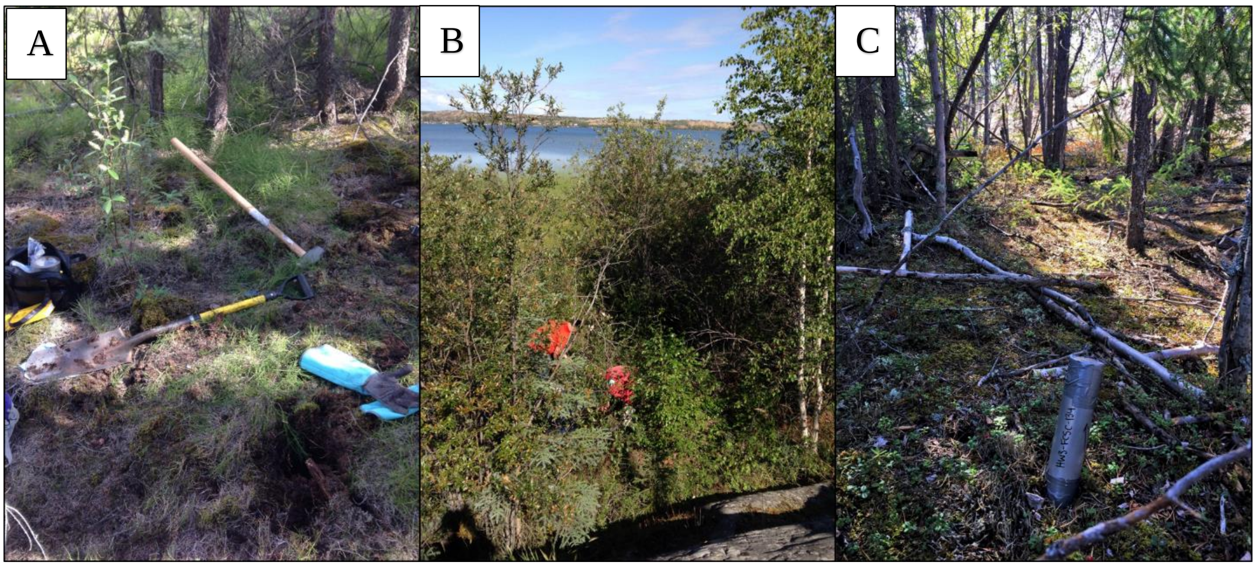

Figure 2-8 - A: Typical example of a Forested Canopy (FCSC) sample location also showing the equipment used for sampling at each site (sledge hammer, shovel, gloves, parafilm and tape (in black bag)). B: A forested canopy sample site in NDilo at the base of an outcrop. C: Forested canopy sample location west of Yellowknife out Highway 3.

Peat (PSC(G)) samples were collected from peatlands and collapsed peatland areas (Fen). These samples were located at lower elevations. Peat cores varied greatly depending on the area, with some consisting of a light orangish-tan fibrous material, and others with a much higher soil content. The deeper peat cores collected exposed permafrost at depth. Fen samples were included in this terrain type and were fully saturated as can be seen in Figure 2-9 below.

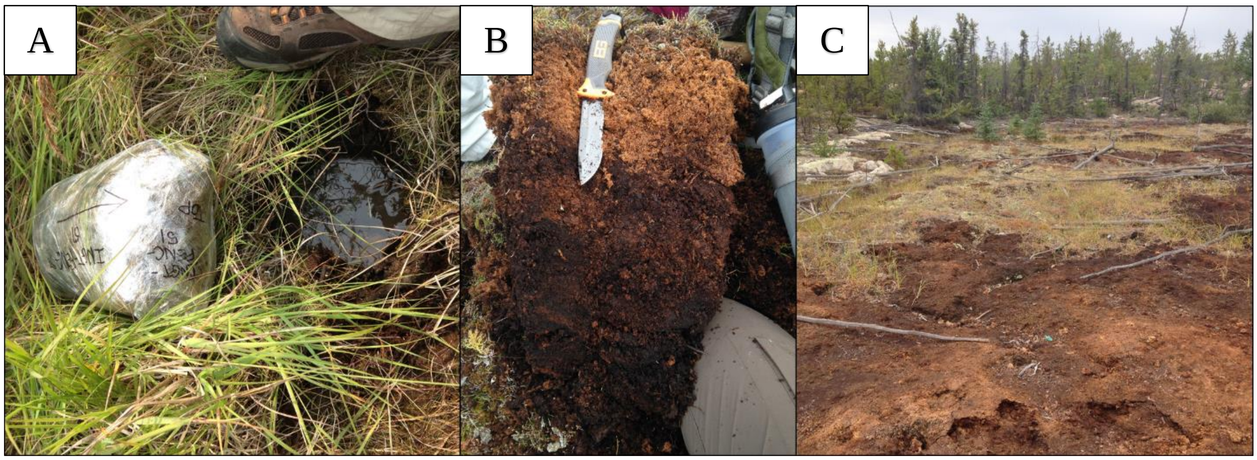

Figure 2-9 - A: Fen sample retrieved off Ingraham Trail. Fen were lumped in with peat for the purposes of this study, as only a handful of fen samples were collected (n = 6). B: Peat core collected in a large peatland off the Bypass Road. C: Peatland accessed from the Bypass Road.

2.1.2 Target Areas

Target areas for sampling (Figure 2-5A/B) were selected based on 1) distance from the former Giant roaster, 2) direction from the roasters with respect to prevailing wind direction, and 3) location with respect to past or on-going research. Within each target area soils were sampled from the four distinct terrain units (when possible) to observe how terrain impacts arsenic variation on a local scale. The target areas outlined in the data tables in Appendix A and B of this report have been summarized below.

Bypass Road

Samples belonging to the Bypass Road target area were retrieved from sites near the Giant Mine Bypass Road, which was built in 2014 to re-route the Ingraham Trail, so that it did not cut directly through the Giant Mine Property. Samples were collected in areas void of rock fragments (blast rock material) believed to be sourced from construction of the road. These samples are proximal to the Giant Mine Property, often falling within less than 1 km to 2 km from the roaster.

Dettah Road

Samples were collected along Dettah road to help assist with risk assessment studies in regard to areas commonly used by the Yellowknife Dene First Nations. Along Dettah road there are several homes, local trapping and foraging routes, as well as an abundance of medicinal plants which are regularly harvested by local community members. The Dettah Road target area also contains samples taken within proximity to research lake YK-67. One sample taken in this target area was retrieved directly within the Dettah community, in willow trees next to the community gardens.

Ndilǫ

The Yellowknife Dene First Nations community of Ndilǫ is located on the tip of Latham Island in Yellowknife. This small community is concerned with the possibility of arsenic contamination in their backyards. Soil samples were retrieved throughout Ndilǫ with the help of Fred Sangris and Mary Black. Fred assisted in indicating areas that were likely to be the least disturbed throughout the community.

TerraX Northbelt Property

TerraX Minerals Inc. has renewed interest in gold exploration within the Yellowknife greenstone belt (YGB). Exploration efforts and ongoing research is occurring in the TerraX Northbelt and Southbelt properties. The TerraX Northbelt is located directly north of the Giant Mine Property and includes the sample sites located around Landing and Vital lakes, as well as at Berry Hill. The South Belt property is located south of Yellowknife in the YGB, along the shore of Great Slave Lake. Access was granted to the Northbelt property in 2015 from TerraX staff.

Ingraham Trail

Ingraham Trail is a well-travelled public highway leading out of Yellowknife towards the east. The Ingraham Trail is a popular tourist route, as it contains multiple day use areas, access points to numerous lakes, and campgrounds. Samples retrieved near the Ingraham Trail were not located downwind of the predominant wind direction of the from the former roasters and were taken at sites distal to mining and processing operations. Metasediments and Prosperous Group granitic plutons are located along Ingraham Trail, east of the YGB. Samples were collected at the far east end of Ingraham Trail as a means of assessing areas believed to be less influenced by mining and processing operations. It is hoped insight regarding background elemental concentrations may be obtained from these samples.

Highway 3

Highway 3 extends west of the City of Yellowknife. Samples taken near Highway 3 are downwind from the roasters in the predominant wind direction, and distal from the mine properties. Some samples were taken far from the city boundary along Highway 3 in areas believed to be minimally influenced by mining and processing activities.

Martin Lake and nearby Research Sites

Previous research completed by Martin Van Den Berghe (2016), focused on the mobility and speciation of arsenic in lake sediments in three research lakes located to the west off the Bypass Road – Martin Lake, BC-20 and Handle Lake. In an attempt to link previous aquatic sediments research to ongoing terrestrial investigations, soil samples were retrieved in the Martin Lake, BC-20 and Handle Lake areas.

North of Giant Mine Property

Numerous samples were retrieved north, northwest and northeast of the Giant Mine Property. These samples were obtained from areas around Duckfish Lake, Homer Lake, and Chan Lake using helicopter access.

Distal Southwest and West Sites

Samples were sought in these locations to achieve a large spatial coverage throughout the study region and to investigate the influence of legacy mining and ore processing activities at sites distal from the point sources of contamination. To achieve the best possible gradient of arsenic concentration downwind from the point source of contamination and with respect to distance, numerous sample sites (labelled NWFAR) were accessed directly west of the Giant Mine Property.

Distal East and Southeast Sites

Samples retrieved around Duck Lake and Mason Lake were included in this target area. Similar to the southwest sample sites, these locations were investigated to achieve a large spatial coverage throughout the study region and to investigate the influence of mining and ore processing activities at distal locations.

Mirage Islands

Three samples (one outcrop, one forest and one peat) were collected on the Mirage Islands, located at the mouth of the Yellowknife Bay, south of the Giant and Con Mine properties.

2.2 Field Methods

2.2.1 Soil Core Collection

Soil cores were retrieved with aluminum tubing that was driven into the soil surface using a drive-head and a sledgehammer, or when possible, human force (Figure 2-10A) When a soil core was not feasible at a sample location due to thin soil or thick vegetation cover, a grab sample was collected in its place. Site conditions favourable of soil core sampling included areas where 1) the soil thickness was often greater than 10cm, 2) the soil was not heavily rooted, 3) there was not a significant volume of large pebbles or gravel, and 4) overlying vegetation (moss, lichen or grasses) were easily cut through using the aluminum core tube. In some areas the moss or grass cover was exceptionally thick and spongy, causing the aluminum tube to sink into and compress the surface at the sample site. In other areas the soil was too dry or thinly dispersed over the area to collect a core sample. At one point an outcrop pocket was completely saturated after a heavy rainfall event and the soil would not stay in the core upon removal. Occasionally large pebbles and roots made coring in some areas nearly impossible.

To account for soil compression resulting from this method of sampling, the distance from the top of the core tube to the soil surface, and the top of the core to the sample surface were measured for each core (Figure 2-10B). Following this measurement, the core was carefully extracted from the ground, and excess aluminum tubing was removed using a pipe cutter.

Parafilm was used to pack the sample tube if space remained between the top of the core and the sample surface. This was done to prevent the core from becoming unconsolidated during transport. The parafilm was also wrapped around each end of the core, and securely taped in place using duct tape (Figure 2-10C). The core was labelled and carefully placed upright in a back-pack or cooler for storage back to the staging warehouse.

Soil cores were collected, ranging from 4.9 to 40 cm in length, so that they could be carefully examined and subsampled at various depths. Multiple soil samples of similar terrain units were collected along the Bypass Road and in one outcrop soil pocket on Vital Lake, to test for variability at the local site scale.

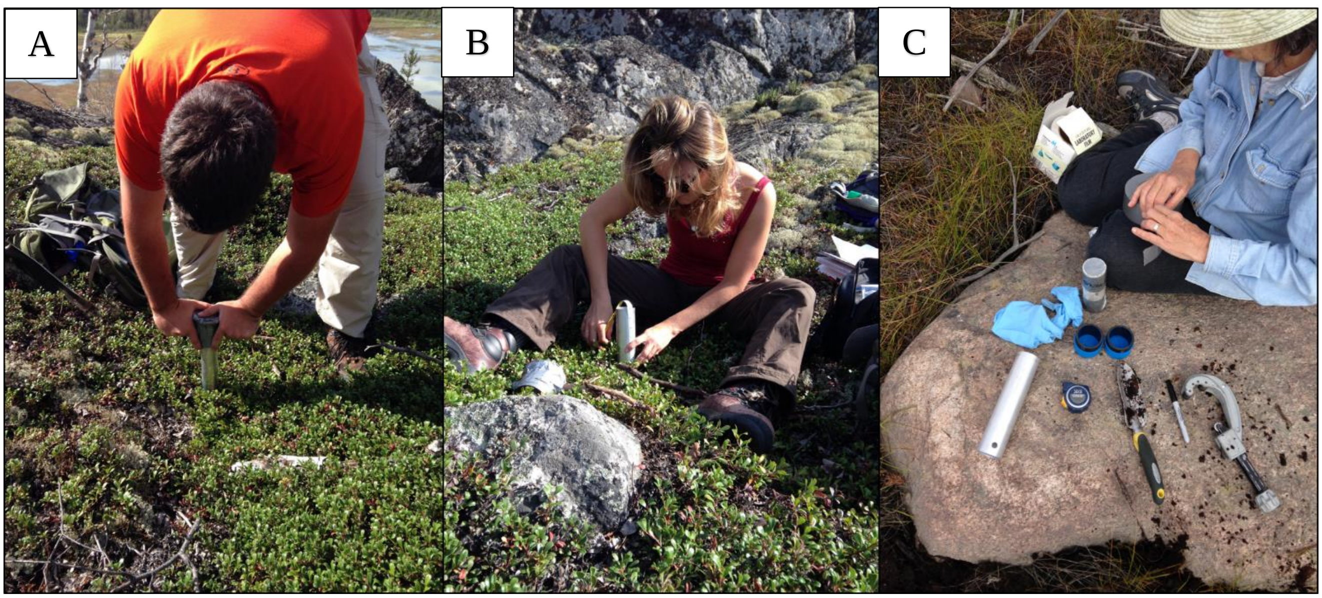

Figure 2-10 - A: Soil core being driven into an outcrop soil pocket. B: Measuring the distance between the top of the soil surface to the top of the core. The top of the sample surface (inside of the tube) to the top of the core was also measured and recorded so that compression could be calculated. C: Help from supervisor, Heather Jamieson, in the field on the first sample day. This image shows the pipe cutters used to cut the excess core from the collected sample, as well as the sample, which has been wrapped in parafilm and is in the process of being duct-taped for transport back to the warehouse where cores were stored.

2.2.2 Peat Core Collection

Peat cores were obtained by using a shovel to remove a section of material approximately 1 to 1.5 cubic feet in size (Figure 2-11A). A sharp knife or saw was then used to cut into the peat and extract a smaller core sample which covered a surface area of approximately 10 square centimeters and extended the total depth of the previously removed material. Peat cores were then wrapped thoroughly in plastic wrap and labelled (Figure 2-11B). In areas where core samples were not feasible due to a thin soil cover, grab samples were retrieved at varying depths using a trowel.

Figure 2-11 - A: Shovel being used to extract a section of peat. B: After removing the peat core from the ground, it was wrapped in plastic wrap and labelled.

2.2.3 Grab Sample Collection

Outcrop, forest, and forest outcrop grab samples were collected using a trowel and packaged into plastic Whirlpak bags. All sampling equipment was wiped clean between sample sites. Examples of grab sample sites are shown in Figure 2-12 below. Cores and grab samples were frozen for transport back to Queen's University and kept frozen prior to lab preparation.

Figure 2-12 - A: An outcrop soil pocket collected on top of the granites just west of the Giant Mine near the Bypass Road. B: Grab sample taken in an outcrop soil pocket off Ingraham Trail. C: Another grab sample retrieved off Ingraham Trail, with varying groundcover from that found in B.

2.3 Sample Preparation

Samples were prepared and subsampled for analysis at Queen's University. Prior to subsampling, the collected samples were kept frozen for transport to the university labs. Brown postal wrapping paper was used to cover the work space for each new sample. A fresh section of paper was rolled out and used for each new sample being prepared. This allowed for a clean workspace and decreased risk of contamination between samples. All sample preparation material, including knives, spatulas, plastic spoons, a measuring tape and protective gloves were cleaned or changed between each sample.

2.3.1 Sub-Sectioning Soil Samples

2.3.1.1 Soil Cores

Two incisions were made on either side of the aluminum core tubes using a table saw. The use of the table saw created aluminum fragments, which contaminated the soil samples. Fragments of aluminum core tube were observed in the soil samples, thus the analytical results for aluminum have been omitted from the data set. Aluminum contamination is discussed further in section 2.4.4 of this chapter.

The cut aluminum core tubes were placed in a refrigerator kept at 4°C to defrost. A ceramic blade was then used to slice into the soil sample and split the core in half. The blade was carefully wiped clean of soil debris each time it was removed from a section of the core, prior to being re-inserted into the core at a different depth. This process was used to prevent down-core contamination and the spread of contaminants from various horizons within the soil cores.

Once split in half, the core tube was measured, and soil compression was calculated prior to sub-sectioning the public health layer (PHL) (top 5cm) (Rencz *et al.* 2011). Compression was calculated using measurements in the field, and varying PH layers were extracted depending on the degree of compression at each of the sample sites. The difference between the soil surface and the sample surface within the tube measured in the field were used to calculate compression. The difference between the soil surface and sample surface was added to the measured core length in the lab. The core length measured in the lab was used instead of the core length calculated in the field, as some rebound occurred within the core tubes following the removal of the core from the subsurface. This new core length was used to determine the ratio between the collected core length, and the actual length of sample contained within the core tube. From this ratio, the degree of compression, and the new public health layer could then be determined using the equations outlined below:

Total Core Length (Uncompressed) = (Length of Sample in Core Tube, measured in lab) + (Difference Between the Soil Surface and Sample Surface, considering rebound effects)

Degree of Compression = [Total Core Length (Uncompressed)] / [Length of Sample in Core Tube (measured in lab)]

New Public Health Layer = 5 cm / (Degree of Compression)

Equation 2-3 Set of calculations used to determine the rate of compression in soil cores, and the representative PHL.

For the deeper forested canopy cores with silty sand, and well compacted clayey material at depth, the degree of compression within the deeper sand-dominated horizons was considered negligible, and compression was instead assumed to only have occurred in the upper organic rich layers. To calculate compression within these samples the following change was made to the above equations.

Total Core Length (Uncompressed) = (Length of Organic Rich Soil, measured in lab) + (Difference Between the Soil Surface and Sample Surface, considering rebound effects)

Equation 2-4 Calculation used to determine the representative PHL in samples with sand at depth.

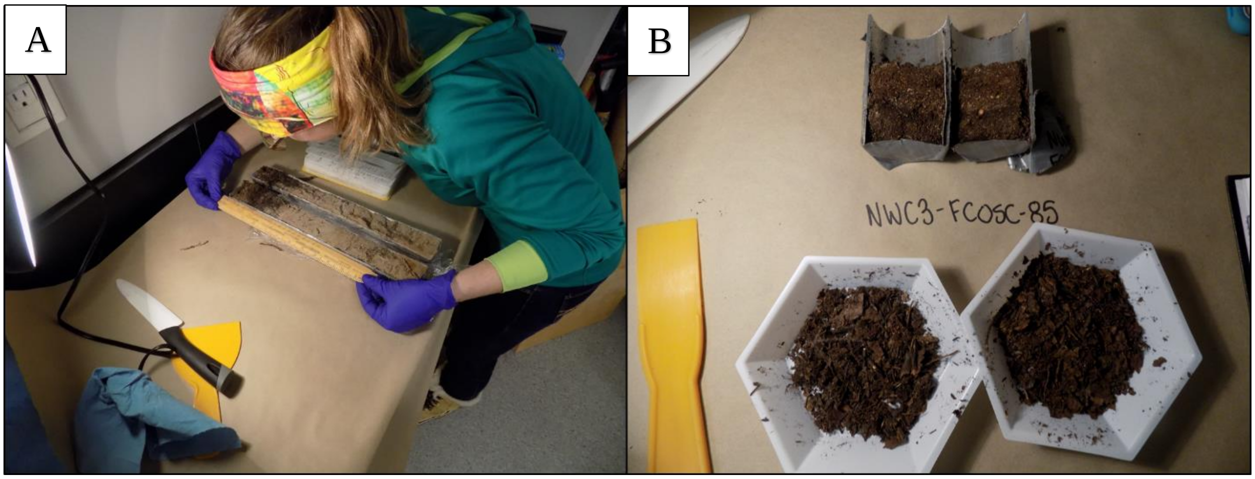

Figure 2-13 - A: Split soil core being measured prior to being sub-sectioned using a ceramic blade (shown in photo). Notes were recorded regarding the changes in soil texture, colour and composition at various depth intervals. B: Sub-sectioned public health layer (0 to 5 cm, taking compression into account) samples were transferred to plastic weight boats and homogenized before being split into Ziploc bags.

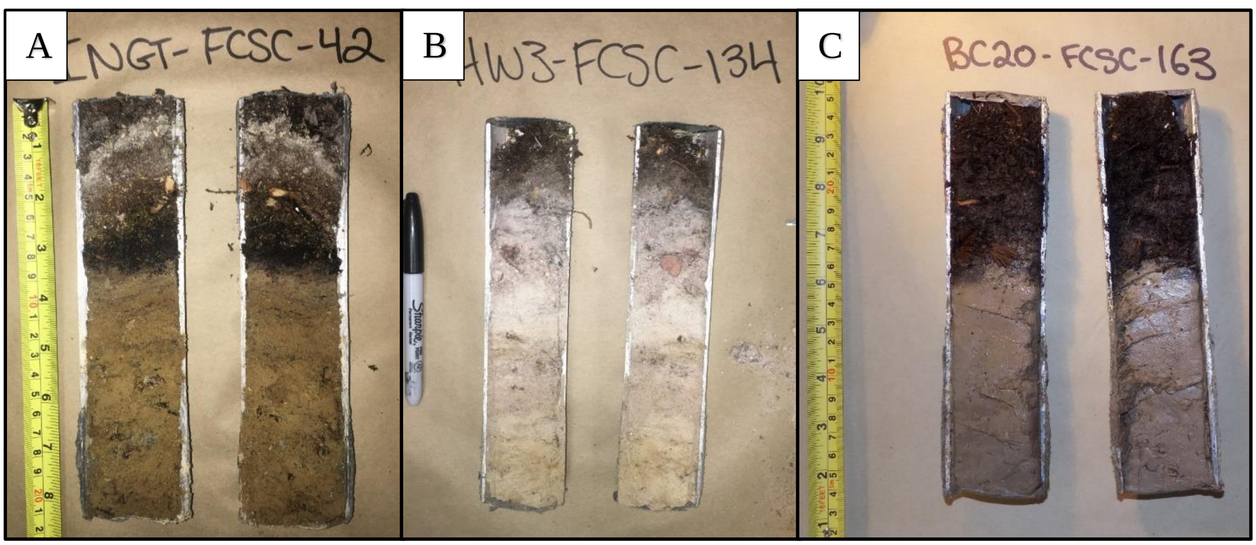

Figure 2-14 - A: Split soil core collected from Ingraham Trail. B: Split soil core collected from Highway 3. C: Split soil core collected from near lake BC20. This figure was included to illustrate the differences in soil found between various sample locations.

The correct PH layer was measured using a measuring tape. A ceramic knife was used to cut the PH layer and extract it from the top of the core tube. The PH layers were placed in plastic weigh boats and homogenized, prior to being separated into 4 subsamples. This process is illustrated in Figure 2-13, while Figure 2-14 illustrates the variability between some soil cores. Subsamples were placed in plastic Ziploc bags before being placed back in the refrigerator at 4°C. Subsamples were kept in the refrigerator until being submitted for analysis at ASU or undergoing further sample preparation.

At 37 locations, down core samples were retrieved or sub-sectioned from collected cores of sufficient length to observe changes in arsenic concentrations at depth. For cores containing compressible organic materials throughout the entirety of their length, the amount of sub sectioned down core material was equal to the compressed length calculated for the PH layer. For cores containing uncompressible, consolidated sand at depth, compression was not assumed throughout the entirety of the core, and instead a section of material 5 cm in length was removed from the base of the core.

2.3.1.2 Peat Cores

Peat samples were kept frozen prior to being sub-sectioned. This was necessary to prevent degradation of the core, and loss of depth control within the sample. When the peat began to defrost it became very difficult to work with and would easily crumble apart. By keeping the peat cores frozen, a more accurate PH layer could be separated from the sample.

A hacksaw was used to remove a 5 cm section representing the PH layer from the top of the peat cores (Figure 2-15). This section was then divided into 4 separate subsamples and placed into plastic bags prior to being analyzed. Peat sub-samples not submitted for analysis were placed back in the freezer for storage, prior to any additional sample preparation for scanning electron microscopy and automated mineralogy.

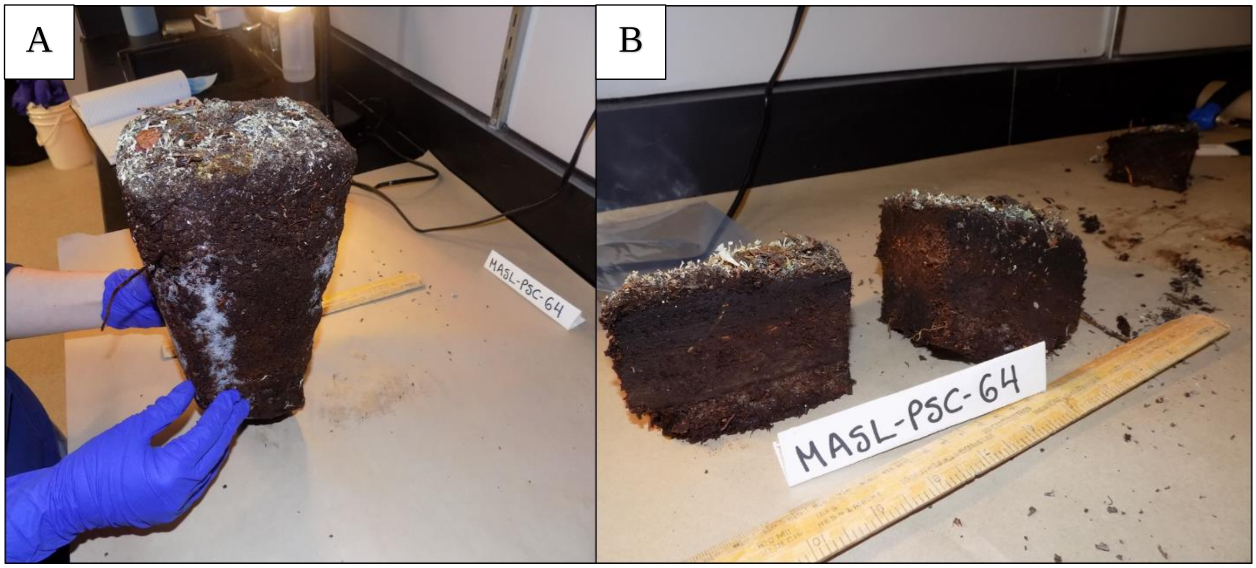

Figure 2-15 - A: Frozen peat core being prepped for sub-sectioning. B: After removing the public health layer (0 to 5cm), the sub-sectioned soil was split into smaller samples to be submitted for analysis.

2.3.1.3 Grab Samples

Grab samples were stored in Whirlpak bags and kept frozen prior to sample preparation. Grab samples with a high degree of moisture had to be placed in a refrigerator kept at 4°C to defrost such that they could be homogenized and separated into sub-samples.

The dry and defrosted grab samples were shaken, broken up, and well mixed within their Whirlpak bags before being emptied into plastic weigh boats for further subsampling (Figure 2-16). For samples with a large amount of organic materials, further homogenization (mixing) had to be completed once the grab samples were in the weigh boats. Long grasses, chunks of moss, small sticks and leaf litter were manually separated into four separate weigh boats, such that approximately equal amounts of all materials were spread between the sub-samples.

Near surface grab sample depths ranged from 3 cm to 14.5 cm. Due to the lack of depth control achieved with the grab samples, these samples are considered separately from the soil cores and public health layer results. Variations in arsenic with depth could mean that the grab samples retrieved from slightly larger depths, such as 6 or 7 cm, may have underestimated arsenic concentrations due to dilution of the public health layer by soil less impacted at depth.

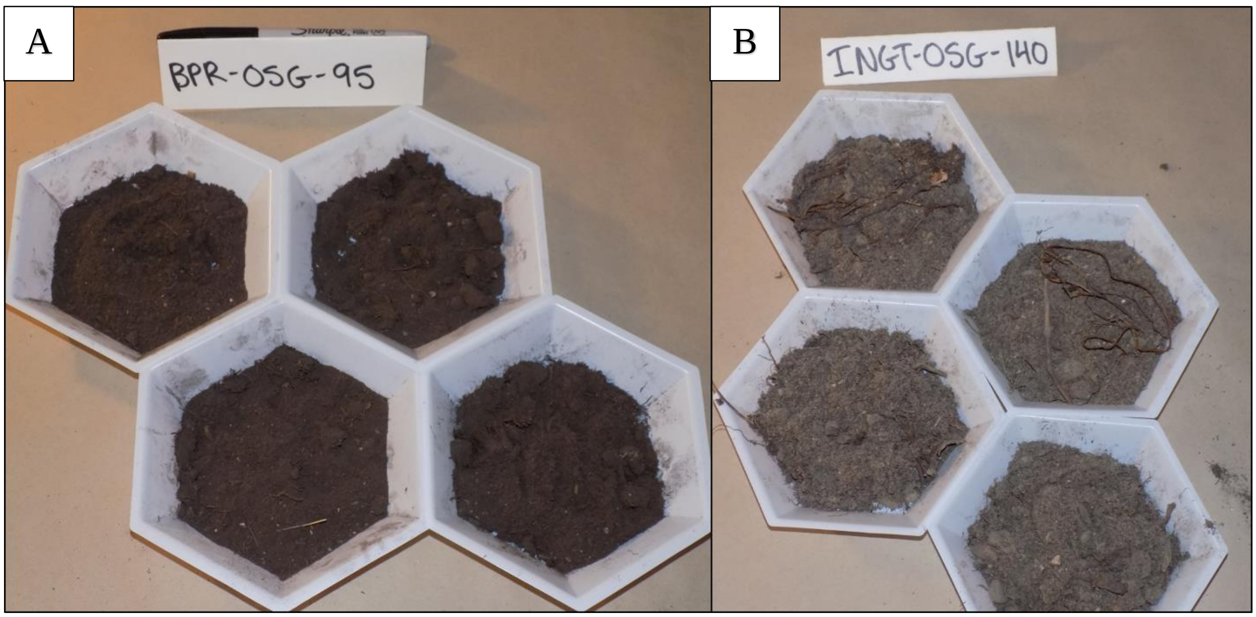

Figure 2-16 - A: Sub-sectioned grab sample collected off the Bypass Road. B: Sub-sectioned grab sample collected off Ingraham Trail. Note the variability in the texture, composition and colour between these two samples.

2.3.2 Preparation for TOC Analysis

One hundred and thirty randomly-selected samples, including parent and split samples, were prepared for total organic carbon (TOC) analysis. Selected TOC samples were emptied into plastic weigh boats and set out to dry. Dried samples were gently ground using a mortar and pestle, before being weighed and repackaged for shipment to the lab in small plastic Ziploc bags.

After each sub-sample was ground and bagged, all sample preparation equipment including the mortar, pestle, spoons, and tweezers, were thoroughly cleaned and dried before proceeding to the next sample. Protective gloves were also changed between each sample and face masks were worn to prevent exposure to arsenic-bearing dust created during the grinding process.

2.3.3 Preparation for SEM/AM

Fifty soil samples were selected to be analyzed using scanning electron microscopy (SEM) and automated mineralogy (AM). SEM samples were selected based on total arsenic concentrations (determined from total elemental results) and target areas. The goal was to select samples with both high and low arsenic concentrations throughout a range of target areas at varying distances from the point sources of contamination. A larger number of samples were selected from target areas of higher interest, such as the Bypass Road directly west of the Giant Mine property or the Dettah Road to the east of Yellowknife Bay. A larger number of samples with high total arsenic concentrations were also selected to increase the probability of positively identifying As_2O_3 particles.

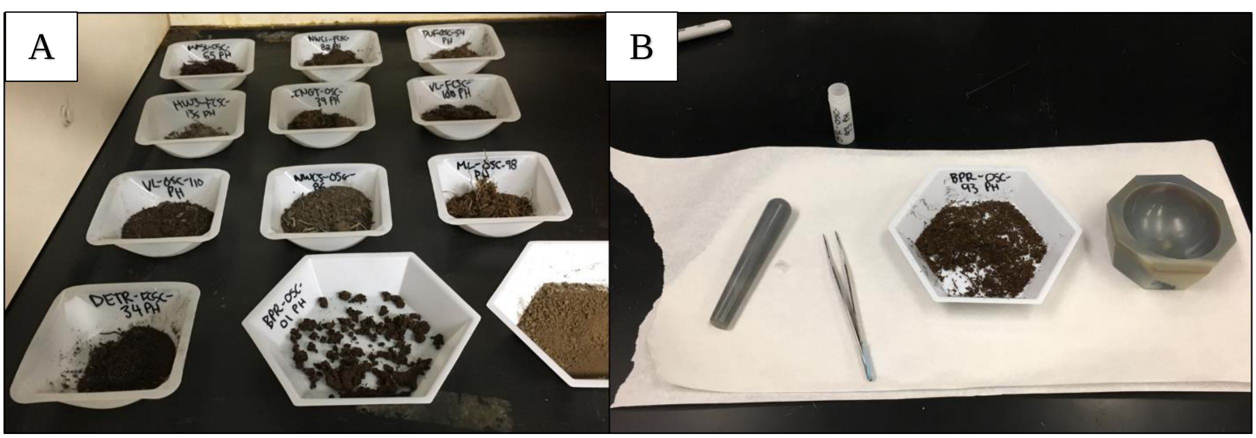

Figure 2-17 - A: Samples being left out to air-dry in a fume hood. B: A sample being gently ground in preparation for epoxy mounting.

For these samples to be properly mounted, they first had to be air-dried (in plastic weigh boats) and gently ground to break up natural clumps of soil (using a mortar and pestle) (Figure 2-17). Air drying was deemed adequate in contrast to drying the samples under nitrogen, due to the near-surface nature of the soils and their existence in a naturally oxidizing environment. Grinding was kept to a minimum to prevent the break-up of larger sized grains. This method was employed to ensure the samples were as representative as possible to the naturally occurring soil in the study area. Large particles, such as sticks, pine needles and large leaves were removed during the grinding process, as these materials are not easily mounted in epoxy.

2.3.3.1 Epoxy Mounting

Before preparing the dried and ground soil samples for epoxy mounting, the mount holders were labelled, and petroleum jelly was used to coat the bottom and sides of the holders, to allow for easy removal of the pucks after hardening. The soil samples were carefully mixed with graphite powder (< 44 microns) using a scoopula, under a fume hood, and applying a ratio of 2 scoops of sample for every one scoop of graphite. After thoroughly mixing the graphite powder into the samples, the epoxy was mixed using a ratio of 1 part epoxy hardener for every 5 parts of epoxy. A small scoop of sample and graphite mix was placed in a mixing cup, and approximately 5 g of epoxy was measured into each cup. This sample and epoxy mixture were stirred for 2 minutes before being poured into the respective mount holder. After 8 to 10 samples were prepared in the mounts, the samples were placed in a vacuum chamber and underwent 3 to 5 rounds of de-gassing before being left to harden for at least a period of 24 hours.

2.3.3.2 Polishing and Carbon Coating

The hardened epoxy mounted soil samples were removed from their holders and carefully labelled. The mounted samples were then hand ground and polished using a 4-step process. The mounts were first ground to remove large crevices and imperfections, as well as any sharp edges (to save fingers throughout the polishing process) using a grinding wheel with 220 grit sandpaper. A progressive grinding table was then used to further grind down the surface of the epoxy mounted soil (Figure 2-18B). This process had to be done meticulously to prevent grinding away too much of the mounted soil. Following the grinding stages, the epoxy mounts were polished using six-micron and one-micron polishing wheels. Six and one-micron liquid diamond solutions were applied to the respective polishing wheels along with a lubricant solution (50% glycerine, 25% ethanol, 25% water) to achieve the necessary level of polishing acceptable for use on the SEM. All 63 mounts (50 original samples, 13 duplicates) analyzed via SEM were polished by hand using this process (Figure 2-18)

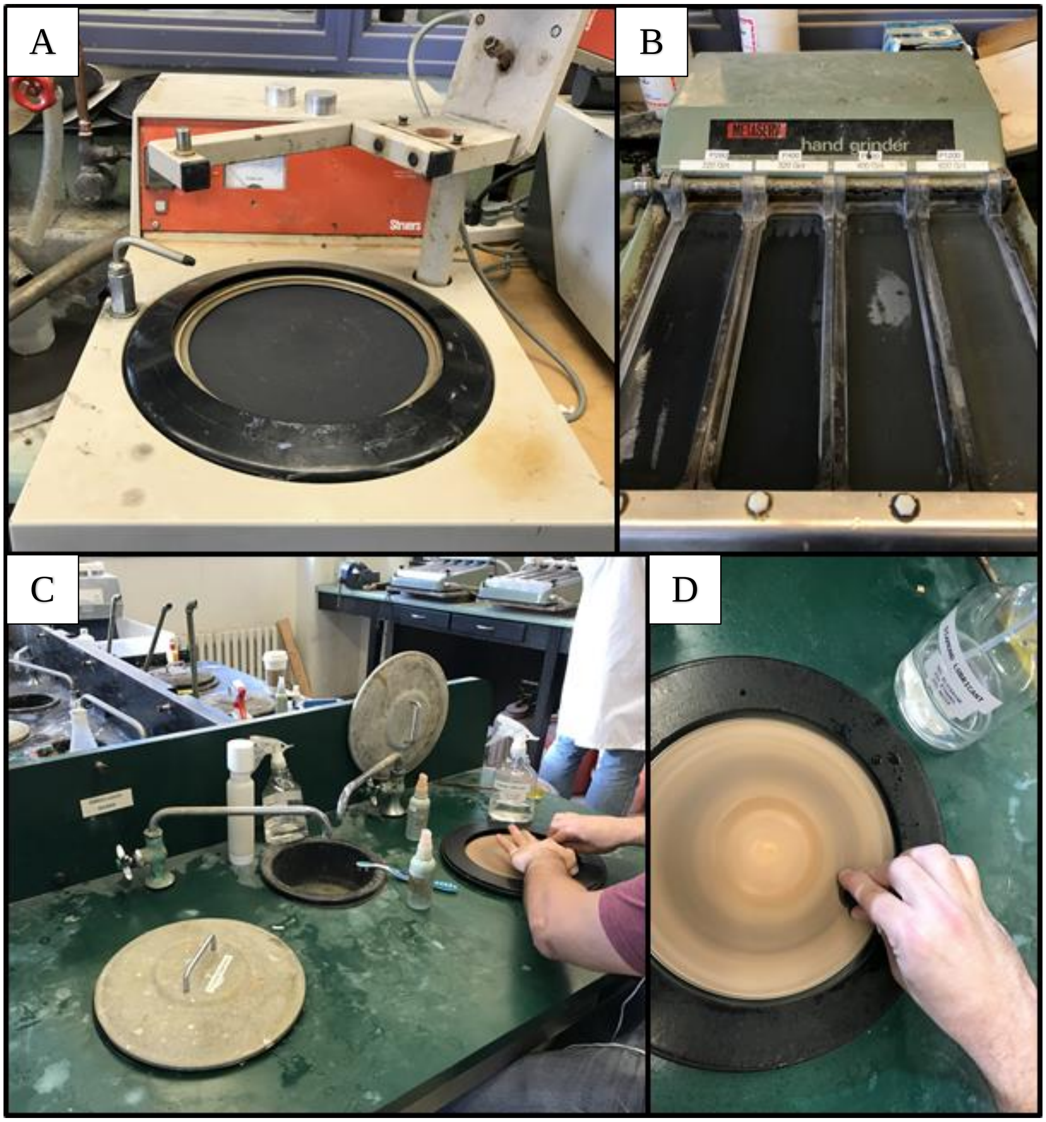

Figure 2-18 - A: Grinding wheel. B: Grinding table with 220, 320, 400 and 600 grit sand paper. C: Polishing table with the 6 micron and 1 micron polishing wheels. Diamond solutions and lubricant bottles are visible. D: 6 micron polishing wheel in work. (Credit to Jonathon Oliver for allowing his photograph to be taken while polishing his samples).

Following polishing, all epoxy mounts had to be carbon coated before they could be scanned on the SEM. This was done by placing 3 to 4 mounts in a vacuum chamber and running current though a graphite rod for 10 to 20 seconds; igniting the rod and allowing the carbon to cover the mounted soil pucks below. The equipment used to complete this procedure is shown in Figure 2-19 below.

Figure 2-19 - Carbon coating equipment - vacuum chamber with carbon coating accessory on top (right), and source of current (left).

2.4 Quality Assurance and Quality Control

Quality assurance and quality control (QAQC) methods were used to confirm accuracy, reproducibility of analytical results and sample homogeneity. Three types of QAQC samples were used to achieve this; split samples (SS), lab duplicates (LD), and certified blanks. The relative percent difference (RPD) between the original samples (parent samples) and QAQC samples were evaluated using the following calculation:

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

Equation 2-5 Relative Percent Difference (RPD) calculation used to complete the QAQC of analytical results.

RPD results between parent and QAQC samples for As values can be found in Appendix D, in addition to results for the certified reference materials and blanks.

2.4.1 Split Samples (n = 34)

Split samples were created by dividing a parent sample into multiple sub-samples and submitting a second portion of the parent sample to the laboratory using a new sample ID. These samples were used to measure sample variability, analytical errors, and accuracy of the data. Reproducibility of results for split samples was slightly higher than lab duplicates with 21% of samples (n=7) having an RPD for arsenic greater than 20%.

2.4.2 Lab Duplicates (n = 31)

Lab duplicates were one of two equivalent portions of the same sample created by the lab from a parent sample or split sample to measure for analytical errors and accuracy of the data as a means of in-house laboratory QA/QC. Reproducibility of lab duplicates was slightly lower than for split samples with 23% of samples (n=7) having an RPD greater than 20%.

2.4.3 Certified Reference Materials and Blanks

The accuracy of lab results was tested using the following certified reference materials: SS-1, SS-2-2, MESS-3 and MESS-4. SS standards were sourced from SCP Science, Quebec, while 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 had an expected result of 18 mg/kg As for MESS-3 and MESS-4 standards based on an average of results obtained for partial digestion. RPD values for As for all standard reference materials were below 20%. Blanks (n=20) were also used by ASU to test for contamination during analytical testing and all fell below the analytical detection limits for the tested parameters. Tables outlining certified reference material and blank results can be found in Appendix D.

2.4.4 Aluminum Core Tube Potential Contamination

Contamination from the aluminum core tubes was identified when aluminum fragments (produced from cutting the tubes) were visible within some sub-sectioned soil core samples. Large aluminum fragments were removed by hand before samples were submitted to ASU for total elemental analysis, however a potential for contamination remained. Aluminum results were removed from the total elemental results table in Appendix B due to this potential for contamination. Appendix D Table D-7 displays the results for three aluminum core samples. Oliver (2018) used the same data in Table D-7 to determine the influence of contamination for various metals on YK area soil samples analyzed at ASU. Aluminum concentrations were the most elevated, and identified as the most likely to potentially affect total aluminum concentrations (Oliver 2018). Magnesium, iron, and copper concentrations in the aluminum tube fragments were also slightly elevated compared to other parameters, however these total metal concentrations in YK area soil samples were not as affected (Oliver 2018, Table F-1).

2.5 Analytical Methods

A portion of each sub-sectioned core and grab sample were submitted for near-total elemental analysis at the Analytical Services Unit (ASU) at Queen's University. The soil samples were neither sieved nor ground prior to analysis. This was done with the intention that the submitted samples would represent the surface material as it might be encountered in the field. Sieving is usually completed to compare results to guidelines or other data sets (Parsons and Little 2015), but previous work (Bromstad *et al.* 2017) had indicated that arsenic trioxide may be present in a range of grain sizes and it was a priority in this study to capture this solid phase. Some samples (n=19) were sieved to less than 2 mm to compare the differences in As concentrations between the less than 2 mm size fraction and parent sample at a handful of sample locations. These results are discussed in Chapter 3 of this report, and can be found in Table J in Appendix J.

2.5.1 Elemental Analysis

A total of 207 parent samples (46 surface grabs, 6 down core (DC) grabs, 122 PHL samples from cores, and 33 DC core samples) were submitted for near-total element analysis. Results for another 34 split samples, 31 lab duplicates, and 21 sieved samples[4] (19 parent (13 cores, 6 grabs) and 2 lab duplicates) were also obtained. Samples were digested for 300 minutes and at 90°C using an aqua regia solution containing a 3:1 volume ratio of hydrochloric and nitric acid. Most elements were analyzed using inductively coupled plasma – optical emissions spectrometry (ICP-OES). Inductively coupled plasma - mass spectrometry (ICP-MS) was used to

[4] Sieved samples were created by collecting the < 2mm sieved fraction from a selection of parent samples to separately analyze the fine fraction.

determine gold concentrations, and for Sb at concentrations less than 10 mg/kg. The digestion procedure for gold used a rinse composed of hydrochloric acid and cysteine rinse, with a standard stabilization method. This method was developed by ASU based on stabilization methods provided in Wang and Brindle (2014) and Wang *et al.* (2014). Gold was analyzed via ICP-MS prior to the other elements via ICP-OES. The cysteine rinse adds some sulphur (S) to the digested samples and blank, thus S results had to be blank subtracted; the average value for the S in the blanks were subtracted from the sample results. Three separate runs were completed for each sample.

2.5.2 Total Organic Carbon

A random selection of 130 samples (including split samples (n=15)) were air-dried and ground before being analyzed for total organic carbon content using the LECO SC444 method. This method calculates organic carbon by subtracting inorganic carbon (determined by ashing the samples at 475 °C) from the total carbon result. Carbon percentages are determined through the combustion and oxidation of carbon to form carbon dioxide. This is achieved by burning the sample at 1350 °C in a stream of purified oxygen. The amount of evolved carbon dioxide is measured using infrared detection and used to calculate the percentages of carbon in each sample (Nelson and Sommers 1982).

2.5.3 Statistical Analyses

All statistical analyses were performed in Minitab 17 and Excel 2016. A Kruskal-Wallis test and Dunn's post hoc analysis was performed to compare arsenic concentrations between terrain units. Regression analyses were used to investigate the relationship between arsenic concentration and the primary factors considered to have a potential impact on its distribution throughout the study area - distance and direction from the Giant Mine roaster, elevation, and

TOC. The relationship between arsenic and other elements or metals of interest were also investigated using regression analyses. All tests were performed at a 95% confidence interval.

2.5.3 Scanning Electron Microscopy coupled with Automated Mineralogy

50 samples were chosen for characterization by SEM/AM to identify arsenic-hosting minerals, determine their morphology, and calculate the distribution of arsenic amongst solid phases. Thirteen duplicate samples (split samples created for SEM analysis) were also run on the SEM, making for a total of 63 SEM/AM scanned epoxy soil mounts. The SEM used a voltage of 25kV, a spot size of 6µm, 300x magnification, a working distance between 11mm and 14mm, and standardized all samples to copper. All measurements were collected using 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. A total of 14 samples could be run on the SEM at a time, and each sample took anywhere between 2 and 6 hours to scan depending on the grain density in the epoxy mounts. Six separate SEM runs were completed to scan all the samples for this study.

Table E-1 in Appendix E outlines the settings that were used for each of those separate scans. Settings varied slightly between SEM runs due to the nature of the equipment, quality of the polished epoxy mounts, and degree of carbon coating on each of the samples; the brightness, contrast, working distance, and grey level settings had to be optimized for each SEM run.

Upon completing the SEM scans, AM was applied to each of the samples using Mineral Liberation Analysis (MLA) software. Every mineral has a unique associated EDS spectrum, which can be used to identify the mineral phases contained within a sample. The MLA software contains a manually created mineral library where the EDS spectra for various mineral phases are stored. Pre-existing knowledge of the anticipated mineral phases in the sample media was necessary to decrease the number of unknown mineral phases identified in the samples. AM is an iterative process; mineral phases were added and removed from the mineral reference library, scanned SEM samples were re-classified using the edited libraries, and results were compared between re-classifications. The primary objective of this process was to ensure mineral phases were being correctly identified based on the EDS spectra included for each phase, and to decrease the number of unknown mineral phases contained within the sample. Examples of scanned SEM grains and their associated EDS spectrums can be found in Appendix H. It is important to note that despite having the ability to characterize a large volume of grains at a relatively fast rate, SEM/AM does have its restrictions when it comes to accuracy in classifying mineral grains. Depending on the orientation of grains within the mounted epoxy, some EDS spectra collected could be representative of multiple mineral phases (ie. combined spectra due to overlapping grains of different minerals). Therefore, it was important to cross-reference the EDS spectra used to create the mineral reference library with EDS spectrum collected manually using the SEM.

Chapter Three: Results and Discussion

3.0 Chapter Overview

Chapter 3 presents the results obtained from total elemental analysis, scanning electron microscopy (SEM) and automated mineralogy (AM). The chapter has been divided into sections, with the first outlining total As results in the Public Health Layer (PHL), grab and down core (DC) samples. The second section reviews various factors that potentially affect the distribution of arsenic throughout the study area; the relationship between total As, distance, direction, terrain type, elevation, and grain size are presented. A third section compares bulk geochemistry results for total As and other total elemental concentrations. Following this section, SEM/AM results are reported for a selection of PHL samples. A fifth section examines the changes in total As concentrations and As species in down core samples. The chapter is concluded with a discussion of the results from these five sections, including a brief comparison between this research and previous studies completed around the Yellowknife area.

3.1 Arsenic Bulk Geochemistry Results

Total As concentrations in PHL soils are displayed in Figure 3-20. Concentrations were divided into five groupings – those lower than the residential remediation guideline of 160 mg/kg, between the residential and industrial remediation guideline of 340 mg/kg, and three other designations at increments exceeding these guidelines (GNWT, 2003). The highest arsenic concentrations found in PHL soils were discovered just west of the Bypass Road to the west, proximal to the Giant Mine property.

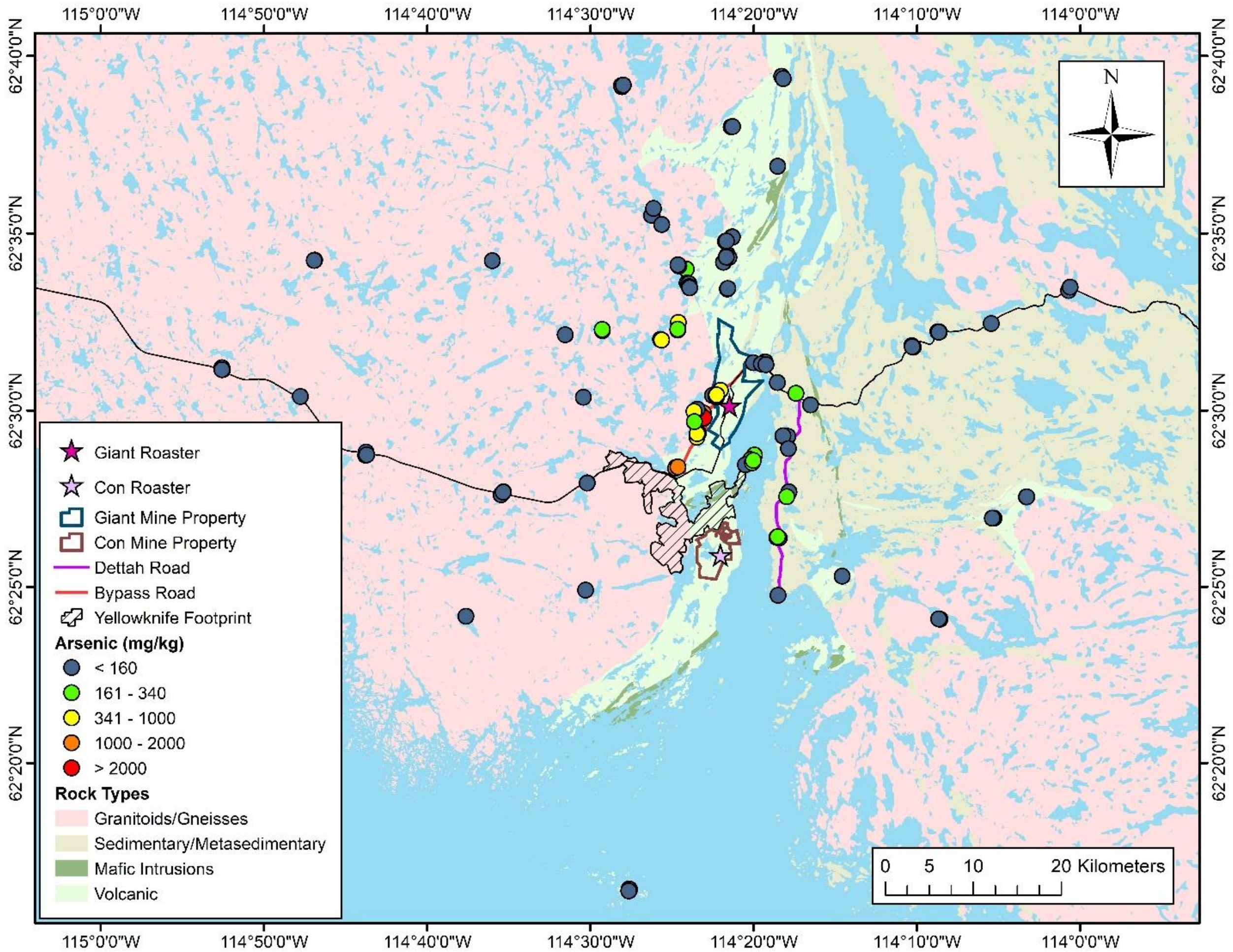

Figure 3-20 Arsenic concentrations in the Public Health layer (PHL) of soil core samples from this study. Additional samples taken by Jon Oliver in 2016 and 2017 are combined with these for the GNWT Open File Report 2017-03 (Jamieson et al. 2017)

Table 3-2 below summarizes the PHL data for various target areas. These designated areas are outlined in Section 2.1.2 of Chapter 2 and were also used in summarizing data presented in the NWT Open File 2017-03 report. The highest arsenic concentrations were found off the Bypass Road ranging from 53 to 3400 mg/kg, with a median of 550 mg/kg. The next highest maximum As concentration for a given target area was collected along the shores of Martin Lake (820 mg/kg). In Ndilǫ, As concentrations ranged from 130 to 280 mg/kg, with four of the five samples collected in this area exceeding the GNWT residential remediation guideline of 160 mg/kg total As. Along the Dettah Road As values ranged from 15 to 270 mg/kg, with a median of 75 mg/kg. For all collected PHL samples, 73% (91 / 125) of samples had concentrations lower than the residential remediation guideline, and 86% (107 / 125) of samples fell below the industrial remediation guideline. Eighteen of the 125 PHL samples had values exceeding the recommended industrial remediation guideline. All site-specific guidelines for the Yellowknife area are much greater than the CCME soil quality guideline of 12 mg/kg arsenic which does not specify residential or industrial regions.

Table 3-2 Total As ranges, means and medians for the target areas covered during the summer of 2015 field season.

Target Area	Bypass Road	Dettah Road	Ndilǫ	Highway 3	Ingraham Trail	TerraX Northbelt	Mirage Islands	Martin Lake Area	North of Giant Mine	SE and E of Yellowknife	> 15 km NW and SW of Yellowknife
Minimum	53	15	130	1.5	4	6	3	6	5	15	8
Maximum	3400	270	280	94	220	200	8	820	65	92	99
Mean	852	104	196	29	44	70	5	229	33	43	40
Median	550	75	180	22	29	60	4	160	29	21	30

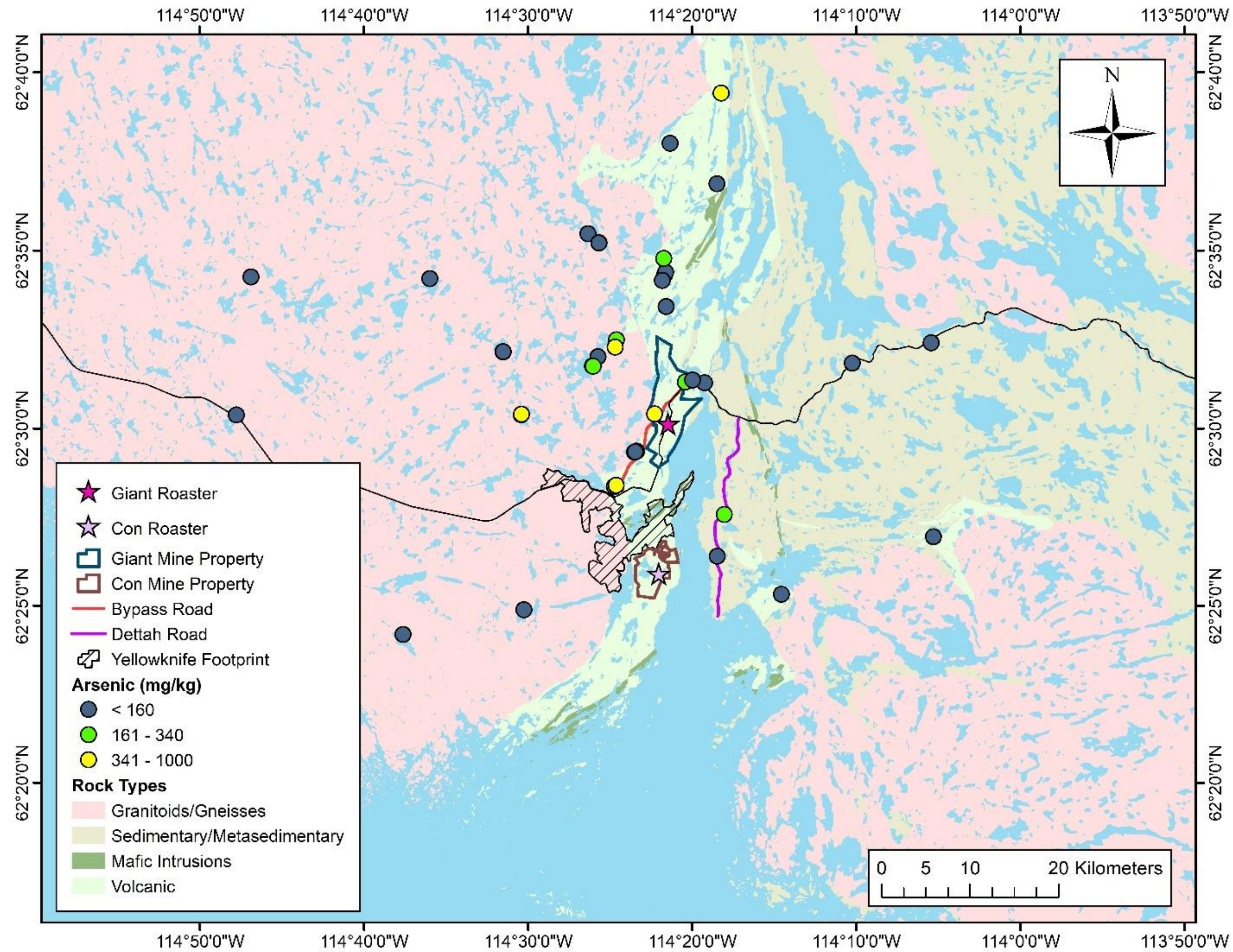

Figure 3-21 Arsenic concentrations in grab samples collected throughout the study area.

Figure 3-21 illustrates the distribution of total arsenic for the collected grab samples. For these samples the influence on contamination from airborne roaster stack emissions is less obvious. Concentrations in grabs did not reach the same maximum values as those found in some core samples (maximum grab = 930 mg/kg, maximum core = 3400 mg/kg). This could be due to the lack of depth control when collecting grab samples; higher As concentrations in the upper few centimeters could be diluted by lower arsenic concentrations in the centimeters beneath. Bromstad *et al.* (2015) indicated that As concentrations decrease with increasing depth, with dramatic decreases seen in soils at depths greater than 30cm. Total depths for grab samples ranged from 3 to 14.5 cm; in some areas thick moss cover increased the total depth of samples.

Grab sample values ranged from 12 to 930 mg/kg total As, with a median of 110 mg/kg. Of the 43 grab samples collected, 67% (29 / 43) were below the recommended residential remediation guideline, and 84% (36 / 43) fell below the industrial remediation guideline. Four of the seven grab samples with total As concentrations above this guideline were collected off the Bypass Road with values ranging from 590 to 930 mg/kg. The other three samples exceeding the industrial remediation guideline were from the Martin Lake Area (390 and 620 mg/kg), and North of Giant Mine (450 mg/kg).

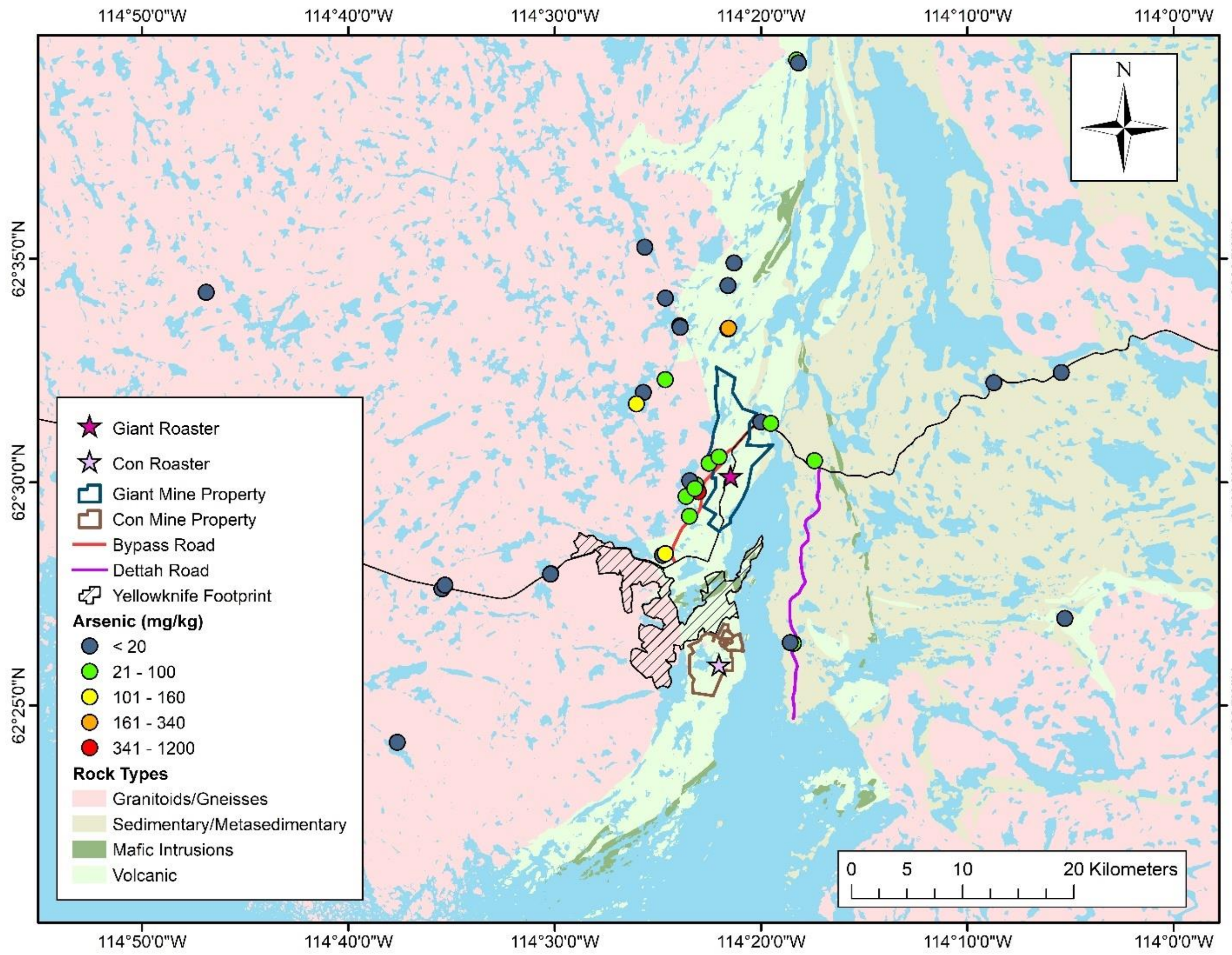

Figure 3-22 Arsenic concentrations in down core (DC) samples.

Figure 3-22 shows that arsenic concentrations in soils at depth were lower than those found in near surface samples. It should be noted that the increments used for displaying total As results in this figure vary from those used to represent PHL and grab samples. A lower boundary of less than 20 mg/kg total As was used to reflect the average background values (10 to 30 mg/kg) for regional till overlying mineralized rock types (volcanics), according to Kerr (2006). Two additional incremental designations were used to illustrate DC samples that fell below the residential remediation guideline, while the upper boundary limits highlight those samples falling between residential and industrial remediation guidelines, and those exceeding the industrial guideline for total As in soil.

DC samples ranged from 1.6 to 1200 mg/kg total As, with a median of 18 mg/kg. 92.3% (34 / 39) of DC samples had total As values less than 160 mg/kg. Two of the highest DC As values were found in peat sample BPR-PSC-161, which also had the highest PHL As concentration reported for the entire sample set. In this sample As concentrations decreased from 3400 mg/kg in the upper 5 cm, to 240 mg/kg at a depth of 17.5 to 22.5 cm, before increasing again at a greater depth of 33.5 to 38.5 cm. The material taken from the greatest depth at this sample site was collected directly above an inferred permafrost boundary (hard frozen ground, refusal reached). This was the only peat sample collected above this type of boundary, thus no concrete conclusions can be made about the downward transport and behavior of As at permafrost boundaries.

3.2 Factors Affecting Total Arsenic Concentrations

Near roaster stacks patterns of anthropogenic contamination from atmospheric deposition can depend on the nature of the emitting source, size and density of the emitted particles, as well as wind direction and strength. The spatial distribution of airborne contaminants in surface soils typically forms an irregular ellipse with the long axis extending in the direction of prevailing winds, and with most metal deposition occurring within 15 to 20 km of the point source (McMartin *et al.*, 2002). Contaminant concentrations decrease with increasing distance until background values are reached typically less than 100 km from the point source (McMartin *et al.*, 2002). The extent of the impact of stack emissions from the ore roasters at Giant has not been determined. One investigation suggested the effects of mining at Giant may be seen greater than 100 km away with spikes in total As concentrations in lake sediments dating back to the 1950s with the onset of roasting at Giant Mine (MacDonald *et al.* 2016). No mineralogical evidence is available to test whether the As in these sediments was of anthropogenic origin, and the possibility of diagenesis leading to As peaks in sediment profiles (Schuh et al. 2018) was not considered.

In this study, total As values were compared against multiple factors to determine how each parameter might influence the distribution of As throughout the study region. In addition to distance, other parameters such as direction from the contaminant source, elevation, terrain type, and the influence of arsenic trioxide grain size were also investigated to determine their role on As distribution around Yellowknife.

3.2.1 Distance from the Giant Mine Roaster

Figure 3-23 shows the inverse relationship that exists between arsenic concentrations and distance from the former Giant Mine Roaster; arsenic concentrations decrease with increasing distance from the roaster. This relationship was also observed in previous studies undertaken throughout the Yellowknife area including work that focused on soils (Hocking *et al.* 1978; Hutchinson *et al.* 1982; Kerr 2006; St. Onge 2007; Bromstad *et al.* 2017), lake waters (Palmer *et* *al.* 2015; Houben *et al.* 2016), and lake sediments (Galloway *et al.* 2015). The previous work completed by Palmer and Galloway in 2015 encouraged this regional geochemical soil survey. Palmer and Galloway estimated that the area of influence from past roasting activities reached distances of 17.5 to 20 km from the contaminant source, as per elevated As concentrations found in lake waters and sediments; because of these studies, soils were obtained within a 30 km radius from Yellowknife and Giant Mine. Additional soil sample data collected by Oliver (2018) was combined with the samples presented in this thesis. Results from this combined regional data set can be found in the NWT Open File 2017-03 (Jamieson *et al.* 2017) and confirmed this same inverse relationship between total As concentrations and distance.

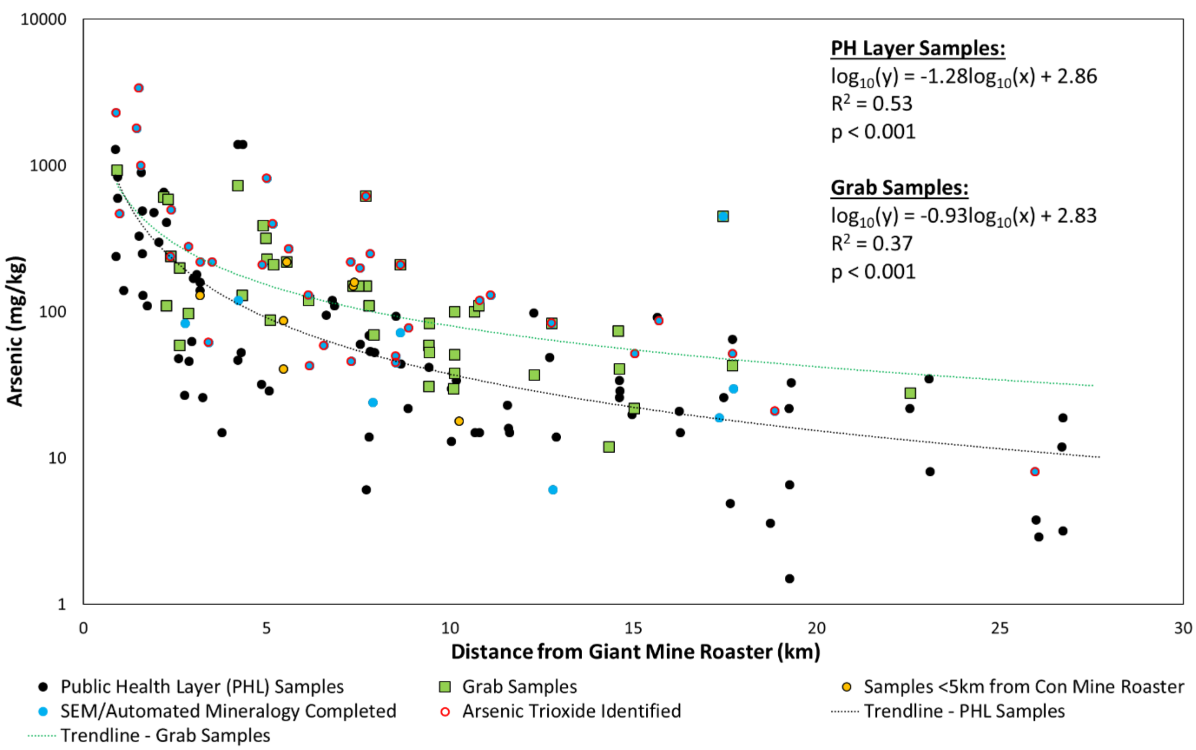

Figure 3-23 Arsenic concentrations in mg/kg versus distance from the former Giant Mine Roaster. Public Health Layer and grab samples were plotted with separate trendlines. Statistical analyses were also completed separately for both sample types; both summaries are reported in the figure. Samples which were analyzed via SEM and automated mineralogy are plotted in blue. A red outline was used to illustrate in which samples arsenic trioxide was identified. Samples collected less than 5 km from the Con Mine Roaster are highlighted.

Table 3-3 Maximum, minimum, median and average total As concentrations in PHL samples for varying ranges of distance from the Giant Mine Roaster.

Distance from Giant Mine Roaster	**0 to 10 km**	**10 to 20 km**	**20 to 30 km**
Maximum (mg/kg)	3400	170	35
Minimum (mg/kg)	6.1	1.5	2.6
Median (mg/kg)	130	22.5	8.1
Average (mg/kg)	394	35	11

At distances of 25 km, both trendlines for grab and PHL samples begin to flatten out, indicating that they may be approaching background levels, however a clear plateau is not reached. This suggests that soil was not collected at distances far enough away from the contaminant sources to adequately determine background values. At distances between 20 to 30 km, arsenic concentrations in PHL samples ranged from 2.6 to 35 mg/kg with a median of 8.1 mg/kg (n = 9) (Table 3-3). When additional soil samples collected by Jonathon Oliver in 2016 and 2017 were included in this analysis total As values in soils at distances of 20 to 30 km ranged from 1 to 63 mg/kg with a median of 40 mg/kg (n = 25) (Jamieson *et al.* 2017). These concentrations were similar to other findings by Hocking *et al.* (1978), Hutchinson *et al.* (1982), Kerr (2006), and St. Onge (2007), who estimated background values of 25 mg/kg, 0 to 50 mg/kg, 5 to 30 mg/kg (unmineralized bedrock), and 13 to 65 mg/kg. The range of values for the most distal and presumably undisturbed samples presented in this report are significantly lower than the 150 mg/kg total As background value reported in previous studies by Risklogic (2002) and the GNWT (2003).

PHL and grab samples were plotted in Figure 3-23, and both trendlines were calculated. The relationship between total As concentration and distance was stronger in the PHL samples (R^2 = 0.53) than the relationship found for grab samples (R^2=0.37). Grab samples do not provide accurate results relating to the depth of the sample (difficult to control precise depth of sample when obtaining grabs), and as a result there is the possibility of overestimating (if less than the top 5 cm were collected) or underestimating (if more than the top 5 cm collected) estimating As concentrations at grab sample locations. The trendline for grab samples predicts higher concentrations of total As at further distances than the trendline calculated for the PHL samples. This increase could be due to an anomalously high total As value (450 mg/kg) found in sample HOML-OSG-57, which was obtained north of the Giant Mine property near Homer Lake. The R^2 value calculated for the PHL samples (n = 125, R^2 = 0.53) was slightly higher (difference of 0.04) than the R^2 value obtained for a similar analysis reported in the NWT Open File 2017-03 report (R^2 = 0.49), which was completed with an additional 311 PHL sample results (n = 436). The arsenic versus distance figure created for the Open File report had more spread in the total As concentrations at distances greater than 20 km, which could explain this decrease in correlation despite the addition of more data (Jamieson *et al.* 2017).

Ten samples were collected within 5 km of the Con Mine Roaster and are highlighted in Figure 3-23. Nine of these samples were obtained along the Dettah Road, with the other collected in Ndilǫ. These samples plot on either side of the trendlines, making it difficult to determine a direct influence from the Con Mine Roaster. In the NWT Open File 2017-03 report, more samples collected closer to the Con Mine property were plotted. Their position above the trendline did suggest that there could be a direct influence from roasting at Con on soils in those areas, however due to a lack of samples collected for this sample set, no direct conclusions can be made.

The data plotted in Figure 3-23 shows considerable scatter around the trendlines. This suggests that other factors such as direction, terrain type, and elevation could play an important role in the distribution of arsenic in soils collected throughout the study area.

3.2.2 Direction from the Giant Mine Roaster

The influence of direction was explored, as previous studies in the region completed by Hocking *et al.* (1982), St. Onge (2006), Palmer *et al.* (2015) and Bromstad *et al.* (2017) indicated that high As areas existed at sites downwind (West) from the former roasting site. PHL samples were divided into groups based on their direction from the Giant Mine roaster. East samples were between 45 and 135 degrees, South samples fell between 135 and 225 degrees, West samples ranged from 225 to 315 degrees, and those to the North were contained between 315 and 45 degrees. As previously reviewed in Chapter 1, the predominant wind direction in the area blows from the east and northeast. After the snowmelt each year, usually in the month of May, there is a period during which an increased frequency of high-velocity wind events (>6.0 m/s) occurs from north-to-south. These north-northwesterly winds generate large plumes of dust from the exposed tailings, which affect the YKDFN community of Ndilǫ and City of Yellowknife located south of the Giant Mine property (Bailey 2017, Fred Sangris personal communication 2015). The effect of these wind patterns are reflected in the 2015 PHL sample results, with the highest medians for total As occurring to the West (median = 110) and South (median = 99). Samples south of the Giant Mine roaster may also experience a greater influence from former Con Mine roasting activities.

Figure 3-24 demonstrates the influence of direction on arsenic concentrations versus distance from the former roaster. PHL samples collected to the west of the roaster (downwind), had the highest correlation (R^2 = 0.67) between As concentration and distance. This implies that predominant winds had a significant role in distributing the airborne As-containing emissions around the source of contamination. PHL samples collected to the south had the next highest correlation (R^2 = 0.60) between As and distance, which could relate back to the south-blowing winds that produce a large dust cloud and occur during the late spring each year (Bailey, 2017). PHL samples collected to the North in the 2015 dataset, had the lowest correlation (R^2 = 0.23), and the highest projected background concentration with the North trendline plateauing at roughly 20 mg/kg As. This poor relationship and higher projected background concentration could be due to a lack of samples collected in the North at distances greater than approximately 17.5 km from the Giant roaster.

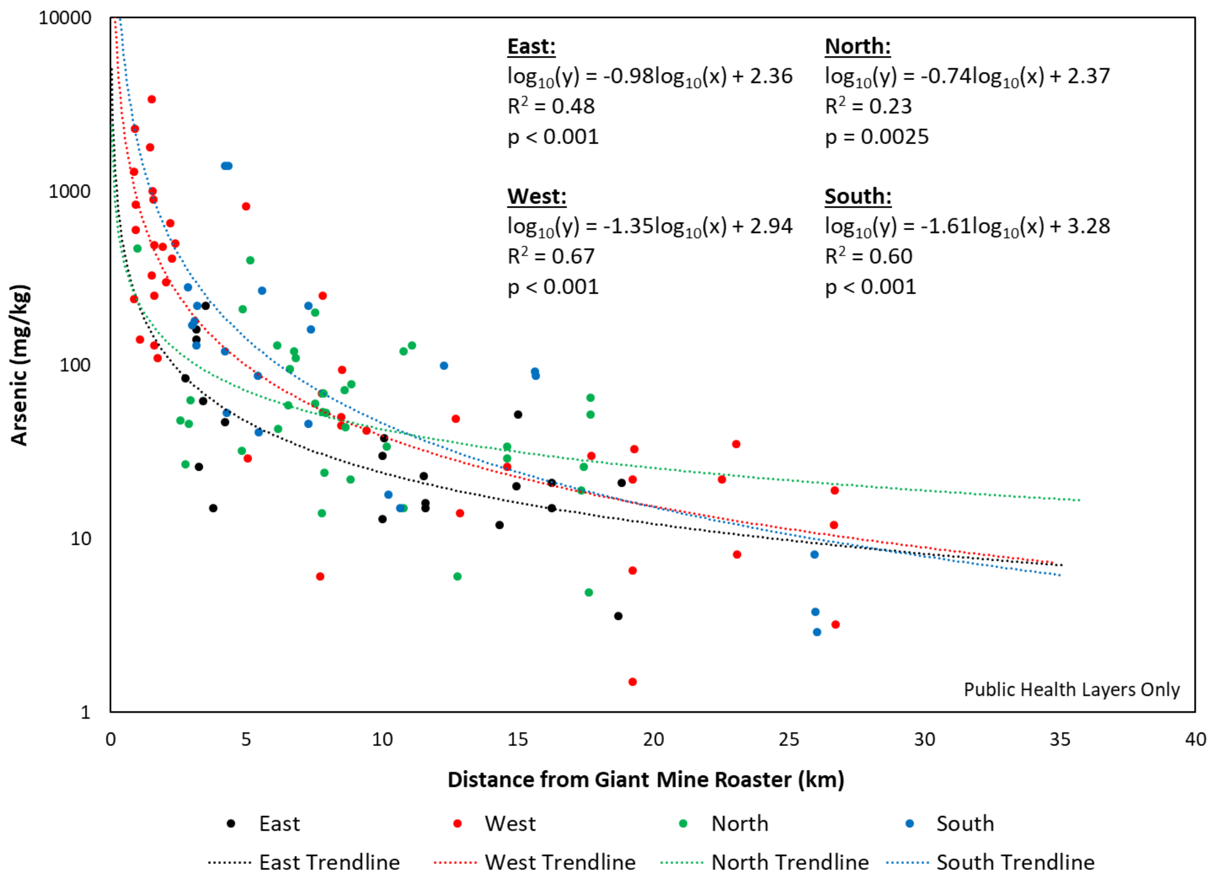

Figure 3-24 Total As concentrations plotted to illustrate the influence of both distance and direction from the former Giant Mine Roaster. Direction classifications were centered around the former Giant Mine roaster as East (45° to 135°), South (135° to 225°), West (225° to 315°), and North (315° to 45°). The coloured symbols represent the arsenic concentrations in PHL samples, and the coloured lines correspond to the trends in As concentration with distance within samples in each of the cardinal directions.

These results vary slightly from those obtained using the combined data set published in NWT Open File 2013-03 report (2017). When more samples were included in the analysis the correlation between As and distance in the west direction increased to an R^2 adjusted value of 0.70 ($p < 0.001$, n = 137), however the correlation with samples collected in the south decreased to an R^2 adjusted value of 0.37 ($p < 0.001$, n = 149). Another significant difference between the 2015 and combined dataset used in the open file report was the difference in correlations for both the North and East PHL samples. When more samples were included in the analysis, the North direction had the third best correlation with an R^2 adjusted value of 0.34 ($p < 0.001$, n = 108), and the East had the worst correlation for total As versus distance with an R^2 adjusted of 0.21 (p

= 0.0012, n = 42). The large difference in the number of samples collected to the East, in comparison to the other three directions may have influenced this weak correlation.

Figure 3-25 below summarizes the range in As concentrations for the four cardinal directions around the Giant roaster. Arsenic values were highest to the West, descended in the South and North, and were lowest occurring to the East of the mine property. A Kruskal-Wallis test with post-hoc comparisons were completed for PHL samples divided into the directional classifications. Groups which showed statistically significant differences were the East and West ($p = 0.0015$), and East and South ($p = 0.0079$). No statistically significant differences were found to exist between the other directions.

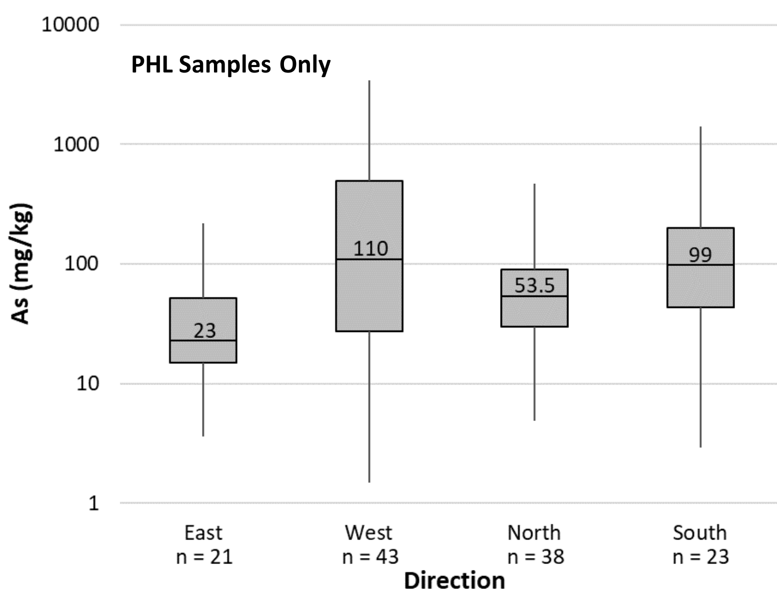

Figure 3-25 Boxplot showing the distribution of data within the four directional categories. Direction classifications were centered around the former Giant Mine roaster as East (45º to 135º), South (135º to 225º), West (225º to 315º), and North (315º to 45º). Median concentrations were 23 mg/kg total As in the East, 110 mg/kg in the West, 53.5 mg/kg in the North and 99 mg/kg total As in the South.

3.2.3 Influence of Terrain Type

Another factor considered during the study was how varying terrain types may influence the distribution of As. Four primary terrain types were sampled; forest outcrop (FCOSC), forest (FCSC), outcrop (OSC) and peat (PSC); descriptions for these terrain types can be found in Chapter 2, Section 3.1.1. Figure 3-26 summarizes the distribution of data between these terrain units in the PHL samples collected throughout the study area (n = 125).

In forest PHL samples total As concentrations ranged from 1.5 to 500 mg/kg, with a median of 34 mg/kg. 83% (34 of 41) of forest samples fell below the residential remediation guideline (160 mg/kg), and 15% (6 of 41) fell between the residential and industrial remediation guideline. Only one sample collected off the Bypass Road (BPR-FCSC-14) exceeded the industrial guideline with a total As concentration of 500 mg/kg.

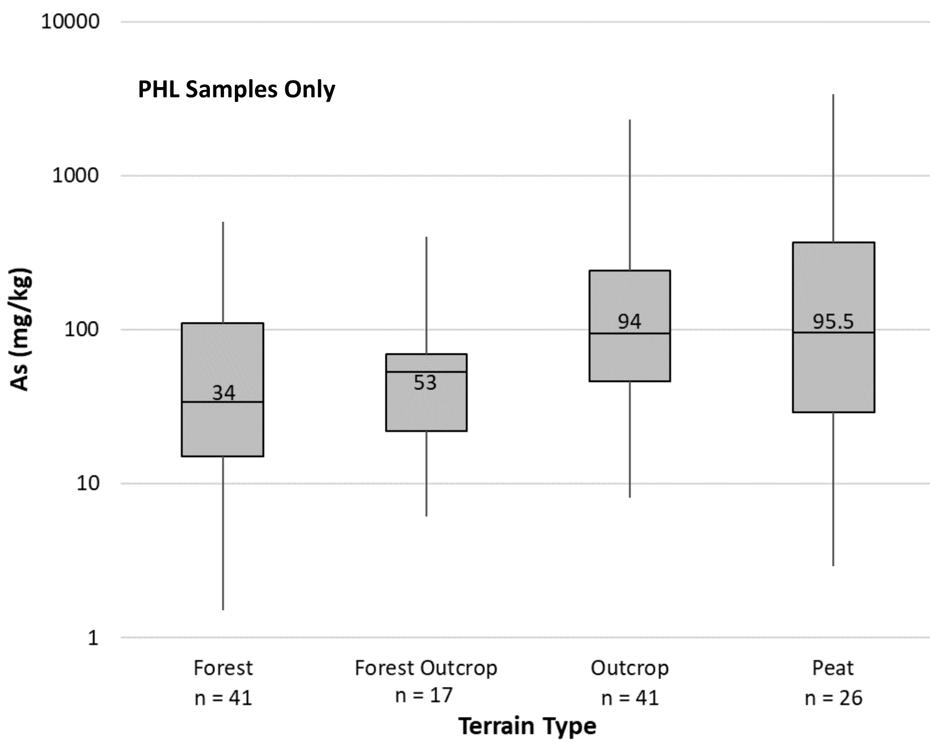

Figure 3-26 Boxplot showing the distribution of arsenic concentrations found within each of the four primary terrain types; Forest (FCSC), Forest Outcrop (FCOSC), Outcrop (OSC), and Peat (PSC). The median value for forest samples was the lowest at 34 mg/kg total As. Forest outcrop had the second lowest median total As concentration at 53 mg/kg. Outcrop and peat samples had significantly higher total As median values at 94 mg/kg and 95.5 mg/kg respectively.

In forest outcrop PHL samples total As ranged from 6.1 to 400 mg/kg, with a median of 53 mg/kg. In these samples 94% (16 of 17) fell at or below the residential remediation guideline, with only one sample exceeding both residential and industrial remediation guidelines at 400 mg/kg. This sample (ML-FCOSC-97) was collected in the Martin Lake area and selected for additional analysis via SEM/AM, results for which will be provided in Section 3.4.2 of this chapter.

Outcrop PHL samples ranged from 8.1 to 2300 mg/kg total As, with a median of 94 mg/kg. The lowest concentrations (≤ 30 mg/kg) in outcrop samples were found on the Mirage Islands, out Ingraham Trail, to the east of the mine properties, and further out Highway 3 to the west. 61% of all outcrop samples (25 of 41) had total As concentrations below the residential remediation guideline, and 17% of sample between the residential and industrial guidelines (7 of 41). 22% of outcrop samples (9 of 41) exceeded the industrial remediation guideline of 340 mg/kg total As. Except for one outcrop sample collected in the Martin Lake area (ML-OSC-103), all samples exceeding this guideline were collected off the Bypass Road directly west of the former Giant Mine roaster.

Peat PHL samples had the largest range in total As concentrations from 2.9 to 3400 mg/kg, with a median of 95.5 mg/kg. 69% (18 of 26) of peat samples fell below the residential remediation guideline, with only one sample falling between the residential and industrial guidelines. Twenty-seven per cent (7 of 26) of the Public Health Layers sampled from peat exceeded the industrial remediation guideline and were located off the Bypass Road. The highest concentration reported for the entire study area was found in peat sample BPR-PSC-161 with a parent sample concentration of 3400 mg/kg, and a split sample value of 4900 mg/kg. The degree of variance between parent and duplicate samples is discussed further in section 2.4 of this chapter.

A Kruskal-Wallis analysis with post-hoc comparisons was completed to evaluate the relationships between total As values and terrain type. This analysis performed on PHL samples from the 2015 field season found the distribution of arsenic concentrations in forest samples were significantly different than outcrop ($p = 0.0007$) and peat ($p = 0.0064$) samples. The distribution of arsenic concentrations in forest outcrop and outcrop samples were also determined to be significantly different ($p = 0.0257$). No statistically significant differences existed between outcrop and peat, forest and forest outcrop, or forest outcrop and peat samples ($p > 0.05$). When this analysis was completed for the combined dataset ($n_{PHL} = 436$, $n_{grab} = 43$), the distribution of arsenic concentrations in forest samples were significantly different than forest outcrop, outcrop and peat samples ($p < 0.001$), with no significant differences found between the distributions of arsenic within the median outcrop, forest outcrop and peat terrain units ($p > 0.05$).

3.2.4 Influence of Elevation

When implementing the field sampling program, it was proposed that elevation may have some influence on the distribution of As throughout the study area. The source of arsenic in soil was thought to be primarily from airborne stack emissions, thus it was hypothesized that samples collected at higher elevations may have higher As concentrations as they intercepted and captured airborne arsenic trioxide dust. During sample collection, higher elevated areas were preferentially sampled, particularly when targeting outcrop soil samples. Outcrop soil pockets were targeted during sampling due to previous work completed by Mackenzie Bromstad, which showed As concentrations being particularly enriched in outcrop pockets likely due to topographic restriction and a dry, cold climate (Bromstad 2011, Bromstad *et al.* 2015, Bromstad *et al.*2017).

Figure 3-27 was created to test if there was a significant relationship between total As concentrations found in soil samples and the elevation at which they were collected. In Figure 3-27A there does not appear to be a relevant relationship between elevation and total As (R^2 = 0.18). Figure 3-27B demonstrates why this may be; as distance from the Giant Mine roaster increases, elevation generally decreases, making it difficult to see if there is a strong influence of elevation at further distances. Overall the change in elevation throughout the entire study area was minimal, ranging from 150 masl to just under 300 masl.

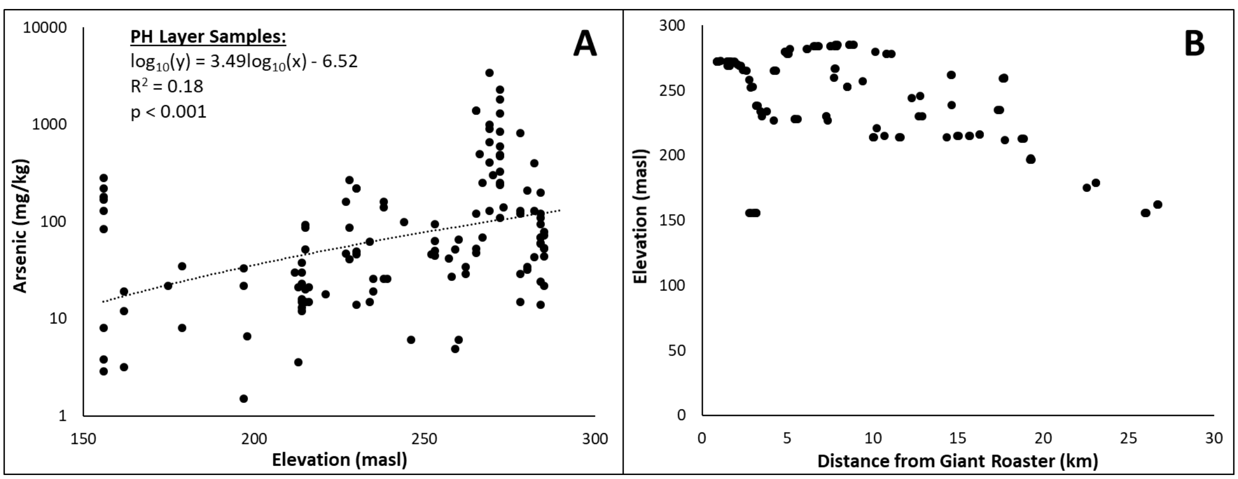

Figure 3-27 A: Total arsenic concentrations versus elevation. There does not appear to be a strong relationship between high arsenic concentrations and high elevation areas. B: Change in elevation with increasing distance from the former Giant Roaster. Overall there is a decrease in elevation within the study area the further one travels from the primary point source of contamination.

In areas closest to the Giant mine site (ie. Bypass Road [0.87 to 4.34 km from Giant], Martin Lake Area [1.74 to 9.43 km from Giant]), distance appears to play a more important role than relative elevation differences, with As concentrations being generally higher in these areas regardless of elevation.

3.2.5 Influence of Grain Size

Nineteen samples were sieved to the less than 2 mm size fraction and submitted to ASU for total elemental analysis. This additional analysis was completed to investigate whether the arsenic containing particles were primarily contained within the smaller size fractions. The < 2 mm fraction was chosen for this analysis as it is common practice to use this size fraction when comparing results to environmental and human health risk assessment guidelines (Health Canada 2010, CCME 2015, Parsons and Little 2015).

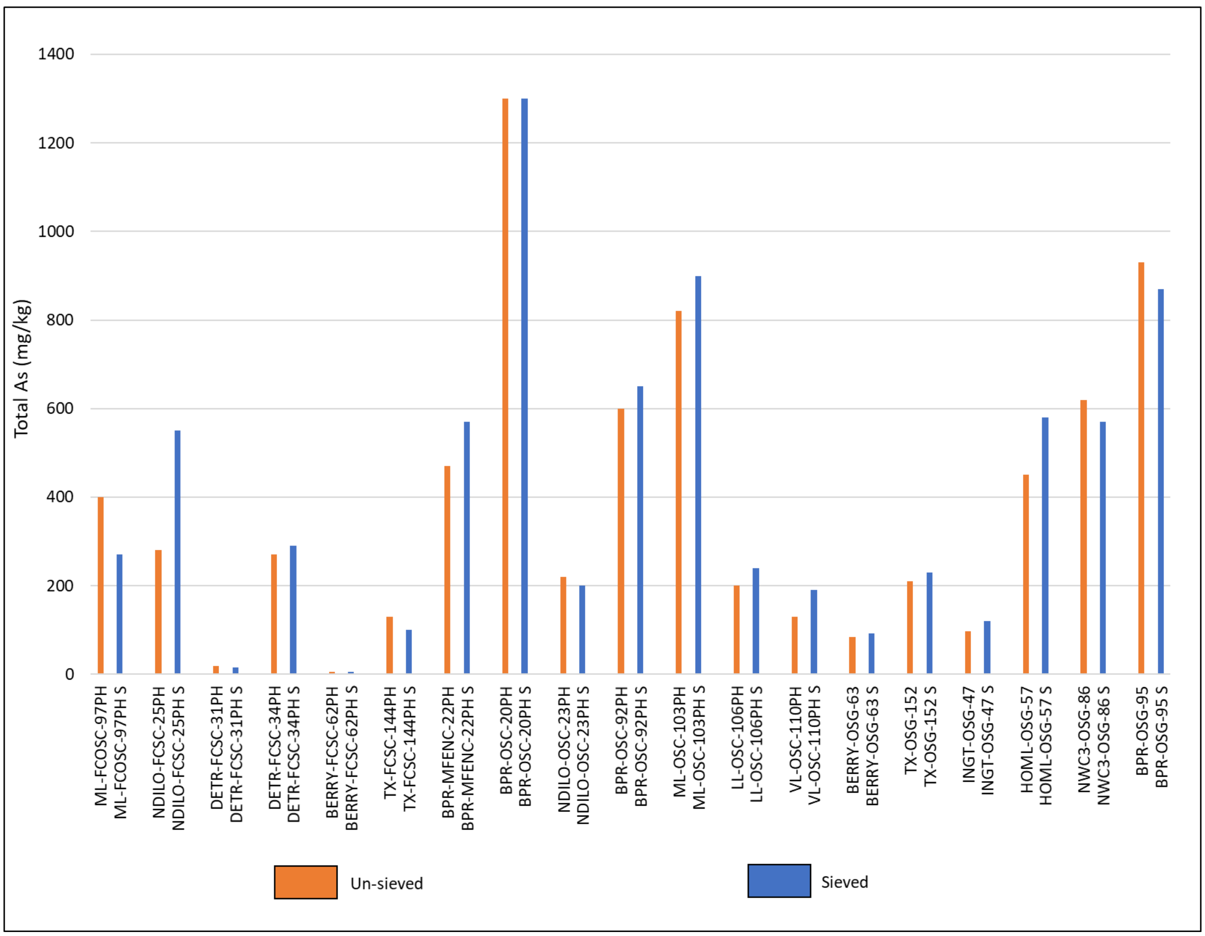

Figure 3-28 Varying total As results between un-sieved and sieved samples.

Figure 3-28 compares the sieved versus un-sieved total As results obtained for the 19 samples. In 11 of the 19 sieved samples (58%), total As results exceeded those found in the originally submitted samples. This could suggest that most of the As-bearing phases are present as small particles (< 2 mm) within the sampled media, however more data should be collected to elucidate this idea.

Table J in Appendix J displays the data used for creating Figure 3-28 and the relative percent differences (RPD) calculated between the original un-sieved and sieved samples. For samples in which the sieved total As results were lower than the un-sieved total As results, a negative RPD was calculated and is shown in red. For samples in which total As concentrations increased in sieved samples, a positive RPD was calculated and is shown in green. RPD's ranged between 0% and 96% for both increases and decreases in total As values between the samples.

Grain size data was also collected for grains identified as As_2O_3 using the SEM/AM for a select 50 samples (63 including duplicates). The samples plotted in Figure 3-29 contained at least 20 grains of arsenic trioxide. Figure 3-29A shows data collected in samples from the Bypass Road (0.87 to 4.34 km from Giant), Dettah Road (3.17 to 10.24 km from Giant) and Ndilǫ (2.86 to 3.18 km from Giant) target areas. Figure 3-29B illustrates grain size curves for samples from the Martin Lake sample area (1.74 to 9.43 km from Giant), and Figure 3-29C shows data collected from the TerraX Northbelt (6.55 to 12.79 km from Giant), Mason Lake (15.64 to 15.69 km from Giant, Southeast and East of Yellowknife), and Ingraham trail (2.37 to 18.86 km from Giant) areas. In general, the distance from the Giant Mine Roaster increases between Figure 3-29A through Figure 3-29C.

These figures show that for samples collected further from the largest point source of contamination (Giant Mine Roaster), the arsenic trioxide grain sizes decrease. This trend was to be expected, as smaller particles have the potential to be transported greater distances from their original source. The total distance emission particles travel depends not only on particle size, but particle shape, particle density, stack height and meteorological conditions (McMartin *et al.* 1999, Keegan *et al.* 2006). Evans *et al.* (1980) reported 6% of particles emitted from a 300 m stack fell within 5 km, while 25% of particles emitted from a 40 m stack also fell within 5 km; indicating that the shorter the stack height the more concentrated the emission fall out will be closest to the point source of contamination. The Giant Mine roaster was constructed to be approximately 46 m in height (150 feet), in an effort to keep most emissions within the mine lease property (Silke 2013). The largest grains of arsenic trioxide were found in areas closest to Giant Mine. For the samples plotted in Figure 3-29A grain sizes ranged from 0.87 to 45 microns. Samples in Figure 3-29B had arsenic trioxide grains ranging between 0.87 and 27 microns. Those in Figure 3-29C had a range in grain sizes between 0.87 and 13.5 microns.

Not all samples scanned on the SEM and analyzed with AM were included in these figures as a lack of arsenic trioxide grains made creating the grain size distribution curves challenging.

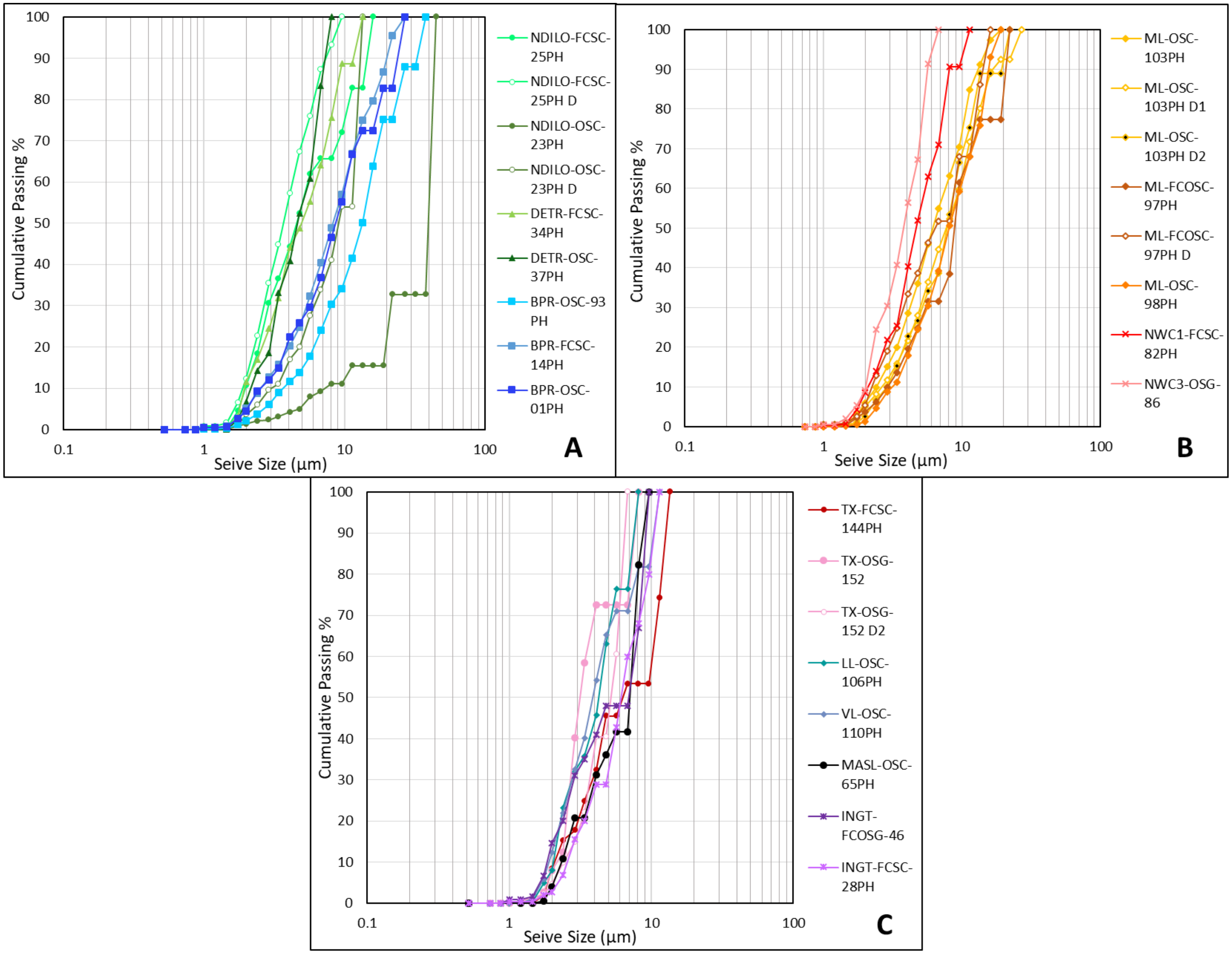

Figure 3-29 Grain size distribution curves for samples with greater than 20 grains of As_2O_3 identified via SEM/automated mineralogy. Range of grain sizes decreased for samples collected at further distances from the Giant roaster. A grain sizes ranged from 0.87 to 45 microns in BPR, Ndilǫ, and Dettah Road samples. B: grain sizes ranged between 0.87 and 27 microns in Martin Lake Area samples. C: grain sizes ranged between 0.87 and 13.5 microns in Ingraham Trail, TerraX Northbelt and Mason Lake samples.

3.3 Arsenic and Other Elements – Bulk Geochemistry Results

The relationships between total As and other elemental concentrations are included in this section. Past studies have determined that elevated As levels typically correspond with other elevated metals (Au, Sb, Zn, Cu, Pb, Cd) in near surface soils, and vegetation (Bromstad *et al.* 2017, Kerr 2006, Hutchinson *et al.* 1982). Bromstad *et al.* (2017) compared As, Sb and Au ratios in soils collected within 4 km of the former Giant Mine roaster to determine the age of roaster-derived As in soils. Antimony is known to occur in minor amounts as an impurity in the arsenic trioxide dust as $(As,Sb)_2O_3$ and Au has been found in the dust within roaster-generated Fe-oxides ranging from 2 to 76 mg/kg (SRK 2002b). Changes in processing, emission controls, and ore grades throughout the life of the mine led to chemical changes in the roaster dust composition. The most significant change occurred pre and post-1964 when the last and most efficient emission controls (two parallel electrostatic precipitators) were implemented at Giant. Table 3-4 below highlights the changes in dust composition around this time. Based on Au/As and Au/Sb, the investigation completed by Bromstad *et al.* (2017) determined that As in soils surrounding Giant were likely deposited prior to 1964, and suggested that topographic restriction by rock outcrops, in addition to a cold, dry, climate could likely contribute to the persistence of arsenic trioxide dust in outcrop soils. Figure 3-30 below illustrates multiple datasets for which Au and Sb ratios in soils were compared to pre and post-1964 roaster derived dust ratios. Trendlines were plotted for the 2011 Bromstad, 2015 Golder, and 2015 Maitland datasets. The 2011 Bromstad outcrop samples, and 2014 Golder PHL samples both indicate a pre-1964 signature with respect to Au/Sb ratios. The 2015 PHL and grab samples, in addition to the 5 core samples collected by Bromstad in 2011 show Au/Sb ratios that are more aligned with the dust released post-1964.

Table 3-4 Pre and Post-1964 Giant Mine roaster ESP and baghouse dust compositions based on data from SRK (2002a) and modified from Bromstad et al. (2017). Pre-1964 dust had slightly less As and Au concentrations were an order of magnitude higher than those post-1964. 85% of emissions from the Giant Mine roaster occurred prior to 1958.

	Average Dust Composition					
Years	As %	As (mg/kg)	Sb%	Sb (mg/kg)	Au (mg/kg)	% of total emissions released from roaster
1949 - 1963	46.4%	464,200	1.22	12,200	36.7	86%
1964-1999	65.3%	653,100	1.11	11,080	3.22	14%

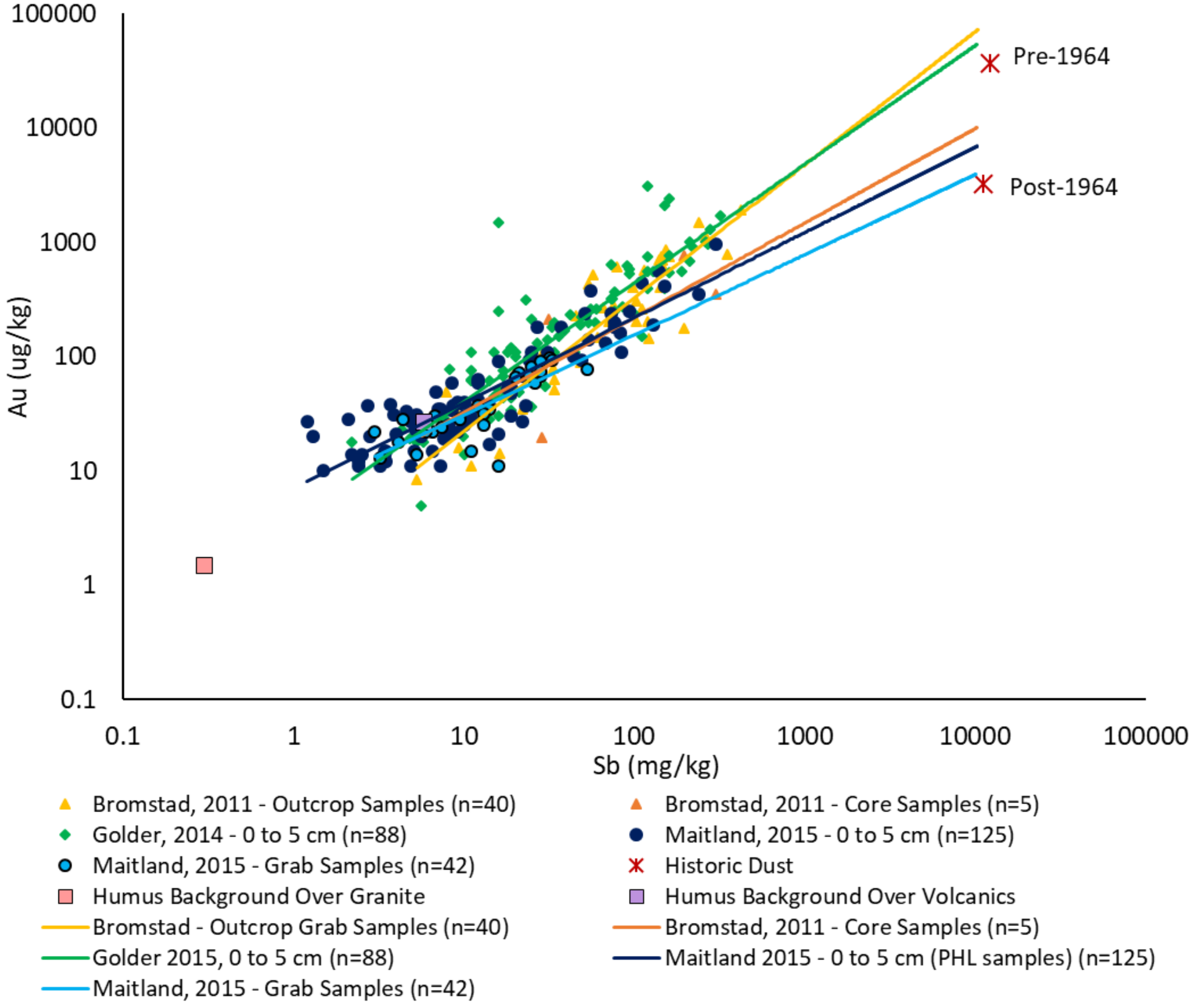

Figure 3-30 Total Au vs. Sb concentrations in soils collected for different sampling programs. Samples plotted in yellow and orange were collected by Mackenzie Bromstad and presented in her 2011 MSc thesis. Samples in green were collected as part of a project commissioned by Golder Associates for which samples were analyzed at Queen's University. Samples plotted in navy and blue were collected during the 2015 field season and are discussed in further detail throughout this report. It should be noted that not all samples are representative of the Public Health Layer (0 to 5 cm). Trendlines were plotted for each of the datasets to determine whether they aligned more with the pre or post-1964 Au/Sb ratios.

The correlation between total As and total Sb for all PHL samples was strongest compared to total As with other metals ($R^2 = 0.8053$). The next best correlation was between total As and Au with an R^2 value of 0.6581. Total As and Pb had a moderately strong correlation with an R^2 value of 0.3929. Total As concentrations showed very little correlation with Ni, Fe, and Zn. Figure 3-31 illustrates the relationship between As and these other metals. Data displayed in blue is representative of values plotted at half the detection limit. The samples were analyzed in separate batches and instrumental error or limited sample size led to varying detection limits. Total As was not compared against Cd or Cr as these elements were below detection limits for the majority of samples (Table B, Appendix B).

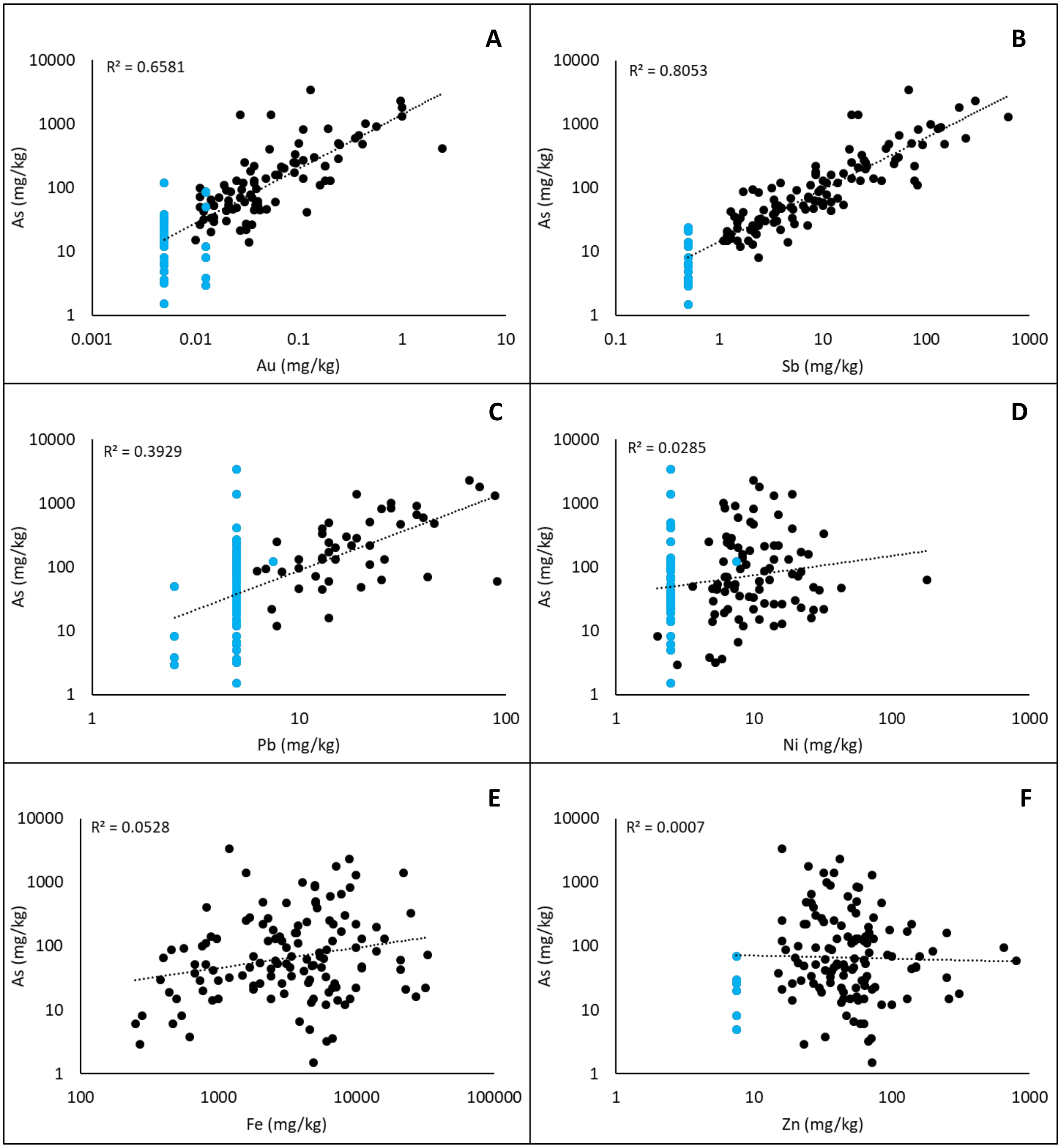

Figure 3-31 A: Total As versus total Au showing a moderate to strong positive correlation. B: Total As versus total Sb showing the strongest positive correlation. C: Total As versus total Pb with a moderate positive correlation. D: Total As versus total Ni showing a weak positive correlation. E: Total As versus total Fe with a weak positive correlation. F: Total As versus total Zn showing a weak negative correlation.

Figure 3-32 below compares total As to total S and total organic carbon results. Data displayed in blue represent samples where S concentrations were reported at less than the detection limit due to instrumental error or limited sample size. Concentrations less than detect were plotted at half the detection limit. Total S results were blank subtracted, as samples were first analyzed for gold, which required a cysteine rinse that added S to the sample. The average value for S in the blanks was then subtracted from sample results. There appears to be a slight correlation between total As and total S with an R^2 value of 0.1746. In addition to particulate matter containing arsenic trioxide dust, SO_2 emissions in the early years of mining were also significant (Hutchinson *et al.* 1982, St. Onge 2006). St. Onge (2006) reported both As and S levels decreased significantly in surface soils with increasing distance from the roaster stack.

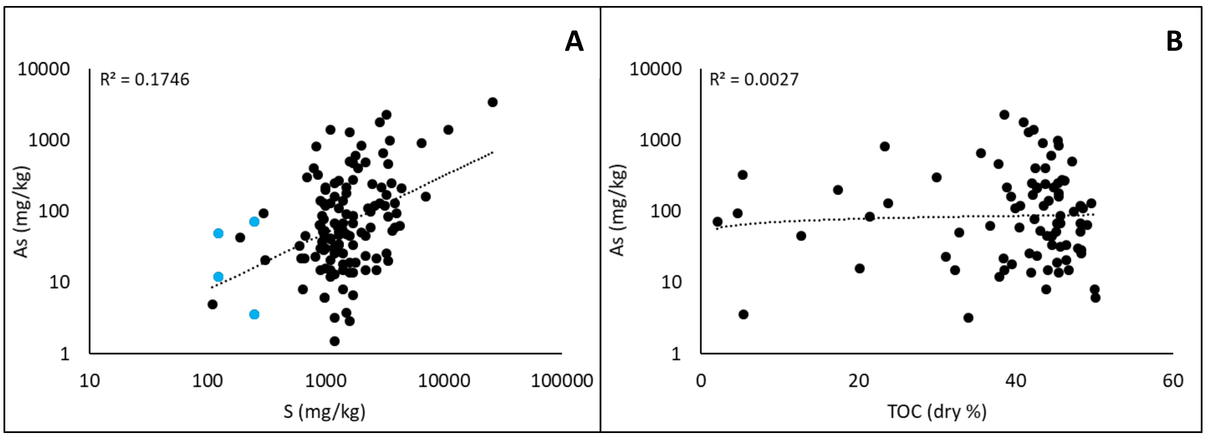

Figure 3-32 A: Total As results versus total S measured in PHL samples. B: Total As versus TOC results presented in dry %, and determined using the LECO SC444 method outlined in Chapter 2 Section 2.5.2.

TOC was analyzed in 84 PHL samples. Figure 3-32 shows there was not a significant relationship between total As and TOC. Bromstad *et al.* (2017) reported finding irregular to polygonal clusters of As_2O_3 grains associated with organic matter, in addition to individual grains not associated with other material. SEM/AM results for the samples discussed in this thesis had similar As_2O_3 associations, with grains also found in clusters of common rock forming minerals such as quartz and feldspar, which may have been caused by clumping of the material during the mounting process. Arsenic will adsorb to organic matter, however the results in Figure

3-32 show there was no strong relationship discovered between organic content and total As concentrations in the PHL samples analyzed.

3.4 SEM / Automated Mineralogy Results: PHL and Grab Samples

The results for all near surface soils analyzed using SEM/AM are presented in this section; this method of mineral identification has been used for Yellowknife area soils by Wrye (2008), Bromstad (2011), Bromstad et al. (2015), Bromstad et al. (2017), and Oliver (2018). Ten phases of As-bearing minerals were included in the mineral reference library used to analyze these samples: arsenolite (model phase used to represent arsenic trioxide, As_2O_3), arsenopyrite (FeAsS), realgar (AsS), enargite (Cu_3AsS_4), scorodite ($FeAsO_4 \cdot 2H_2O$), As-bearing pyrite, Fe-Ca arsenate, As-bearing manganese oxide mixes, As-bearing iron oxides and iron oxide mixes, and finally, As-bearing organics mixed with iron oxides. The weight percent distributions for the 10 arsenic hosts included in the AM Mineral Liberation Analysis (MLA) reference library and used for analyzing the PHL and DC samples can be found in Table F and Table G of Appendix F and Appendix G, respectively. A complete summary of all mineral phases included in the mineral reference library can also be found in Table E-2 of Appendix E.

For known model mineral phases (ie. arsenolite, arsenopyrite, realgar, enargite, and scorodite) the percent of As present in each phase could be determined using standard chemical compositions and molecular weights of the elements. For less well-defined mineral phases containing mixed spectra approximate As weight percents were established based on previous work completed in the area. Walker *et al.* (2005) documented roaster-generated Fe-oxides in tailings at Giant ranging from < 1 wt. % up to 7 wt. % As (both As(III) and As(V)), while Schuh *et al.* (2018) reported finding authigenic Fe-oxyhydroxides with an average of 3 wt. % As in lake sediments. In addition to these previous studies, for an element to produce a visible peak in a collected EDS, the element must form approximately 3% of the solid phase being scanned. As such, As wt. % in the As-bearing Fe-oxides, Mn-oxides, and Fe-oxides with organics was estimated to be 3 wt. % for the purposes of completing weight percent distribution calculations between all of the As-bearing phases present in a given sample. The wt. % of As in the As-bearing pyrite phases was determined based on previous work completed by Chryssoulis (1990), who analyzed 99 pyrite grains collected from the Giant Mine property and found an average As content of 0.68 wt.%. An Fe-Ca arsenate phase was also included in the mineral reference library for which a 15 wt.% As was applied based on work completed by Bailey (2017).

The density value for As-bearing Mn-oxide mixed phases was estimated at 4.0 g/cm^3. This value was assumed after considering the densities for two common Mn-oxides (hausmannite (4.76 g/cm^3) and birnessite (3.0 g/cm^3), the density of As-bearing Fe-oxides (and Fe-oxide mixed phases) (4.5 g/cm^3), and the density for As-bearing organic and Fe-oxide phases (3.0 g/cm^3). The Mn-oxide phases were assumed to be denser than the mixed As-bearing organic and Fe-oxide phases, but not as dense as the As-bearing Fe-oxides (density for maghemite assumed). The range of densities between the two common soil forming Mn-oxide phases (birnessite and hausmannite), helped with determining the mid-range estimated density of 4.0 g/cm^3 for these As-bearing Mn-oxide phases. A summary table outlining all mineral phases contained in the mineral reference library, their densities, formula's, elemental percent compositions, and the source of information or assumptions used in determining the former properties can be found in Table E-2 of Appendix E.

Figure 3-33 shows a graphical representation between the non-As-bearing and As-bearing phases identified in PHL samples. It is important to note the scale along the x-axis of the figure;

starting at 80% it is clear that even though various phases of As are present in soils throughout the study region, they do not comprise a large percentage of the overall soil-forming materials. In all but one sample (INGT-FCOSG-46), the non-As bearing mineral phases made up over 90% of the soil media. Sample INGT-FCOSG-46 had an anomalously high concentration of As-bearing Mn-oxide phases, which appeared to occur as replacement textures along the edge of woody, and stem-like organic structures. Arsenic trioxide, identified in the AM software as arsenolite and shown in red in Figure 3-33, was present in most samples, albeit in relatively small amounts. Outcrop samples collected in the Bypass Road (BPR-OSC-93PH, BPR-OSC-01PH), Martin Lake (ML-OSC-98PH), Ndilǫ (NDILO-OSC-23PH), and the Vital Lake or TerraX Northbelt (VL-OSC-110PH) target areas had the highest relative As_2O_3 modal %.

The remainder of this section will highlight the As speciation in select soil samples from the various target areas. These target areas include the Bypass Road, the Martin Lake Area, Ndilǫ and the Dettah Road, Ingraham Trail, Highway 3, the TerraX Northbelt property, and various distal sample sites.

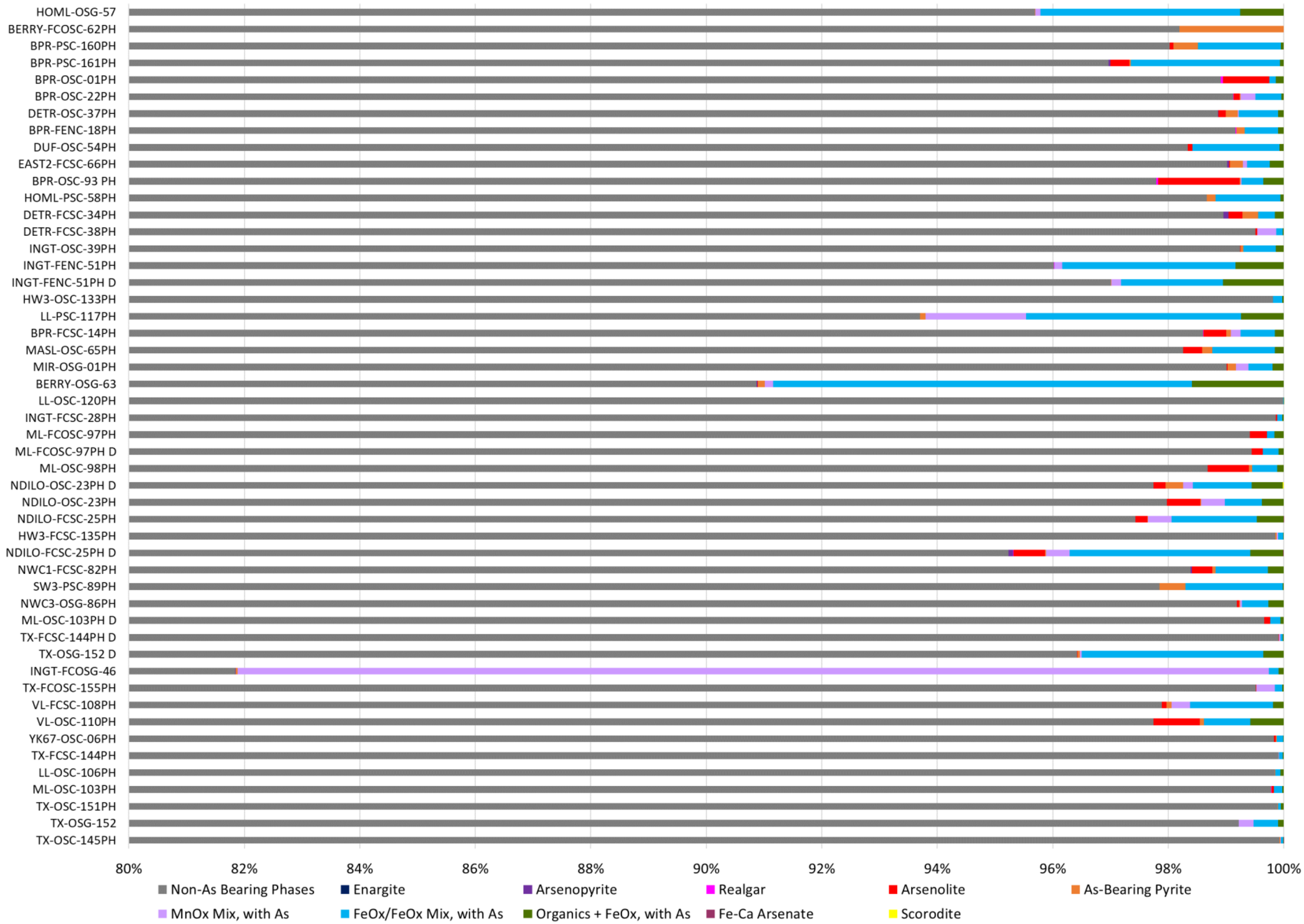

Figure 3-33 Modal Mineralogy for all PHL samples analyzed by SEM and automated mineralogy. This figure illustrates the weight percent difference in soils between non-As-bearing and As-bearing phases.

3.4.1 Bypass Road

Seven core samples collected along the Bypass Road to the west of Giant Mine were selected for SEM/AM following bulk geochemistry analysis. Three outcrop samples, two peat samples, one forest canopy sample, and one fenland sample were analyzed in order to assess differences in As speciation between various terrain types. Outcrop samples BPR-OSC-93 and BPR-OSC-01 were selected because they had the highest measured As concentrations for this terrain type within the Bypass Road target area. BPR-OSC-22 was a sample collected beside an outcrop area in an open field. This sample was originally labelled BPR-MFENC-22, as the field resembled a fenland but ended up consisting primarily of dry sand; it was grouped with outcrop samples during analysis due to lack of forest cover. Peat samples, BPR-PSC-160 and BPR-PSC-161 were also chosen for their high As levels, with BPR-PSC-161 having the highest measured As content found for all the collected samples. BPR-FCSC-14 had the highest As level in forest canopy samples, and BPR-FENC-18 did not have the highest As value of the two fenland samples collected along the Bypass Road, but was chosen to increase the overall range of As content in samples analyzed by SEM for this area.

Figure 3-34 illustrates the weight percent distribution of As-bearing phases in samples collected along the Bypass Road. In all samples, apart from fenland sample BPR-FENC-18, the primary As-host was identified as As_2O_3. This was not surprising due to the proximity of these samples to the Giant Mine roaster, the main source of arsenic trioxide contamination throughout the study area. The second most common As-hosts were Fe-oxide and mixed Fe-oxide phases. These results were expected based on previous research investigating the composition of roaster-generated dust (Fawcett and Jamieson 2011, INAC 2007, SRK 2002a) and soil sampling completed in the area by Wrye (2008) and Bromstad *et al.* (2017). The presence of roaster derived As_2O_3 and As-bearing roaster derived Fe-oxides were originally confirmed in soils on the Giant Mine property by Wrye (2008). Sample BPR-FENC-18 was unique in that it was fully saturated upon retrieval. The organic-rich nature of fenland soils coupled with a high degree of saturated, could lead to more reducing conditions, which may explain the relatively high presence of As-sulphide phases (realgar) present in this sample. A summary of all the identified As-bearing phases, their wt. % distributions and respective concentrations for the Bypass Road samples analyzed by SEM can be found in Table 3-5 below. No scorodite, enargite, or Fe-Ca arsenate phases were identified in Bypass Road samples.

Table 3-5 Summary of As-bearing phases, their weight percent distributions and respective concentrations in Bypass Road samples.

	Mineral Phase	**Arsenolite**	**MnOx Mix, with As**	**FeOx/FeOx Mix, with As**	**Organics + FeOx, with As**	**Arseno pyrite**	**Realgar**	**As-Bearing Pyrite**	**Total As Results (ASU) (mg/kg)**
	Density (g/cm^3)	**3.70**	**4.00**	**4.50**	**3.00**	**6.07**	**3.56**	**5.01**	
	wt % As in each Phase	**76%**	**3%**	**3%**	**3%**	**46%**	**70%**	**1%**	
BPR-OSC-01PH	wt. % As	94%	0%	0.45%	0.66%	0%	4.7%	0%	
	mg/kg As	**1696**	**0**	**8.2**	**12**	**0**	**84**	**0**	**1800**
BPR-FCSC-14PH	wt. % As	89%	1.6%	5%	1.4%	0%	2.4%	0.16%	
	mg/kg As	**447**	**8.0**	**25**	**7.0**	**0**	**12**	**0.8**	**500**
BPR-FENC-18PH	wt. % As	0%	0%	52%	9%	0%	36%	3%	
	mg/kg As	**0**	**0**	**62**	**11**	**0**	**44**	**3.6**	**120**
BPR-OSC-22PH	wt. % As	75%	7.3%	12%	1.2%	0%	4.2%	0.12%	
	mg/kg As	**354**	**34**	**55**	**5.8**	**0**	**20**	**0.54**	**470**
BPR-OSC-93 PH	wt. % As	96%	0.044%	0.96%	0.95%	0%	2%	0.0073%	
	mg/kg As	**2209**	**1.0**	**22**	**22**	**0**	**46**	**0.17**	**2300**
BPR-PSC-161PH	wt. % As	74%	0%	21%	0.63%	4%	0%	0.045%	
	mg/kg As	**2514**	**0**	**715**	**21**	**149**	**0**	**1.5**	**3400**
BPR-PSC-160PH	wt. % As	53%	0%	43%	2%	0%	0%	3%	
	mg/kg As	**525**	**0**	**426**	**17**	**0**	**0**	**31**	**1000**

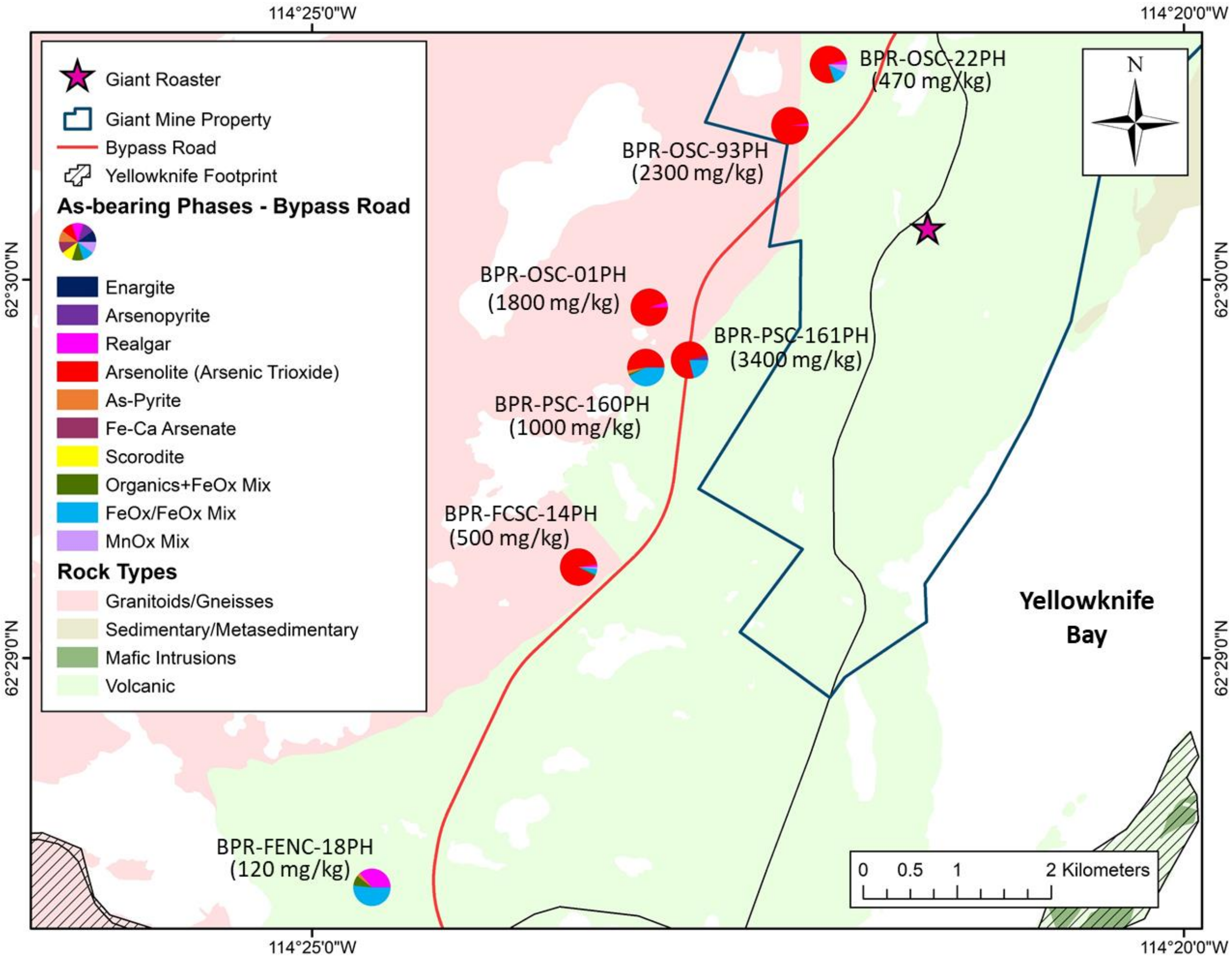

Figure 3-34 Bypass Road SEM/AM results showing the weight % distribution of various As-bearing phases present in soils throughout the study area. Corresponding total As concentrations for each of the samples are in parentheses.

Figure 3-35 shows examples of As_2O_3 grains found in samples collected off the Bypass Road. The SEM identifies the arsenolite (As_2O_3) phases based on their brightness and distinct As peaks. The As_2O_3 was often found dispersed as individual grains throughout the sample media and occasionally was found clumped together with other common rock-forming minerals such as feldspars, micas, and quartz.

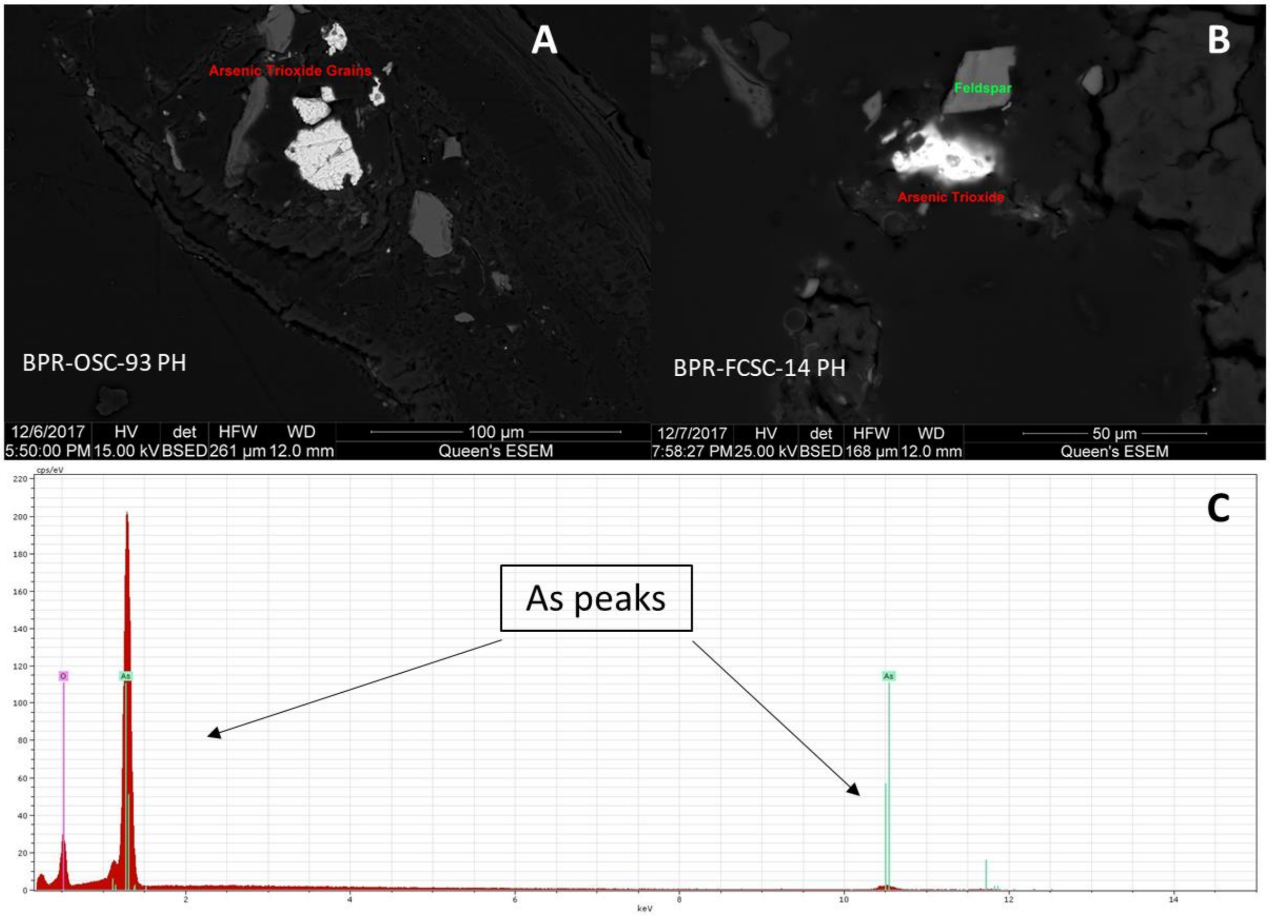

Figure 3-35 A: Examples of As_2O_3 grains found in outcrop sample BPR-OSC-93PH. B: An As_2O_3 grain next to an identified feldspar phase in forest canopy sample BPR-FCSC-14PH. C: Example of an energy dispersive x-ray spectroscopy (EDS) spectrum collected for an As_2O_3 grain showing the two primary As peaks used during identification.

3.4.2 Martin Lake Area

Five sample locations were analyzed around the Martin Lake target area; three outcrop samples (ML-OSC-103, ML-OSC-98, NWC3-OSG-86 (grab)), one forest outcrop sample (ML-FCOSC-97), and one forest canopy sample (NWC1-FCSC-82). This area is located west of the Giant Mine property and Bypass Road. The AM results for the samples collected around Martin Lake are displayed in Figure 3-36 below. Duplicate samples were analyzed for samples ML-OSC-103PH and ML-FCOSC-97PH and are indicated with a “D.” Values used to construct these weight percent distribution figures can be found in Table F of Appendix F. Table 3-6 in this section also outlines the wt. % and associated total As-concentrations for each As-bearing phase identified in Martin Lake area samples.

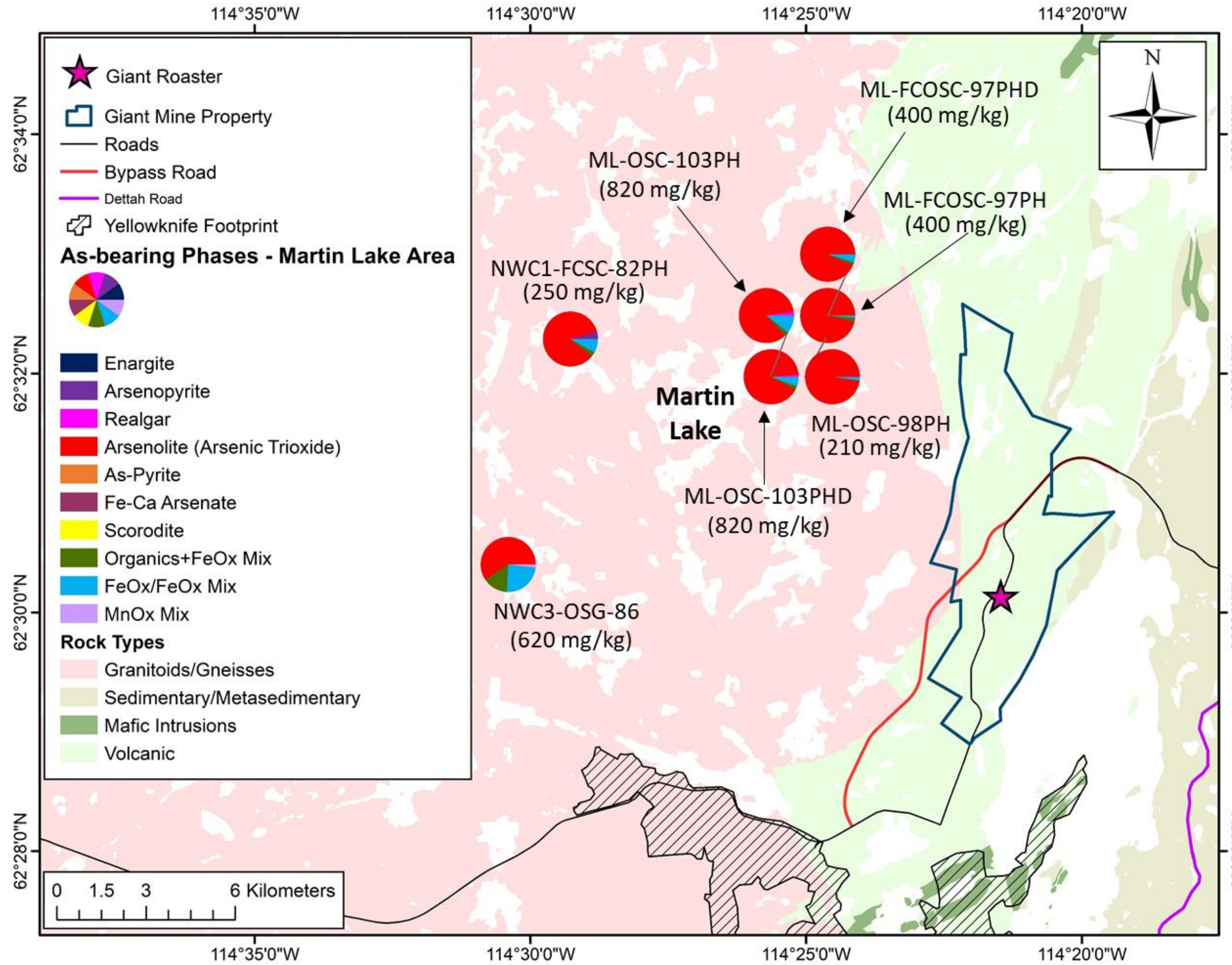

Figure 3-36 Weight percent distribution of As-bearing phases in samples collected within the Martin Lake target area west of the Giant Mine property.

Similar to the Bypass Road target area, As_2O_3 (arsenolite) was the primary As host in these samples. The highest total As concentration from this area was measured in ML-OSC-103PH. NWC3-OSG-86 is not representative of the Public Health Layer (grab sample), however it was included in the analysis due to its relatively high total As concentration. After arsenolite, the next most common As host in Martin Lake area samples were Fe-oxides and Fe-oxide mixes containing As. Reproducibility for duplicate samples were good for samples from this area. All samples collected around Martin Lake exceed the GNWT residential remediation guideline (160 mg/kg), and only two samples (ML-OSC-98PH, NWC1-FCSC-82PH) fell below the industrial remediation guideline (340 mg/kg).

Table 3-6 below outlines the weight % and concentrations (mg/kg) of As phases identified in Martin Lake area samples. Arsenopyrite and enargite were each identified in one sample; arsenopyrite was found in sample NWC1-FCSC-82 and enargite in sample ML-OSC-103PH D. These As-bearing phases, in addition to Realgar and As-bearing pyrite, are believed to be products of natural soil forming processes, likely derived from weathered bedrock. Realgar (n= 3) and As-bearing pyrite (n=6) were also identified in several samples collected around the Martin Lake area.

Table 3-6 Summary of As-bearing phases, their weight percent distributions and respective concentrations in Martin Lake area samples.

	Mineral Phase	**Enargite**	**Arsenolite**	**MnOx Mix, with As**	**FeOx/ FeOx Mix, with As**	**Organics + FeOx, with As**	**Arseno pyrite**	**Realgar**	**As-Bearing Pyrite**	**Total As Results (ASU) (mg/kg)**
	Density (g/cm^3)	**4.45**	**3.70**	**4.00**	**4.50**	**3.00**	**6.07**	**3.56**	**5.01**	
	wt % As in each Phase	**0.19**	**0.76**	**0.03**	**0.03**	**0.03**	**0.46**	**0.70**	**0.0068**	
ML-FCOSC-97PH	wt. % As	0%	96%	0%	1.5%	2.1%	0%	0%	0%	
	mg/kg As	**0**	**386**	**0**	**5.9**	**8.3**	**0**	**0**	**0**	**400**
ML-FCOSC-97PH D	wt. % As	0%	93%	0.051%	4.8%	1.9%	0%	0%	0.0068%	
	mg/kg As	**0**	**373**	**0.2**	**19**	**7.5**	**0**	**0**	**0.027**	**400**
ML-OSC-98PH	wt. % As	0%	97%	0%	2.1%	1%	0%	0%	0.067%	
	mg/kg As	**0**	**204**	**0**	**4.5**	**1.3**	**0**	**0**	**0.14**	**210**
ML-OSC-103PH	wt. % As	0%	85%	0.0037%	11%	2.4%	0%	2.3%	0.091%	
	mg/kg As	**0**	**694**	**0.03**	**87**	**20**	**0**	**19**	**0.75**	**820**
ML-OSC-103PH D	wt. % As	0.017%	91%	0%	5.6%	2.1%	0%	1.1%	0.010%	
	mg/kg As	**0.14**	**747**	**0**	**46**	**18**	**0**	**9.3**	**0.082**	**820**
NWC3-OSG-86	wt. % As	0%	59%	1.9%	24%	15%	0%	0%	0.15%	
	mg/kg As	**0**	**367**	**12**	**148**	**92**	**0**	**0**	**0.91**	**620**
NWC1-FCSC-82PH	wt. % As	0%	85%	0%	8%	2.6%	4.2%	0.44%	0.13%	
	mg/kg As	**0**	**211**	**0**	**20**	**6.6**	**10**	**1.1**	**0.33**	**250**

3.4.3 Ndilǫ and the Dettah Road

Weight percent distributions for two samples collected in the Yellowknife Dene First Nation community of Ndilǫ and four samples collected along the Dettah can be found in Figure 3-37 A and B, respectively. A high degree of reproducibility between duplicate samples in Ndilǫ confirmed AM methods worked well for these samples.

NDILO-OSC-23PH and NDILO-FCSC-25PH were chosen as they had the highest total As concentrations reported out of the five samples collected from the community of Ndilǫ. In parent outcrop sample, NDILO-OSC-23PH, almost all (91 wt. %) of the As is hosted as As_2O_3 (arsenolite). In parent forested canopy sample, NDILO-FCSC-25PH, 67 wt. % As is hosted as As_2O_3. Between these two samples, the outcrop sample had higher wt. % As_2O_3 than the forested canopy sample. This occurrence was predicted due to the nature of atmospheric deposition; it was believed forested canopy areas could potentially restrict the deposition of As_2O_3 as roaster dust emissions became caught up and trapped in the overlying canopy. Fe-oxides and Fe-oxide mixes were the next most common As-bearing phases identified in Ndilǫ samples. Other As-hosting phases identified in these samples included As-bearing Mn-oxides, and As-bearing Fe-oxides mixed with organics. Trace amounts of Fe-Ca arsenate and As-bearing pyrite were also identified. Scorodite, an Fe-arsenate mineral phase produced during the autoclave process at Con Mine, was identified in one sample, NDILO-OSC-23PH D. This was the only grain of scorodite found in all samples analyzed via SEM/AM. A possible source for this scorodite could be windblown tailings dust from Con Mine, located just over 5 km to the southwest of Ndilǫ. The calculated wt.% and As-bearing phase concentrations for all Ndilǫ and Dettah samples can be found in Table 3-7.

Along the Dettah Road, As_2O_3 was once again the most common phase of As occurring in soils comprising between 61 and 85 % of the total As. In sample YK67-OSC-06PH, Fe-oxides were the second most common As-bearing phase, with trace amounts of organics with Fe-oxides, and As-bearing pyrite. Arsenopyrite was the second most common As-host in sample DETR-FCSC-34PH making up 16 wt.% of the total As in the sample. This sample also had a small percentage of Fe-oxides (3.4 wt.%), Fe-oxides mixed with organics (2 wt.%), and As-bearing pyrite (0.79 wt.%). Samples DETR-OSC-37PH and DETR-FCSC-38PH were collected close to one another to observe differences between outcrop and forested canopy terrain types. Of the total As present in these samples, DETR-OSC-37PH (outcrop sample) contained 79 wt.% As_2O_3, whereas DETR-FCSC-38PH (forest sample) contained 61 wt.% As_2O_3. The outcrop soil had a higher percentage of As_2O_3 than the forested canopy soil much like the same observation made in Ndilǫ. The second most significant As-bearing phase in DETR-OSC-37PH were once again the Fe-oxides (15 wt.%); smaller amounts of organics with Fe-oxides (2.4 wt.%), arsenopyrite (1.1 wt.%), As-bearing pyrite (1.2 wt.%), and enargite (0.7 wt.%) were also present at this location. This was the second sample in which enargite was identified out of the entire set of samples analyzed via SEM/AM. In DETR-FCSC-38PH the second most significant As-bearing phase was identified as Mn-oxides (26 wt.%); Fe-oxides (7.9 wt.%), arsenopyrite (4.2 wt.%), and organics with Fe-oxides (1.2 wt.%) were the other phases present in this sample.

Table 3-7 Summary of As-bearing phases, their weight percent distributions and respective concentrations in Ndilǫ and Dettah Road samples.

	Mineral Phase	**Enargite**	**Arseno lite**	**Scoro dite**	**MnOx Mix, with As**	**FeOx/ FeOx Mix, with As**	**Organics + FeOx, with As**	**Fe-Ca Arsen ate**	**Arseno pyrite**	**Realgar**	**As-Bearing Pyrite**	**Total As Results (ASU) (mg/kg)**
	Density (g/cm^3)	**4.45**	**3.70**	**3.27**	**4.00**	**4.50**	**3.00**	**3.92**	**6.07**	**3.56**	**5.01**	
	wt % As in each Phase	**0.19**	**0.76**	**0.32**	**0.03**	**0.03**	**0.03**	**0.15**	**0.46**	**0.70**	**0.0068**	
DETR-FCSC-34PH	wt. % As	0%	78%	0%	0%	3.4%	2%	0%	16%	0%	0.79%	
	mg/kg As	**0**	**210**	**0**	**0**	**9.1**	**5.4**	**0**	**44**	**0**	**2.1**	**270**
DETR-OSC-37PH	wt. % As	0.70%	79%	0%	0.26%	15%	2.4%	0%	1.1%	0%	1.2%	
	mg/kg As	**1.5**	**174**	**0**	**0.58**	**34**	**5.2**	**0**	**2.3**	**0**	**2.6**	**220**
DETR-FCSC-38PH	wt. % As	0%	61%	0%	26%	7.9%	1.2%	0%	4.2%	0%	0%	
	mg/kg As	**0**	**28**	**0**	**12**	**3.6**	**0.54**	**0**	**1.9**	**0**	**0**	**46**
YK67-OSC-06PH	wt. % As	0%	85%	0%	0%	13%	1.0%	0%	0%	0%	0.58%	
	mg/kg As	**0**	**53**	**0**	**0**	**8.3**	**0.61**	**0**	**0**	**0**	**0.36**	**62**
NDILO-OSC-23PH	wt. % As	0%	91%	0%	2.5%	3.7%	2.4%	0%	0%	0%	0.022%	
	mg/kg As	**0**	**201**	**0**	**5.6**	**8.2**	**5.2**	**0**	**0**	**0**	**0.049**	**220**
NDILO-OSC-23PH D	wt. % As	0%	73%	2.5%	2.4%	13%	7.6%	0%	0%	0%	1.0%	
	mg/kg As	**0**	**161**	**5.4**	**5.2**	**29**	**17**	**0**	**0**	**0**	**2.2**	**220**
NDILO-FCSC-25PH	wt. % As	0%	69%	0%	5.4%	19%	6%	0.12%	0%	0%	0.010%	
	mg/kg As	**0**	**195**	**0**	**15**	**53**	**17**	**0.33**	**0**	**0**	**0.027**	**280**
NDILO-FCSC-25PH D	wt. % As	0%	71%	0%	2.1%	15%	3%	0.19%	6%	1.6%	0.013%	
	mg/kg As	**0**	**200**	**0**	**6.0**	**43**	**8.3**	**0.55**	**18**	**4.4**	**0.037**	**280**

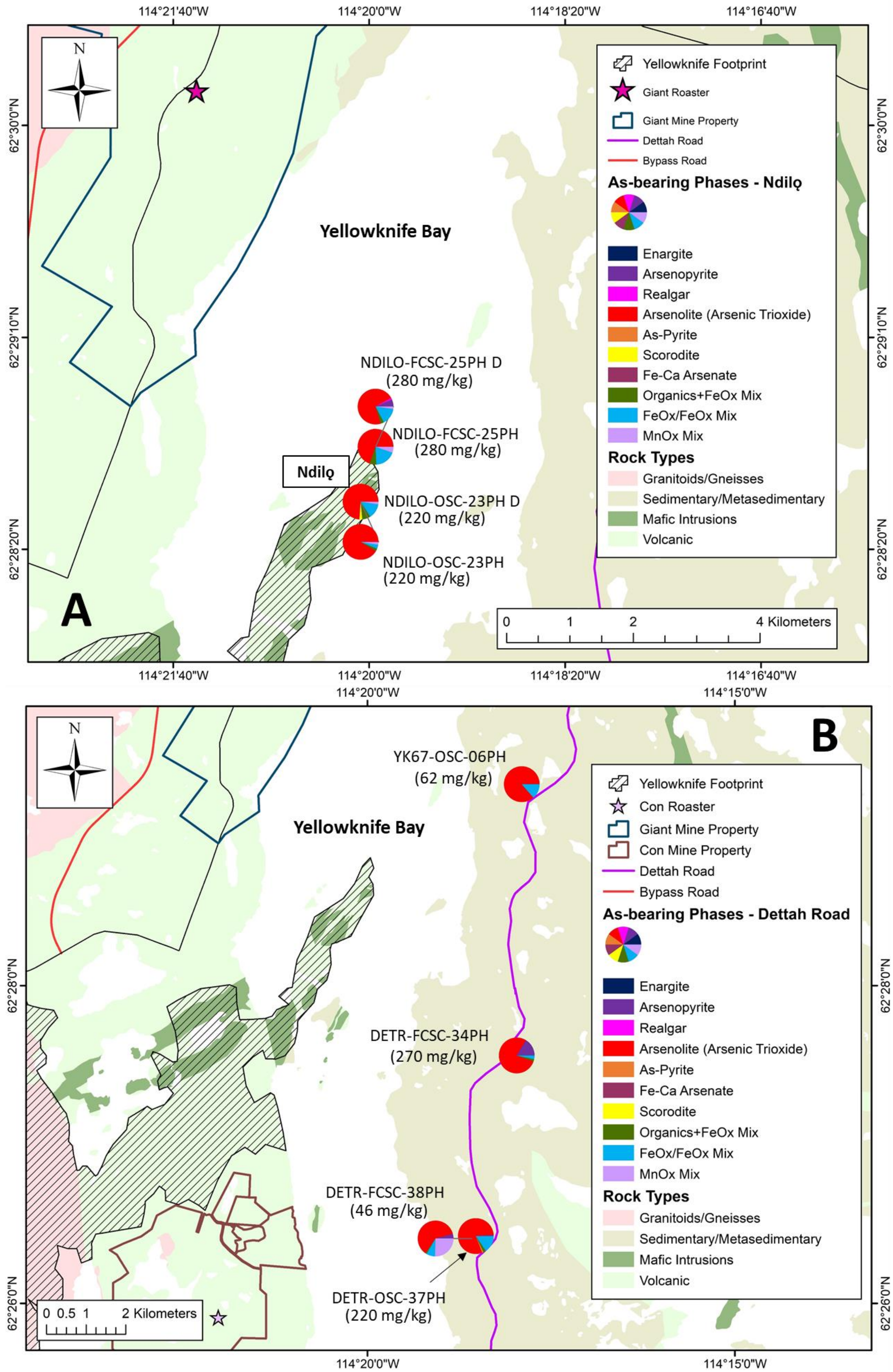

Figure 3-37 A: Weight percent distribution of As-bearing phases for two samples and their respective duplicates collected from the Yellowknife Dene First Nations community of Ndilǫ. B: Weight percent distribution of As-bearing phases in samples collected along the Dettah Road.

3.4.4 Ingraham Trail

Four samples (plus one duplicate) that were collected along the Ingraham Trail and mounted for As speciation analysis are plotted in Figure 3-38. Fenland sample INGT-FENC-51PH and its duplicate were the only samples in which As_2O_3 was not identified; much like the absence of As_2O_3 in Bypass Road fenland sample BPR-FENC-18PH. INGT-FENC-51PH was collected in a saturated marshland at the beginning of the Ingraham Trail to the NE of the Giant Mine roaster. Heading east down the Ingraham Trail near the turnoff for the Dettah Road, forest sample INGT-FCSC-28PH was also collected. This sample had the highest total As concentration out of all core samples collected along the Ingraham Trail and was the only core sample collected that exceeded the residential remediation guideline, with 83 wt.% of the total As identified as As_2O_3. The remainder of As in the sample was hosted by Fe-oxides (13 wt.%), and organic Fe-oxide mixes (4 wt.%), with trace amounts of As-bearing pyrite identified.

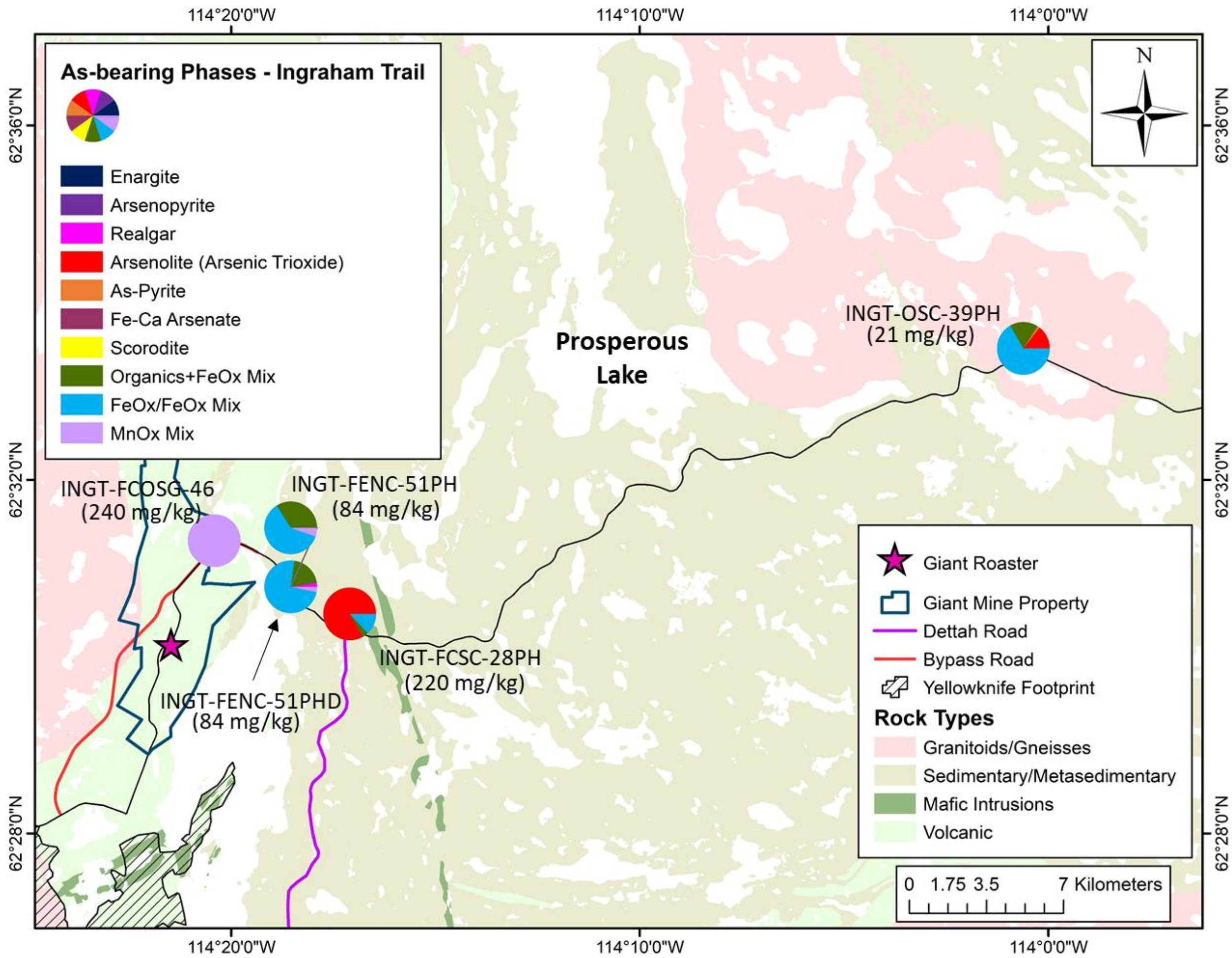

Figure 3-38 Weight percent distribution of As-bearing phases in samples collected along the Ingraham Trail to the N and NE of the Giant Mine roaster. Arsenic trioxide was found in all samples except fenland sample INGT-FENC-51PH.

Outcrop sample INGT-OSC-39PH was the furthest sample (19 km from Giant Roaster, 23 km from Con Roaster) collected out Ingraham Trail to the east of the Giant Mine property. Despite not being in the predominant down-wind direction from the Giant roaster, As_2O_3 (arsenolite) was still identified in this sample making up 14 wt.% of the total As concentration. Arsenic-bearing Fe-oxides and organics mixed with Fe-oxides made up the remainder of the total As in the sample at 67 wt.% and 17 wt.%, respectively. 1.4 wt.% of the total As was identified as As-bearing pyrite. Sample INGT-FCOSG-46 also had the highest total As concentration reported for grab samples collected in this target area. It was anomalous in composition, being the only sample identified as containing 98 wt.% As in As-bearing Mn-oxide minerals. Figure 3-39A shows an example of the types of grains identified as Mn-oxide As-bearing phases; they were spongy, woody organics or stem-like structures that appeared to be replaced by Mn-oxide mixed mineral phases that also contained trace amounts of As. Other As-bearing phases identified in grab sample INGT-FCOSG-46 included Fe-oxides (0.88 wt.%), As_2O_3 (0.66 wt.%), organics mixed with Fe-oxides (0.5 wt.%), arsenopyrite (0.15 wt.%), and As-bearing pyrite (0.04 wt.%). Figure 3-39 B, C, and D all show examples of roaster generated Fe-oxides found in sample INGT-FCOSG-46; they can be distinguished from authigenic Fe-oxides by their spongy, concentric ring, micro-porous nanocrystalline textures, and are predominantly grains of maghemite (Walker *et al.* 2015). Due to the laborious method of manually searching for these grains of As-bearing Fe-oxides and identifying them as roaster-generated or naturally derived based on texture and physical appearance, for the purposes of this thesis, this distinction between natural and roaster-generated Fe-oxides was not reported for SEM/AM samples. All As-bearing Fe-oxide phases were grouped into the Fe-oxides and Fe-oxide mixed phases category, thus for this phase category it is important to recognize that not all As-bearing Fe-oxide phases identified were roaster-generated.

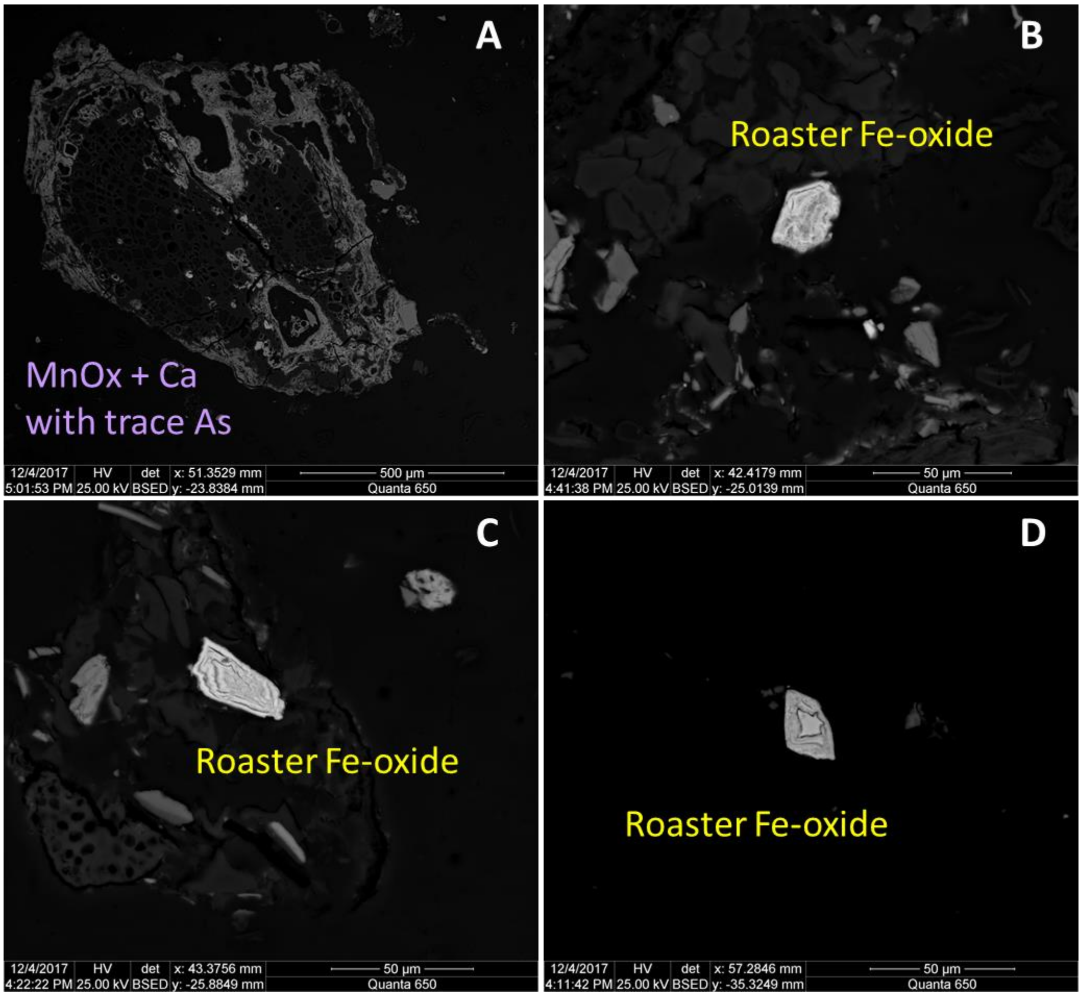

Figure 3-39 A: Mn-oxide phase with trace amounts of As identified. B: Spongy roaster-generated Fe-oxide. C,D: Concentric roaster-generated Fe-oxide grains. All grains in Figure 3-39 were found in grab sample INGT-FCOSG-46.

3.4.5 Highway 3

In the two samples collected out Highway 3 (8.5 km from Giant Roaster, 8 km from Con Roaster) the primary As-bearing phase was identified as Fe-oxides (Figure 3-40), which made up 81 wt.% of the total As in outcrop sample HW3-OSC-133PH and 67 wt.% of the total As in forest sample HW3-FCSC-135PH. Both of these samples had relatively low total As concentrations (Figure 3-40), which fell far below the residential remediation guideline of 160 mg/kg. Arsenolite (As_2O_3) was identified in both samples making up 6.3 wt.% of the As in HW3-OSC-133PH, and 1.6 wt.% of the total As in HW3-FCSC-135PH. Outcrop sample HW3-OSC-

133PH contained two other As-bearing phases (organics with Fe-oxides (12 wt.%) and As-bearing pyrite (0.59 wt.%)), while sample HW3-FCSC-135PH contained three other phases (Mn-oxides (21 wt.%), organics with Fe-oxides (6.8 wt.%), and As-bearing pyrite (4 wt.%).

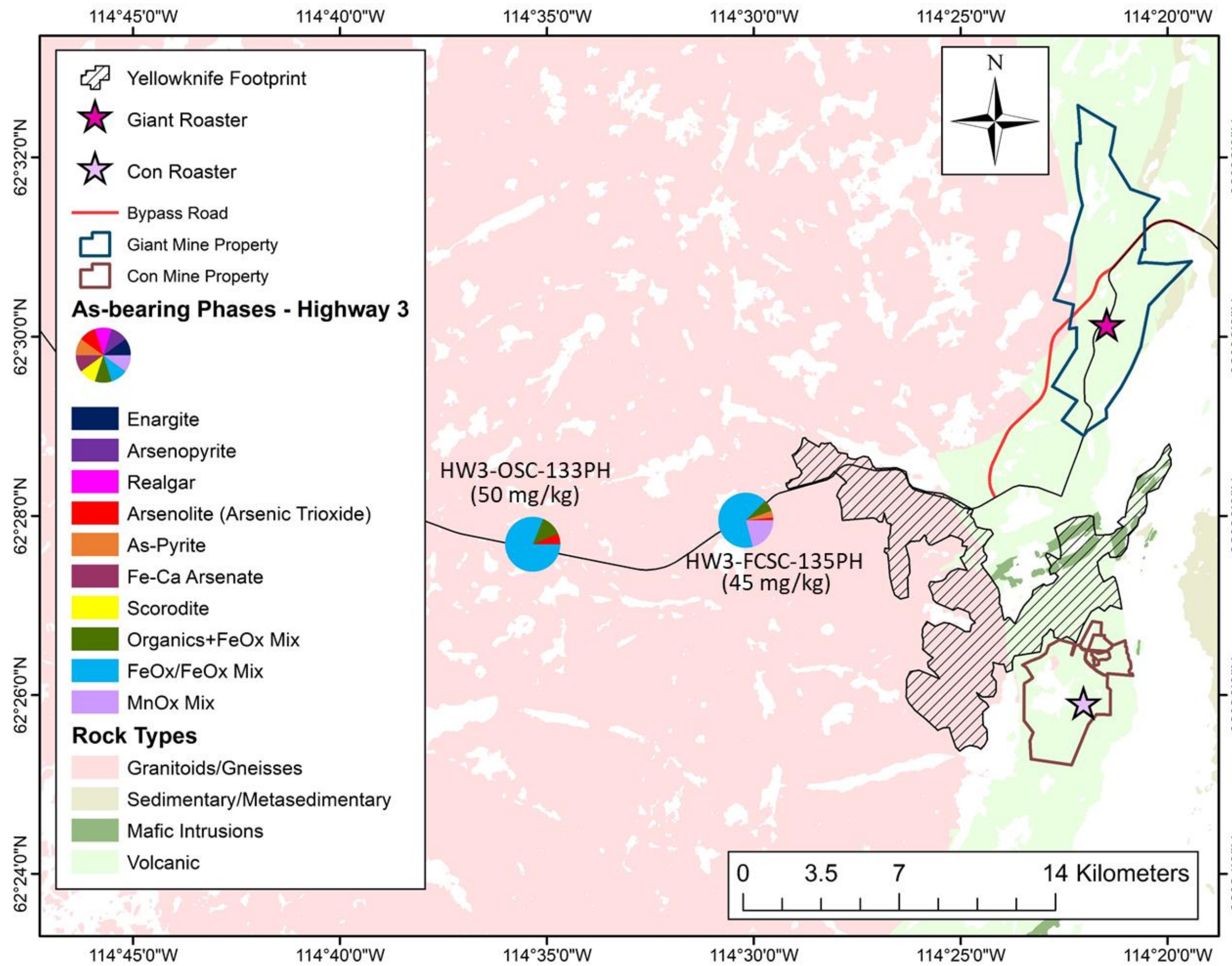

Figure 3-40 Weight percent distribution of As-bearing phases for two samples collected just outside the City of Yellowknife to the west along Highway 3.

3.4.6 TerraX Northbelt

The TerraX Northbelt target area is an area of active gold exploration. The target area also includes samples collected along the shores of Landing and Vital Lake, which were accessed over a two-day portage expedition. Total As concentrations in this area were highly variable between samples, but never exceeded the industrial remediation guideline of 340 mg/kg total As. The As-bearing phases for samples collected in this target area were also quite variable, as seen in Figure 3-41 and summarized in Table 3-8.

Table 3-8 Summary of As-bearing phases, their weight percent distributions and respective concentrations in TerraX Northbelt samples.

	Mineral Phase	**Arsenolite**	**MnOx Mix, with As**	**FeOx/FeOx Mix, with As**	**Organics + FeOx, with As**	**Fe-Ca Arsenate**	**Arseno pyrite**	**As-Bearing Pyrite**	**Total As Results (ASU) (mg/kg)**
	Density (g/cm^3)	**3.70**	**4.00**	**4.50**	**3.00**	**3.92**	**6.07**	**5.01**	
	wt % As in each Phase	**0.76**	**0.03**	**0.03**	**0.03**	**0.15**	**0.46**	**0.0068**	
LL-OSC-106PH	wt. % As	39%	0.13%	37%	24%	0%	0%	0.13%	
	mg/kg As	**78**	**0.25**	**73**	**48**	**0**	**0**	**0.25**	**200**
LL-PSC-117PH	wt. % As	0%	29%	58%	12%	0%	0%	0.33%	
	mg/kg As	**0**	**7.0**	**14**	**2.9**	**0**	**0**	**0.08**	**24**
LL-OSC-120PH	wt. % As	86%	0%	13%	0.75%	0%	0%	0.26%	
	mg/kg As	**50**	**0**	**7.9**	**0.44**	**0**	**0**	**0.15**	**59**
VL-FCSC-108PH	wt. % As	53%	8.2%	33%	4.8%	0%	0%	0.48%	
	mg/kg As	**64**	**9.9**	**40**	**5.7**	**0**	**0**	**0.57**	**120**
VL-OSC-110PH	wt. % As	94%	0%	3.4%	2.7%	0%	0%	0.08%	
	mg/kg As	**122**	**0**	**4.4**	**3.5**	**0**	**0**	**0.1**	**130**
BERRY-FCOSC-62PH	wt. % As	0	0	0	0	0	0	100%	
	mg/kg As	**0**	**0**	**0**	**0**	**0**	**0**	**6.1**	**6.1**
BERRY-OSG-63	wt. % As	3.5%	1.6%	75%	17%	0%	1.7%	0.29%	
	mg/kg As	**2.9**	**1.3**	**63**	**15**	**0**	**1.4**	**0.24**	**84**
TX-FCSC-144PH	wt. % As	48%	4.4%	35%	13%	0%	0%	0.13%	
	mg/kg As	**62**	**5.8**	**45**	**17**	**0**	**0**	**0.17**	**130**
TX-FCSC-144PH D	wt. % As	30%	23%	33%	14%	0%	0%	0.27%	
	mg/kg As	**39**	**30**	**43**	**18**	**0**	**0**	**0.35**	**130**
TX-OSC-145PH	wt. % As	0.27%	3.6%	66%	13%	0.034%	10%	7.4%	
	mg/kg As	**0.12**	**1.6**	**28**	**5.6**	**0.015**	**4.2**	**3.2**	**43**
TX-OSC-151PH	wt. % As	0%	0.088%	49%	51%	0%	0%	0.09%	
	mg/kg As	**0**	**0.063**	**35**	**37**	**0**	**0**	**0.065**	**72**
TX-OSG-152	wt. % As	1.5%	34%	52%	13%	0%	0%	0.0054%	
	mg/kg As	**3.0**	**71**	**108**	**28**	**0**	**0**	**0.011**	**210**
TX-OSG-152 D	wt. % As	9%	1%	80%	10%	0%	0%	0.21%	
	mg/kg As	**19**	**2.1**	**167**	**21**	**0**	**0**	**0.45**	**210**
TX-FCOSC-155PH	wt. % As	21%	53%	21%	3.9%	0%	1.1%	0%	
	mg/kg As	**16**	**42**	**16**	**3.1**	**0**	**0.86**	**0**	**78**

In forest outcrop sample BERRY-FCOSC-62PH, peat sample LL-PSC-117PH, and outcrop sample TX-OSC-151PH, no grains of As_2O_3 were identified. Outcrop sample VL-OSC-110PH had the highest measured As_2O_3 concentration (114 mg/kg) out of all samples the area, despite not having the highest overall total As concentrations. As_2O_3 comprised only 39 wt.% of the total As in outcrop sample LL-OSC-106PH, however due to the samples high total As value, this sample had the second highest As_2O_3 concentration (78 mg/kg) for the area. As-bearing Fe-oxides were found in all samples (ranging from 3.4 to 84 wt.%) except one sample collected on Berry Hill (BERRY-FCOSC-62PH). This sample had a very low total As concentration and did not polish well, having the lowest number of grains scanned out of all SEM mounted samples (113 grains). Due to the very low number of total grains analyzed in BERRY-FCOSC-62PH, it is likely these results are not truly representative of the soils present at this location.

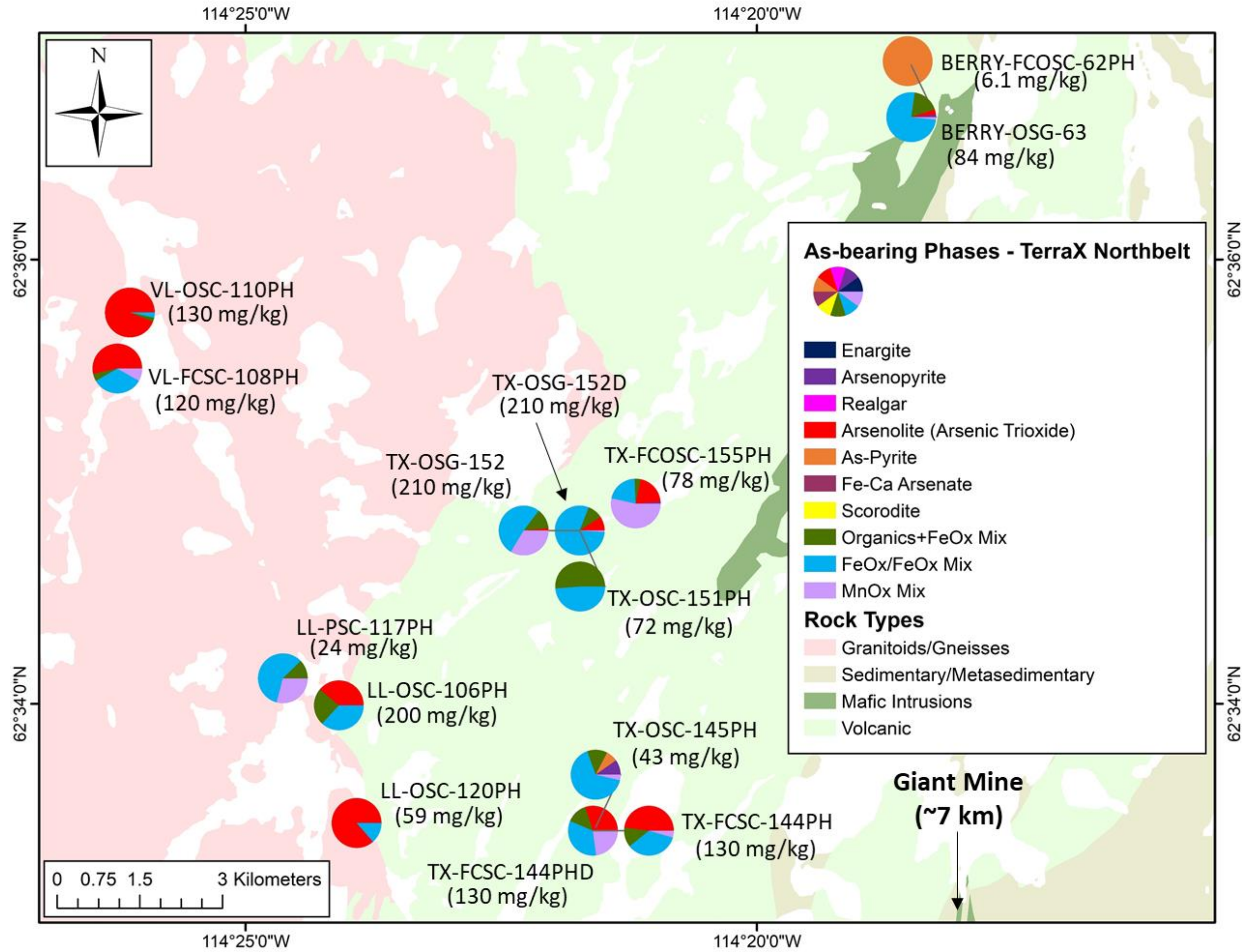

Figure 3-41 Weight percent distribution of As-bearing phases in samples collected in the TerraX Northbelt property, north of the Giant Mine Property.

Sample TX-OSC-145PH was anomalous in that it had very low As_2O_3 concentrations near surface and was the only collected sample that contained As_2O_3 at depth. This sample is discussed in Section 3.5 of this Chapter.

No distinct patterns in total As concentrations and As speciation are evident in the TerraX Northbelt samples. Total As values vary significantly between sample locations, and close-range samples were found with both a presence and absence of As_2O_3 grains (ie. TX-OSG-152 and TX-FCOSC-155PH, versus TX-OSC-151PH).

3.4.7 Distal Sites

Seven samples collected by helicopter access were selected for SEM analysis. Table 3-9 and Figure 3-43 below summarize the wt.% distribution and concentrations of the As-bearing phases identified in these samples. Six of the seven distal site samples had relatively low total As concentrations (< 100 mg/kg), with outcrop grab sample HOML-OSG-57, collected close to Homer Lake, having a significantly higher total As concentration of 450 mg/kg. Despite having high measured total As, no As_2O_3 was identified in this sample. Peat sample HOML-PSC-58PH taken close to Homer Lake was void of As_2O_3 as well. The other distal peat sample (SW3-PSC-89PH) was chosen over outcrop grab samples collected in the southwest to keep the focus on Public Health Layer samples. This sample did not mount and polish well, thus despite having a lack of As_2O_3 identified, it is possible some of the sample material could have been lost in the sample preparation process. Mason Lake outcrop sample MASL-OSC-65PH had the second highest measured total As at a distal site and the highest concentration of As_2O_3 identified making up 87 wt.% (75 mg/kg) of the As in this sample. Outcrop sample DUF-OSC-54PH was collected near Duck Fish Lake near the northern limit of the study area, at a similar distance from the Giant roaster as the Homer Lake samples (between 17 and 18 km), which were absent of As_2O_3. Despite DUF-OSC-54PH's relatively close proximity to the Homer Lake samples, the As in this sample was hosted primarily by As_2O_3 (58 wt.%) and Fe-oxides (40 wt.%), both indicative of contamination through roaster stack emissions and once again drawing attention to the seemingly irregular distribution of these contaminant emissions over the study area.

Table 3-9 Summary of As-bearing phases, their weight percent distributions and respective concentrations in distal site samples.

	Mineral Phase	Arsenolite	MnOx Mix, with As	FeOx/FeOx Mix, with As	Organics + FeOx, with As	Arseno pyrite	As-Bearing Pyrite	Total As Results (ASU) (mg/kg)
	Density (g/cm^3)	**3.70**	**4.00**	**4.50**	**3.00**	**6.07**	**5.01**	
	wt % As in each Phase	**0.76**	**0.03**	**0.03**	**0.03**	**0.46**	**0.0068**	
MIR-OSG-01PH	wt. % As	23%	21%	35%	18%	0%	3%	
	mg/kg As	**1.8**	**1.7**	**2.9**	**1.5**	**0**	**0.24**	**8.1**
MASL-OSC-65PH	wt. % As	87%	0%	11%	1.6%	0%	0.43%	
	mg/kg As	**76**	**0**	**9.2**	**1.4**	**0**	**0.37**	**87**
SW3-PSC-89PH	wt. % As	0%	0%	93%	1%	0%	6.1%	
	mg/kg As	**0**	**0**	**28**	**0.31**	**0**	**1.8**	**30**
HOML-OSG-57	wt. % As	0%	2.1%	79%	19%	0.83%	0.022%	
	mg/kg As	**0**	**9.5**	**353**	**83**	**3.7**	**0.098**	**450**
HOML-PSC-58PH	wt. % As	0%	0%	92%	5.3%	0%	3.1%	
	mg/kg As	**0**	**0**	**17**	**1.0**	**0**	**0.59**	**19**
EAST2-FCSC-66PH	wt. % As	23%	4.2%	24%	15%	30%	3.2%	
	mg/kg As	**12**	**2.2**	**12**	**7.9**	**16**	**1.7**	**52**
DUF-OSC-54PH	wt. % As	58%	0%	40%	2.3%	0%	0%	
	mg/kg As	**30**	**0**	**21**	**1.2**	**0**	**0**	**52**

No As_2O_3 was expected to be found in outcrop sample MIR-OSG-01PH, collected in the Mirage Islands, due to its southerly location out on Great Slave Lake (approximately 26 km from Giant roaster), and its relatively lower total As concentration. Regardless of these factors, two grains of As_2O_3 were identified, comprising approximately 23 wt.% of total As in this sample. It is suggested that these results be considered carefully. Figure 3-42 illustrates one of the As_2O_3 grains identified in MIR-OSC-01PH; a distinct grain is difficult to distinguish, and appears to be present in an irregular, rough area of the epoxy mount. Despite carefully cleaning the epoxy mounted soil samples at

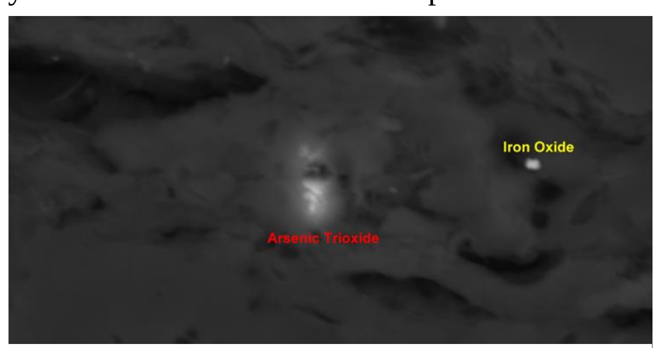

Figure 3-42 Grain of arsenic trioxide present in Mirage Island outcrop sample MIR-OSC-01PH. A small iron oxide particle is also identified. The As_2O_3 particle appears to occur in a rough part of the epoxy. When x-rayed using the SEM, a hole was burned through the As_2O_3 grain.

numerous stages throughout the polishing process, it is possible that a grain or two of As_2O_3 left on a grinding table or polishing wheel could become stuck in an irregular surface in the epoxy.

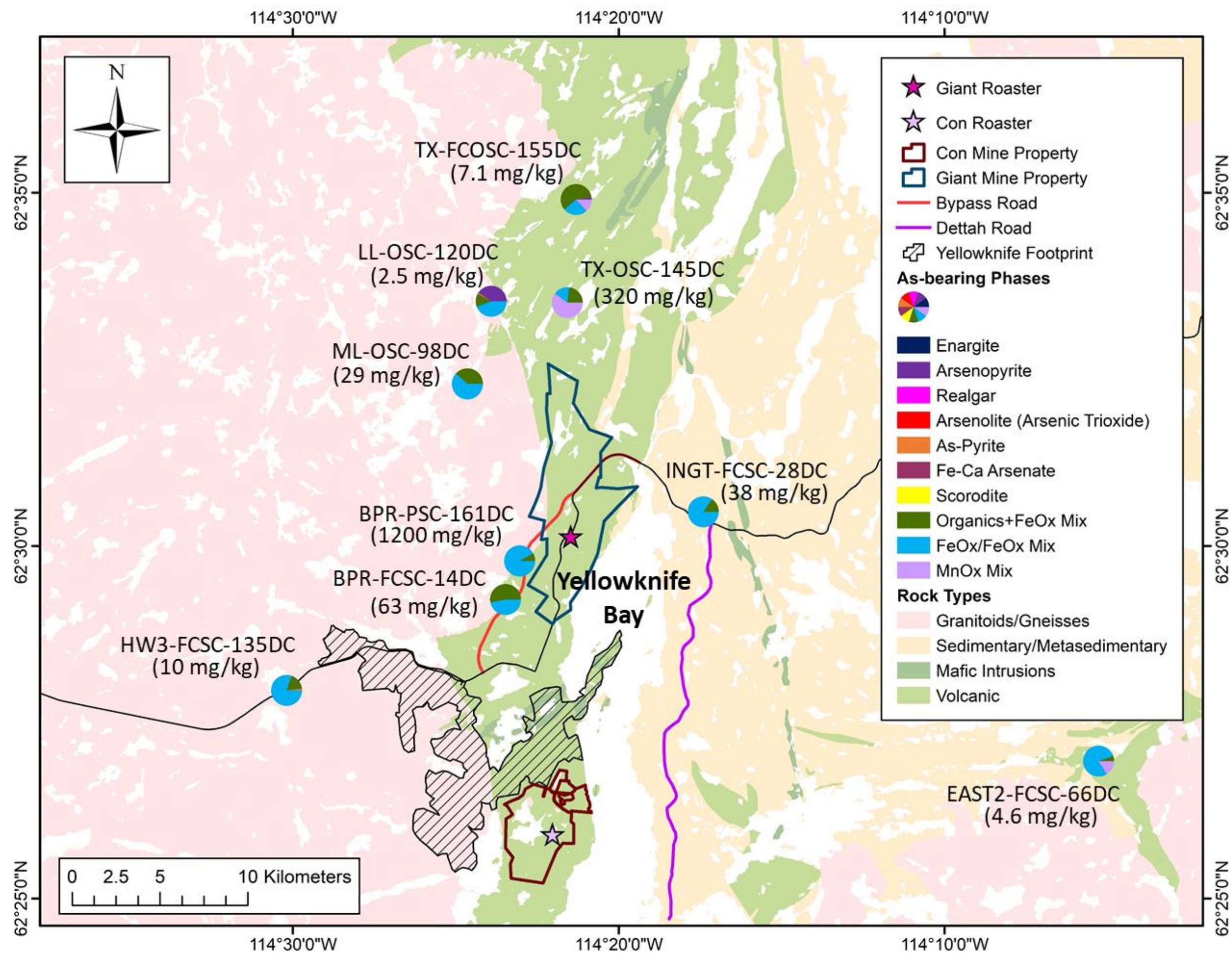

Figure 3-43 Weight percent distribution of As-bearing phases in soil samples collected from a variety of distal locations accessed using a helicopter.

3.5 Down Core Sample Analysis

To compare the arsenic concentrations and arsenic-bearing phases from deeper soils to the near-surface soils, down core samples were sub-sectioned from 37 cores and submitted for total elemental analysis. Nine of those samples were also run on the SEM for AM analysis. Figure 3-22 in section 3.1 illustrated the variations in down core total As concentrations throughout the study area. This section aims to expand on those findings and present the AM results for the 9 mounted down core samples.

3.5.1 Changes in Total Arsenic

Figure 3-44 Anomalous down core sample TX-OSC-145 with silty sand at surface beneath leaf litter and dark silty organic rich soil at depth.

Figure 3-45 shows the change in arsenic concentrations with increasing depth for 37 core samples. PHL results were plotted at a depth of 2.5 cm, the midway point between 0 to 5 cm. Down core (DC) samples were collected in 5 cm intervals sub-sectioned from the base of the cores and plotted using the midway point method. In 34 of the 37 samples, total arsenic concentrations decrease with increasing depth. The dashed lines connecting the PHL to the down core results were included to illustrate the decreasing trend in total As concentrations, but do not imply that As decreases linearly with depth. These results are similar to other studies completed in the Yellowknife area, which also reported significant decreases in total As concentration with depth (Hocking *et al.* 1978; Kerr 2006; Bromstad *et al.* 2015, 2017). For down core samples analyzed in this study, total arsenic concentrations ranged from 1.6 to 1200 mg/kg, with a median of 18.5 mg/kg.

Only one outcrop sample (TX-OSC-145) increased in total As concentration at depth. This sample transitioned from light sandy soil at the surface to darker silty soil at depth; this down core progression was anomalous in comparison to other samples collected, which typically exhibited an opposite downward trend (dark organic rich soil at the surface, with lighter sandy soil at depth). TX-OSC-145 is shown in Figure 3-44 and could be the result of soil being overturned or otherwise disturbed. At the time of sampling extensive exploration work was being completed in the TerraX Northbelt property where this sample was collected. Undisturbed sites were targeted; however, it is possible that the soil at this location could have been re-worked in some way at a previous date. Another explanation for this phenomenon could be the downward transport of elements from the surface layers to material at depth due to an increase in pore space and hydraulic conductivity characteristic of sandy material.

In two peat samples (BPR-PSC-161, LL-PSC-117), a second down core sample was collected due to distinct changes in material at depth. In sample BPR-PSC-161, the peat material transitioned from light brown, fibrous peat to a dark blackish-brown, soil-rich peat (approximately 20 cm), before transitioning back to lighter brown, fibrous peat at depth (approximately 36 cm). In sample LL-PSC-117, the material transitioned from peat at the surface, to a light grey clay material at depth; two samples were taken from the clay material, the first directly beneath the dark black soil-rich peat material (approximately 12.5 cm), and the second at a greater depth (approximately 22 cm). These samples show slightly different trends than the other down core samples collected, with LL-PSC-117 increasing in arsenic concentration from 23 mg/kg in the PHL to 43 mg/kg, before decreasing again to 19 mg/kg. BPR-PSC-161 had the highest PHL arsenic concentration reported throughout the entire sample area. This sample decreased from 3400 mg/kg in the PHL (4900 mg/kg in split sample) to 240 mg/kg total As at a depth of 20 cm (220 mg/kg in duplicate), before increasing to 1200 mg/kg total As at the furthest depth of approximately 36 cm (1100 mg/kg in duplicate). More peat samples would need to be collected and analyzed at various depth intervals to determine the reasons for these changes in total As concentrations at depth. One theory that could be investigated further would be to determine the role of permafrost on the accumulation of elements at depth. Arsenic could be transported downward through the relatively porous peat and become trapped in the material in contact with the permafrost boundary.

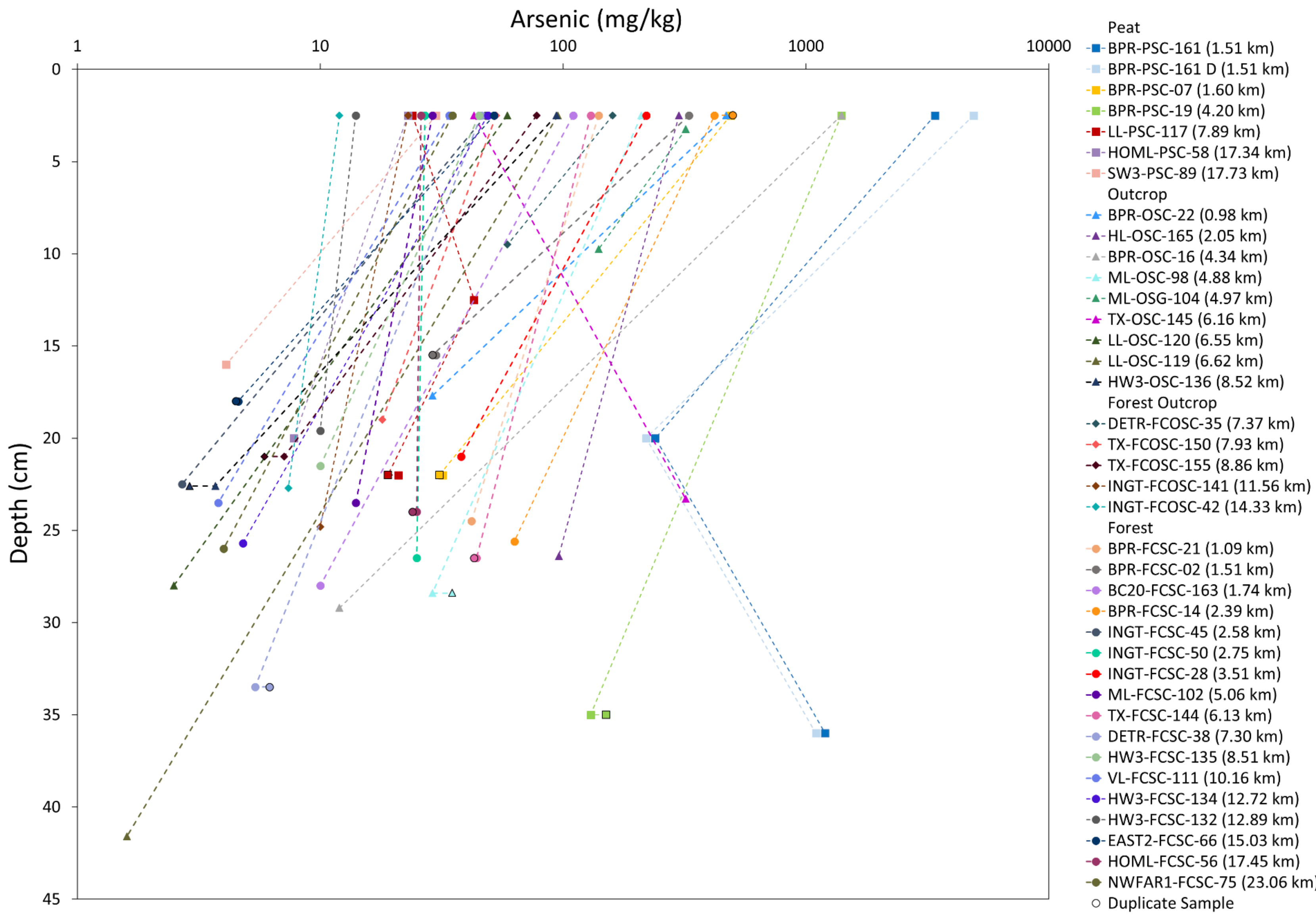

Figure 3-45 Down core sample results in 37 core samples showing a general trend of decreasing total As concentrations with increasing depth.

3.5.2 Arsenic Species in Down Core Samples

Ten parent DC samples and 1 DC split sample were mounted, run on the SEM and analyzed using AM. Figure 3-46 displays the modal mineralogy for these down core results. It is important to note the scale along the x-axis when observing these results. A very small percent of scanned samples consist of As-bearing phases. In all the samples, over 97% (modal percentage) of scanned particles were non-As-bearing phases, primarily consisting of common rock-forming minerals, such as quartz, feldspars, micas, and other silicate minerals (ex. enstatite, olivine, epidote, etc.). TX-OSC-145 was the only sample in which As_2O_3 (arsenolite) was found at depth, with two grains identified. Mn-oxides, Fe-oxides, and mixed oxide phases were the most prevalent As-bearing phases identified in DC samples. Table 3-10 below summarizes the wt.% distribution and respective concentrations of the As-bearing phases in down core samples plotted in Figure 3-47.

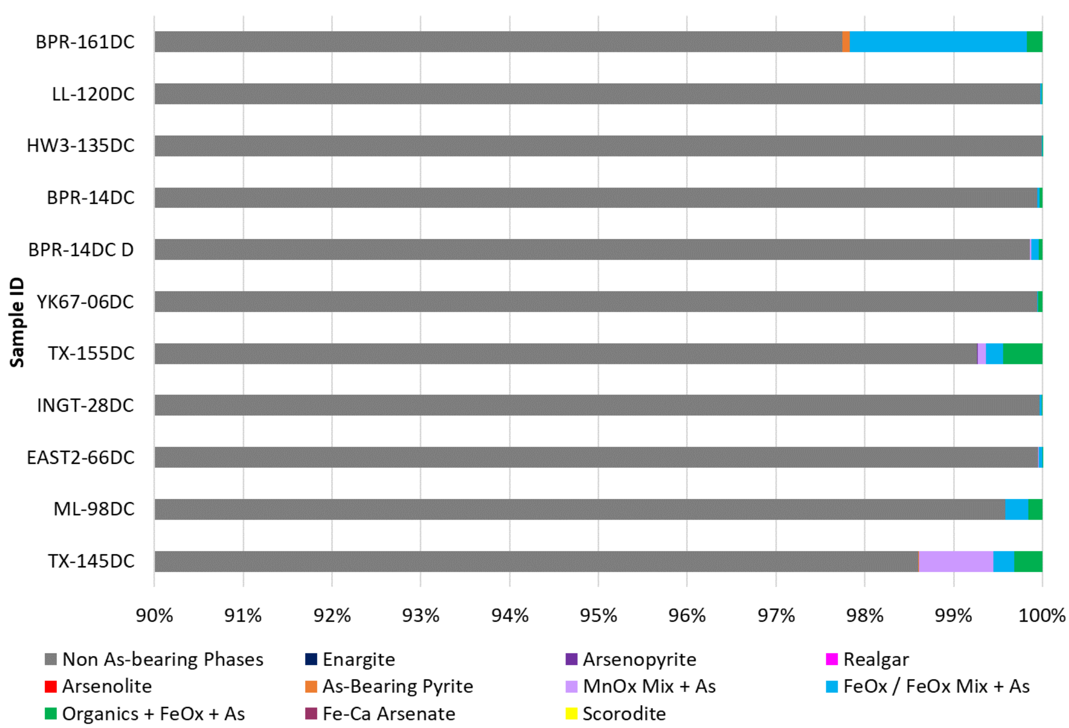

Figure 3-46 Modal mineralogy in down core samples. Over 97% of scanned particles in all down core samples belonged to non-As-bearing phases.

Table 3-10 Weight percent distribution and concentrations of As-bearing phases in down core samples.

	Mineral Phase	Arsenolite	MnOx Mix + As	FeOx/FeOx Mix + As	Organics + FeOx + As	Arsenopyrite	As-bearing Pyrite	Total As Results (ASU) (mg/kg)
	Density (g/cm^3)	3.70	4.00	4.50	3.00	6.07	5.01	
	wt % As in each Phase	0.76	0.03	0.03	0.03	0.46	0.0068	
BPR-FCSC-14DC	wt. % As	0%	0%	45%	55%	0%	0.17%	
	mg/kg As	**0**	**0**	**28**	**35**	**0**	**0.11**	**63**
BPR-FCSC-14DC D	wt. % As	0%	12%	60%	29%	0%	0%	
	mg/kg As	**0**	**7.4**	**38**	**18**	**0**	**0**	**63**
BPR-PSC-161DC	wt. % As	0%	0%	90%	9%	0%	1%	
	mg/kg As	**0**	**0**	**1086**	**102**	**0**	**12**	**1200**
LL-OSC-120DC	wt. % As	0%	0%	42%	14%	43%	1.4%	
	mg/kg As	**0**	**0**	**1.0**	**0.35**	**1.1**	**0.036**	**2.5**
TX-OSC-145DC	wt. % As	0.051%	61%	16%	23%	0%	0.076%	
	mg/kg As	**0.16**	**195**	**51**	**74**	**0**	**0.24**	**320**
TX-FCOSC-155DC	wt. % As	0%	14%	25%	60%	2.2%	0.011%	
	mg/kg As	**0**	**0.96**	**1.7**	**4.2**	**0.16**	**0.00078**	**7.1**
ML-OSC-98DC	wt. % As	0%	0.0021%	60%	40%	0%	0.093%	
	mg/kg As	**0**	**0.00061**	**17**	**12**	**0**	**0.027**	**29**
INGT-FCSC-28 DC	wt. % As	0%	0%	83%	16%	0%	0.61%	
	mg/kg As	**0**	**0**	**32**	**6.1**	**0**	**0.23**	**38**
HW3-FCSC-135 DC	wt. % As	0%	0%	80%	18%	0%	1.9%	
	mg/kg As	**0**	**0**	**8.0**	**1.8**	**0**	**0.19**	**10**
EAST2-FCSC-66DC	wt. % As	0%	17%	76%	5%	0.72%	0.69%	
	mg/kg As	**0**	**0.78**	**3.5**	**0.25**	**0.033**	**0.032**	**4.6**

At first glance, the down core samples in Figure 3-47 do not look like the As speciation results found in PHL samples. Arsenic trioxide is not nearly as prevalent, despite some down core samples being chosen from areas with prevalent As_2O_3 contamination. Bypass Road samples BPR-FCSC-14PH and BPR-PSC-161PH both contained high wt. % values of As_2O_3 (88 wt.% and 74 wt.%, respectively), but had no As_2O_3 present in their respective down core samples. The absence of As_2O_3 in soils at depth enforces the hypothesis that roaster stack emissions have contributed to elevated As concentrations in near surface soils surrounding

Yellowknife, and indicates that As_2O_3 is not being transported downward through the soil media from the surface.

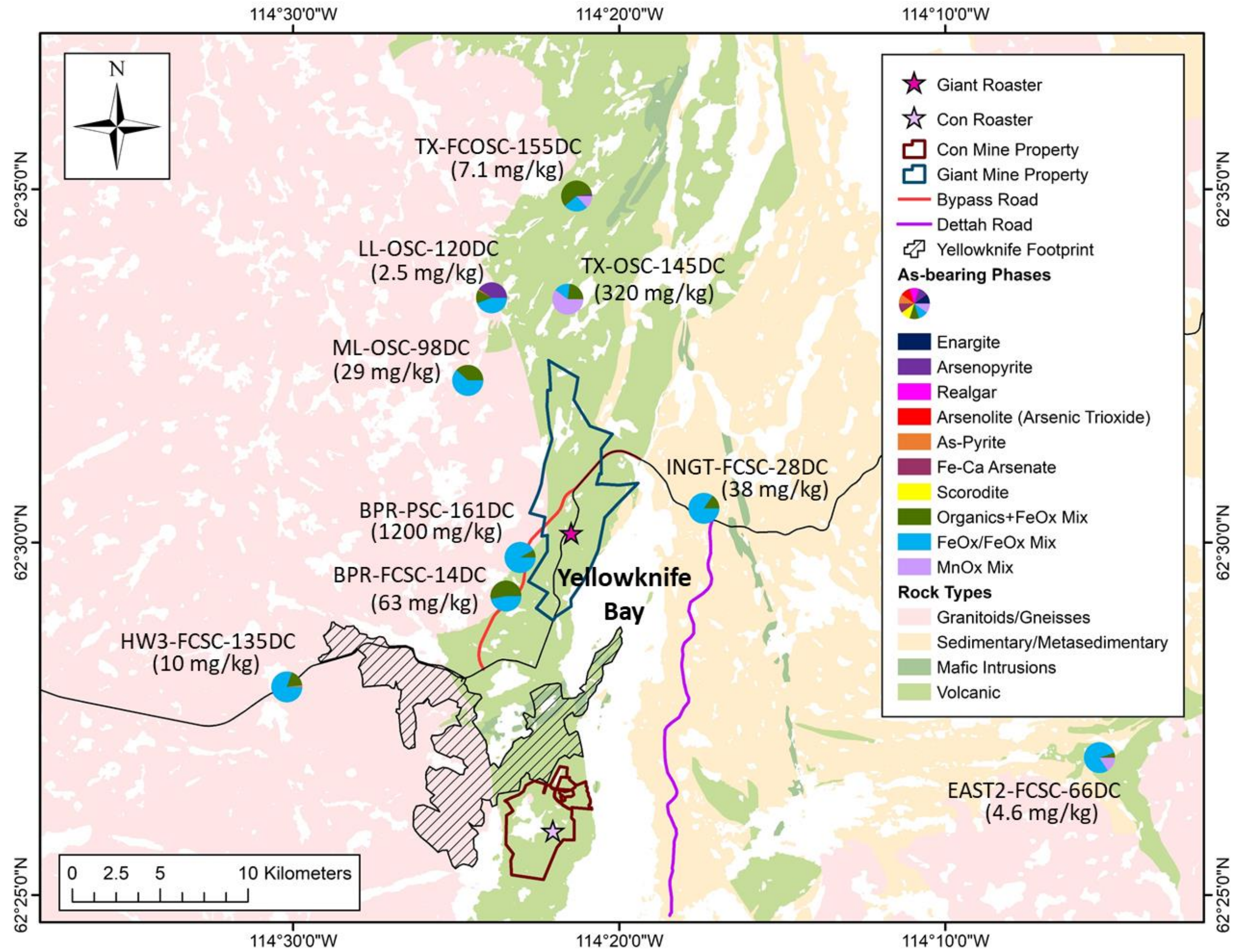

Figure 3-47 As-bearing phases identified in down core samples by SEM/AM.

3.6 Discussion

Arsenic contamination around Yellowknife, NT has been an ongoing issue since the beginning of ore roasting at Giant Mine in 1949. Inadequate emission controls during the early years of operation is known to have resulted in the release of more than 20,000 tonnes of roaster-generated As_2O_3 to surrounding environments, with approximately 86% of emissions released prior to 1963 (Jamieson, 2014; Wrye, 2008). The presence of contamination in soils around Yellowknife has been documented numerous times following the onset of mining in the region, however a comprehensive soil survey looking at As speciation in regional soils had not yet been completed. With the use of scanning electron microscopy, coupled with AM, the distinct phases in which As persists in near surface soils could be determined. Studies completed by Wrye (2008) and Bromstad (2011) first confirmed the presence of As_2O_3 and roaster-generated Fe-oxides in soils on the Giant Mine property, however since then limited work had been done to investigate the presence of anthropogenic As contaminated in regional soils beyond the Giant Mine property.

This research has confirmed elevated As concentrations in Yellowknife soils can be attributed to anthropogenic influences. This is a result that has not gone unnoticed by local Yellowknife and Dene First Nations citizens residing in the area; after three years of uncontrolled roaster emissions at Giant (1949-1951), the accidental poisoning death of a local Dene child led to the first development of As emission controls (Sandlos and Keeling 2012), and still resonates with the local community. Today the risk of exposure to As is still a prevalent topic of conversation amongst Yellowknife area residents, with increasing media coverage, and the initiation of a health effects biomonitoring program in July of 2017 (Kyle 2017).

3.6.1 Factors Affecting Total As Concentrations

Various parameters and their influence on total As were investigated and reported in section 3.2 of this report. Distance was one of the most influential determinants of total As concentrations in soils, with As levels significantly decreasing with increasing distance from the contaminant sources – a result also seen in numerous other studies completed throughout the study area looking at not only soils but lake waters and sediments (Hocking *et al.* 1978; Hutchinson *et al.* 1982; Kerr, 2006; St.Onge, 2007; Palmer *et al.* 2015; Galloway *et al.* 2015; Houben *et al.* 2016; Bromstad *et al.* 2017). Direction also played an important role in the distribution of As, with samples collected in the downwind direction having the greatest correlation in terms of decreasing total concentrations with increasing distance from the roaster. Elevation changes were not significant enough throughout the study area to have a clear effect on measured As values. The grain size of As_2O_3 did impact the distance roaster dust emissions were transported throughout the region, with larger grains (upwards of 45 microns) only found in areas proximal to Giant Mine, and with maximum grain sizes decreasing with increasing distance.

Terrain type also appeared to have an impact on As loading patterns seen throughout the region, with outcrop and peatland samples having the highest reported As levels. Soil pockets on outcrops were observed to trap water after precipitation events, acting as a sink for As carried from higher topographic areas due to washdown effects. Outcrop soil pockets had previously been identified as areas with elevated As levels by Wrye (2008) and Bromstad (2011, 2017), thus it was expected that outcrop samples would contain high overall As concentrations. Peat samples were difficult to analyze due to the fluffy, organic-rich nature of the material. They did not mount in epoxy easily and did not polish well as the peat material had a high affinity for water and was easily plucked out of the epoxy during polishing, making it difficult to draw conclusions in regard to how As was hosted in this terrain type. Based on these results however, it could be suggested that areas with poor drainage capabilities, or sinks for runoff, have a greater chance at accumulating As compounds. Outcrop and peatlands were also void of tall or dense tree canopies, meaning that roaster dust emissions would have been deposited directly on surface soils at these sites, and not accumulated on the leaves, branches, or bark of trees overshadowing the soil material below. Kerr (2006) suggested this accumulation of roaster derived dust on vegetation surfaces, or the ability for dissolved As to be taken up by the roots of plants, likely accounts for the elevated As values measured in spruce bark and Labrador tea samples collected in the area.

3.6.2 Relationship Between Total As, As_2O_3, and Other Elements

As, Sb and Au were the strongest correlated elements throughout the sampled areas. These findings coincided with those found by Bromstad *et al.* (2017), however the most recently collected samples did not share the same Sb to Au ratios as those collected by Bromstad (2011) and Golder (2015). Bromstad *et al.* (2017) reported outcrop and PHL samples with a Sb/Au signature indicative of pre-1964 deposition. Samples collected during the summer of 2015 had a Sb/Au signature more representative of dust emissions released out of Giant's roaster stack post-1964. This was not expected, due to the significant decrease in Au, Sb and As levels following the installation of more efficient emission controls by 1964.

Reproducing the same age-related trends between Sb/Au as reported by Bromstad et al. (2017), may not have been feasible for several reasons. The difference in soil composition between soils formed in highly mineralized zones (YGB), and those derived in areas distant from a source of mineralization, may have impacted the distribution of Au throughout the study area.

Despite the assumption that Au in near surface soils was likely sourced from poor control over stack emissions in the early years of operation, some Au in soils on the Giant Mine property (Bromstad (2011) and Golder (2015) soils were collected within the Giant Mine property lease (Bromstad 2011, Bromstad *et al.* 2015)) may have also been derived from the mineralized underlying geology. The ratio of Sb to Au in roaster dust emissions is more likely a cluster of ranges around the two points for pre- and post-1964 dust shown in Figure 3-30. These ratios are a representative estimate of the exact metal ratios in dust released from the Giant roaster stack before and after 1964. The trendlines for the various data sets illustrated in Figure 3-30 were extended forward to show where the data sets fall in relation to the pre- and post-1964 dust ratios. The trendlines for all Maitland 2015 data and Bromstad 2011 outcrop core data point to a dust ratio between the reported pre- and post-1964 dust ratios, thus the samples collected for this study cannot be definitively dated using the Sb/Au dust ratios.

The discrepancy in pre- and post-1964 emission trends in soil samples collected on and off the Giant Mine property lease could also be due to the relative weight of gold particles (density – 19.32 g/cm^3) in comparison to the roaster generated Fe-oxides (density of maghemite = 4.9 g/cm^3) and As_2O_3 (3.74 g/cm^3) released out the stack. Figure 3-48A compares total Au to total Pb concentrations (density = 11.34 g/cm^3) reported in PHL samples. Data displayed in blue was plotted at half the detection limit. The relationship between these heavier elements in PHL samples was well correlated (R^2 = 0.8411). Figure 3-48B and Figure 3-48C show the relationship of these heavier elements with respect to distance from the Giant roaster stack. Both Au and Pb concentrations in PHL samples decrease quickly with increasing distance from the Giant roaster, suggesting that these heavier particles are likely concentrated in PHL soils on or proximal to the Giant mine property. It is logical to assume that with a relatively higher density, Au particles would be some of the first grains to fall out of roaster emissions and settle in near-surface soils. If Au particles in roaster dust were unable to travel to further distances with the As_2O_3 dust and other emission contaminants, the ratio between Au and Sb at sample sites further from the roaster would not be representative of the actual Sb/Au ratio in the dust released out the stack. Using Sb/Au ratios to date the influence of dust emissions in soils around Giant Mine is only accurate for areas located closest to the source of emissions. The use of Sb/Au ratios is not an accurate means of dating roaster generated dust in the off-lease environment.

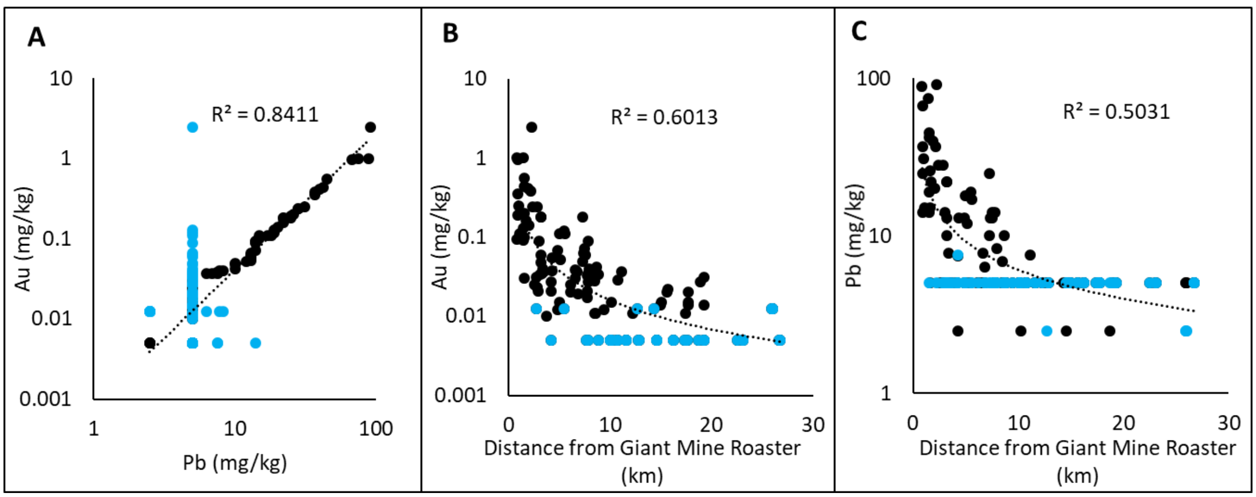

Figure 3-48 A: Total Au vs total Pb concentrations in PHL samples. B: Total Au in PHL samples compared to distance from the Giant Mine Roaster. C: Total Pb in PHL samples compared to distance from the Giant Mine Roaster.

Total As concentrations have also been compared to total As_2O_3 concentrations in Figure 3-49 below. Samples with higher total As did tend to have increased levels of As_2O_3, especially in the Bypass Road, Dettah Road, Ndilǫ, and Martin Lake target areas, which were located closest to the sources of contamination. Samples collected to the East (Ingraham Trail), and North (TerraX Northbelt) did not have as strong of correlation between total As and total As_2O_3 concentrations. TerraX Northbelt, Highway 3, and Ingraham trail samples that fall further below the total As versus total As_2O_3 trendline, likely deviate from this trend due to the influence of high natural As concentrations in NWT rock units; high As concentrations in Yellowknife area soils, are not entirely dependent on the influence of roaster-emission contamination.

These results were similar to those found for total As concentrations versus direction, in which samples to the East were found to be significantly different than those to the West and South. Distance from the contaminant sources and direction with respect to prevailing winds have contributed to the distribution of roaster dust emissions throughout the study area.

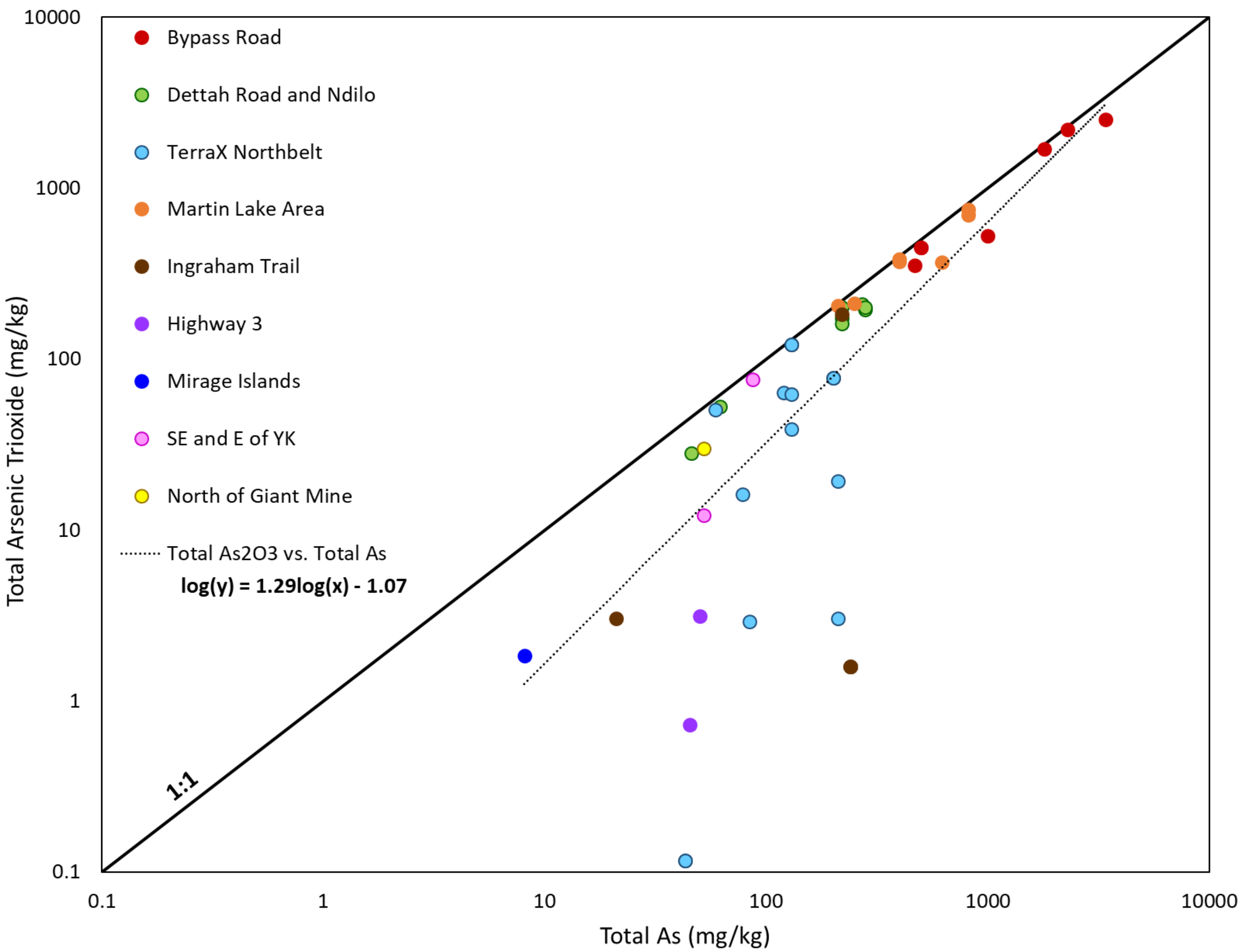

Figure 3-49 Total As versus total As_2O_3 concentrations in AM samples. Samples with As_2O_3 concentrations < 1 mg/kg could not be plotted because logarithmic scales were used to plot the data.

3.6.3 Arsenic hosts in Near Surface Soils (PHL and grab samples)

Arsenic, like many chalcophile elements, is released by sulfide oxidation, can be modified by various biogeochemical processes, and can be attenuated by adsorption or co-precipitation with Mn or Fe-minerals, clays, and organic matter (Bowell *et al.* 2014). Large variations in As concentrations are often observed in nature on all scales as they may be influenced by a number of natural processes. Figure 3-50 below was modified from Bowell *et al.* (2014) and summarizes the methods in which As is cycled within the surface environment. Biological transformations and the oxidation or reduction of As can form species that will mobilize or attenuate (Bowell *et al.* 2014). Organic matter can influence the speciation and complexation of arsenic.

This study investigated the presence of 10 As-bearing phases in Yellowknife area soils, as previously outlined at the beginning of section 3.4. Table 3-11 summarizes the number of near surface samples in which the As-bearing phases were identified, as well as the maximum number of grains of a given phase found in an automated mineralogy sample. Enargite and Fe-Ca arsenate phases were very rarely found in near surface (PHL and grab) soil samples with one grain of enargite identified in 2 samples, and 3 samples with Fe-Ca arsenate identified (maximum of 3 grains). Scorodite was the even less frequent, with only one grain identified in one sample collected in Ndilǫ.

The roaster-generated dust from Giant Mine contains an average of 60 wt.% As (INAC, 2007). As_2O_3 comprises approximately 80% of the dust, with the second most common As-bearing phase belonging to roaster-generated Fe-oxides (INAC, 2007; SRK, 2002a). Results from this study confirm the presence of this roaster-generated dust in soil media beyond the mine lease property and in many instances the majority of As is present as either As_2O_3 or Fe-oxide phases. Fe-oxides and Fe-oxide mixes (including those mixed with organic matter), were the most common As-bearing phases found in near surface soils. It was difficult to distinguish between authigenic and roaster-generated Fe-oxides or Fe-oxide mixes that contained As using SEM and automated mineralogy methods. Roaster-generated Fe-oxides have been identified primarily as concentrically zoned (Figure 3-39), nanocrystalline grains of maghemite with <0.5 to 7 wt.% As (mixture of As^{5+} and As^{3+}); some of these Fe-oxides grains were also identified as a mixture of maghemite and hematite (Figure 3-39) (Walker *et al.* 2005). Thus some of the particles identified as iron oxides might be roaster-generated maghemite or hematite and others might be the type of iron oxyhydroxide that forms naturally in soils, although the As associated with both is likely from stack emissions. As-bearing pyrite and As_2O_3, were the next most common As-bearing phases identified in near surface soils, with As_2O_3 identified in approximately 83% of the collected samples. The presence of As_2O_3 in near surface samples is concerning for local Yellowknife residents, as it is considered one of the most bioaccessible forms of As (Plumlee and Morman, Mine Wastes and Human Health 2011). It has been suggested that the persistence of this relatively soluble form of As (As_2O_3 solubility = 10 to 16 g/L (Pokrovski *et al.*, 1996), versus arsenopyrite solubility = 0.00999 g/L at 25^{o}C (Craw *et al.*, 2003)) could be due to the Sb content in As_2O_3 dust at Giant (Riveros *et al.*, 2000; Bromstad *et al.*, 2017).

Table 3-11 Summary of As-bearing phases and the number of samples out of 50 samples containing each phase, in addition to the maximum number of grains found in a near surface sample.

	Enargite	Arsenopyrite	Realgar	As_2O_3	As-Bearing Pyrite	MnOx Mix, with As	FeOx/FeOx Mix, with As	Organics + FeOx, with As	Fe-Ca Arsenate	Scorodite
# of Samples Containing As-Bearing Phases	2	12	11	41	45	30	49	49	3	1
Maximum # of Grains Found in a Given Sample	1	8	10	689	44	3179	21103	8760	3	1

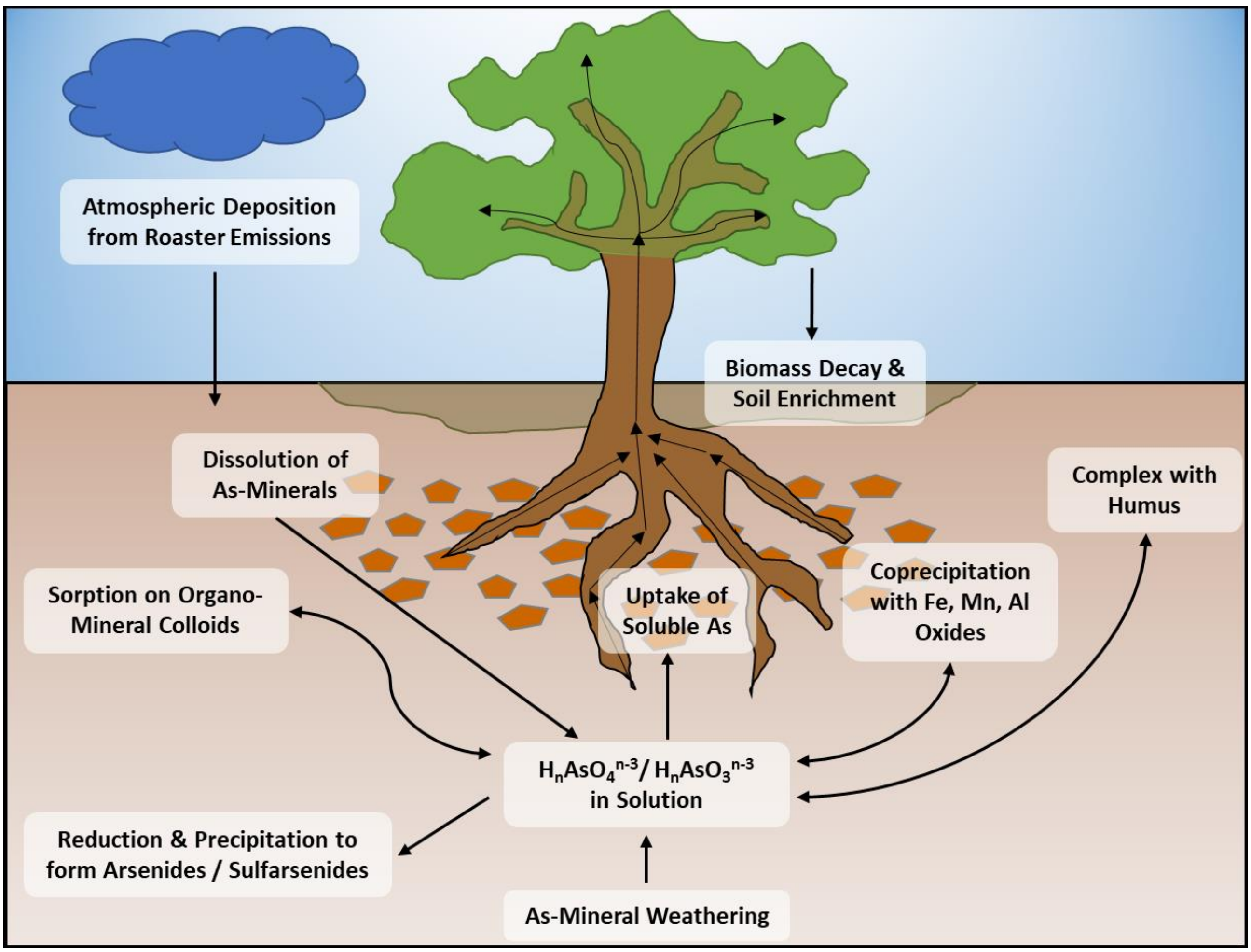

Figure 3-50 Arsenic cycling within the surface environment, modelled after (Bowell, et al. 2014).

Mn-oxide mixes containing As were also quite common, occurring in 30 of the 50 scanned epoxy mounted soils. Manganese oxides commonly occur in soils as minor constituents, primarily as dark coatings on particle surfaces. These oxide phases are chemically complex, often amorphous in nature, and exist in a continuous range of compositions between MnO and MnO_2. Mn-oxides have a strong adsorption capacity for metal cations due to their pH dependent charge, small particle size and large surface area (Goldberg, et al. 2012), which likely explains the presence of As with these phases in some soil samples.

As-sulphide phases, arsenopyrite and realgar, were identified in approximately one fifth of samples. Realgar phases were identified most commonly in samples collected in saturated fenland areas where reducing conditions leading to the precipitation of realgar would be expected to exist.

Local variability in total As concentrations is not well defined, but is believed to be the result of natural variability in soils and the irregular nature in which airborne emissions are dispersed throughout an environment. Biomass loading of As in near surface samples could also play a role in the irregular distribution of As concentrations in Yellowknife area soils. If vegetation from a given area has a higher affinity to uptake dissolved As from soil media, it can become concentrated in the stems, needles or leaves of said vegetation. When those leaves, stems or needles fall off and are re-introduced to the surface environment it can lead to an enrichment in metals concentrated within the plant media (Bowell, et al. 2014).

3.6.4 Arsenic Hosts in Down Core Samples

In down core samples, only 6 of the 10 As-bearing phases were present. These phases, and the number of grains found in each of the down core samples are outlined in Table 3-12.

Only two grains of As_2O_3 were found in one down core sample collected from TerraX Northbelt property. In sample BPR-FCSC-14PH, 689 grains of As_2O_3 were identified in the PHL, however no grains were found in the down core sample and down core sample duplicate from this sample location. This discovery indicates that As_2O_3 is not being transported downwards from the surface to soil at depth and confirms that the introduction of As_2O_3 to soils is likely the result of atmospheric deposition from roaster stack emissions. Fe and Mn-oxides were the most common As-bearing phases found in down core samples. This result was not surprising as As is known to co-precipitate with Fe, Mn and Al-oxide minerals; it is to be expected that these phases would be present in more evolved soil horizons at depth. Kerr (2006) also reported a decrease in As concentrations with depth, but did not identify the species of As present in down core samples.

Table 3-12 Summary of As-bearing phases and the number of grains for each phase identified in down core samples.

	TX-OSC-145DC	ML-OSC-98DC	EAST2-FCSC-66DC	INGT-FCSC-28DC	TX-FCOSC-155DC	BPR-FCSC-14DC D	BPR-FCSC-14DC	HW3-FCSC-135DC	LL-OSC-120DC	BPR-PSC-161DC
Arsenolite (As_2O_3)	2	0	0	0	0	0	0	0	0	0
Arsenopyrite	0	0	1	0	1	0	0	2	0	0
As-Bearing Pyrite	10	6	5	9	4	1	5	5	0	2
MnOx Mix, with As	5890	1	41	0	221	0	0	0	2	0
FeOx/FeOx Mix, with As	1852	1185	79	240	481	17	41	39	26	19
Organics + FeOx, with As	6006	2685	49	135	1724	49	20	11	32	4
Total Grain Count	**542370**	**466755**	**318241**	**273700**	**210252**	**66917**	**118961**	**90819**	**23688**	**579**

3.6.5 Estimating Background Concentrations

Total solid phase arsenic concentrations in soils generally range between 0.1 and 55 mg/kg, with estimates for the global average baseline concentration falling between 5 to 10 mg/kg (Boyle and Jonasson 1973, Smedley and Kinniburgh 2002). Higher arsenic concentrations in soils are often attributed to geogenic anomalies or anthropogenic activities, such as atmospheric loading from roaster stack emissions (Smedley and Kinniburgh 2002, Bauer and Blodau 2006, Wenzel 2013). The average As in content in soils across Canada is 6.6 mg/kg (Reimann *et al.* 2009), whereas background arsenic concentrations in the Yellowknife area have been a topic of debate for quite some time. As mentioned previously in section 3.2.1 earlier studies (eg. Hocking *et al.* 1978, Hutchinson *et al*. 1982, Kerr 2006, St. Onge 2007) investigating soils in the area estimated background concentrations ranging anywhere between 0 to 300 mg/kg total As depending on bedrock geology. For unmineralized areas, there is a general consensus between studies that average background As concentrations in the Yellowknife area fall between 25 and 30 mg/kg (Hocking *et al.* 1978, Hutchinson *et al.* 1982, Kerr 2006, St.Onge 2007). For this study, too few samples were collected at distal reference locations uncontaminated by roaster emissions to confidently draw conclusions in regards to a reasonable background As concentration. The addition of more samples at distances between 20 and 30 km from the contaminant source for the preparation of NWT Open File 2017-03, resulted in a median As concentration of 40 mg/kg, which is just slightly higher than the average background concentrations found in other studies. Two grains of As_2O_3 were identified in a sample collected approximately 26 km from the Giant roaster on the Mirage Islands south of Yellowknife, out on Great Slave Lake; thus collecting samples at greater distances would be required to accurately estimate background arsenic concentrations in Yellowknife area soils. Following the collection of the soil samples reported in this thesis, MacDonald *et al.*(2016) reported seeing possible evidence of As contamination in lake sediments located between 100 and 430 km south of Giant Mine. Lake sediments sampled from two farfield lakes had peaks in As concentrations dating back to the 1950s, coinciding with the commencement of roasting at Giant Mine (MacDonald *et al.* 2016).

3.6.6 Comparison to Past Studies

In 1978, Hocking *et al.*, released a report documenting the impact of gold smelter emissions on vegetation and soils surrounding the Yellowknife area. At that time, Giant and Con were both actively operating mines. Widespread sampling of vegetation and soils was completed at 52 sites surrounding Yellowknife. The primary goals of the survey were to determine levels and patterns of contamination. Plant ecology and conditions were also investigated at 43 of the sites, which were selected to represent effective parameters such as soil type, direction and distance from contaminant sources. The sample sites were located within 40 km of Yellowknife, and from each site 4 one-quart samples of soil were collected from the A0, A1, A2 and B soil horizons. Samples of new willow browse growth, black spruce needles and twigs, rock lichens, and soil surface lichens were collected to assess the influence of As_2O_3 and SO_2 emissions on plant health.

The depth of soil horizons varied greatly between sites. The heterogeneity of vegetation between the sample sites made comparing the health of plant ecology across the region relatively difficult. Within 1 km of the Giant roaster, especially to the W and NW, there was drastic deterioration of both forest and outcrop vegetation, with trees and shrubs showing symptoms of SO_2 injury. Hocking *et al.* (1978) estimated background As concentrations in near surface soils are approximately 25 ppm.

Hocking *et al.* (1978) determined arsenic contamination in surface soils and vegetation from roaster emissions decreased roughly in an inverse square monotonic pattern around both point sources of contamination (Giant and Con roasters) (Figure 3-51). The steep slope of the profile suggested particulate fallout likely dominated over gaseous dispersion methods, which could be due to the rapid condensation of arsenic trioxide vapor. When Hocking *et al.* completed their study in 1978, it was estimated that the contribution of Con Mine is expected to be roughly one third of that from Giant Mine. This estimated contribution is higher than what might be expected from emissions data, due to the possible remobilization and transport of arsenic from the tailings ponds at Con Mine. Present day estimates suggest Con Mine's contribution of environmental contaminants was roughly one tenth of that from Giant. If Giant Mine had stopped roasting at around the same time as Con Mine, the effects of roaster emissions around Yellowknife may not have been as severe today; however, 86% of total Giant emissions are known to have occurred prior to 1963. For the 2015 study it was difficult to make any definite connections in the differences between Giant and Con Mine emissions on soil arsenic due to the relatively smaller number of samples collected proximal to the Con roaster. Work has since been completed by Oliver (2018) to distinguish the differences between Giant and Con Mine contamination in Yellowknife area soils.

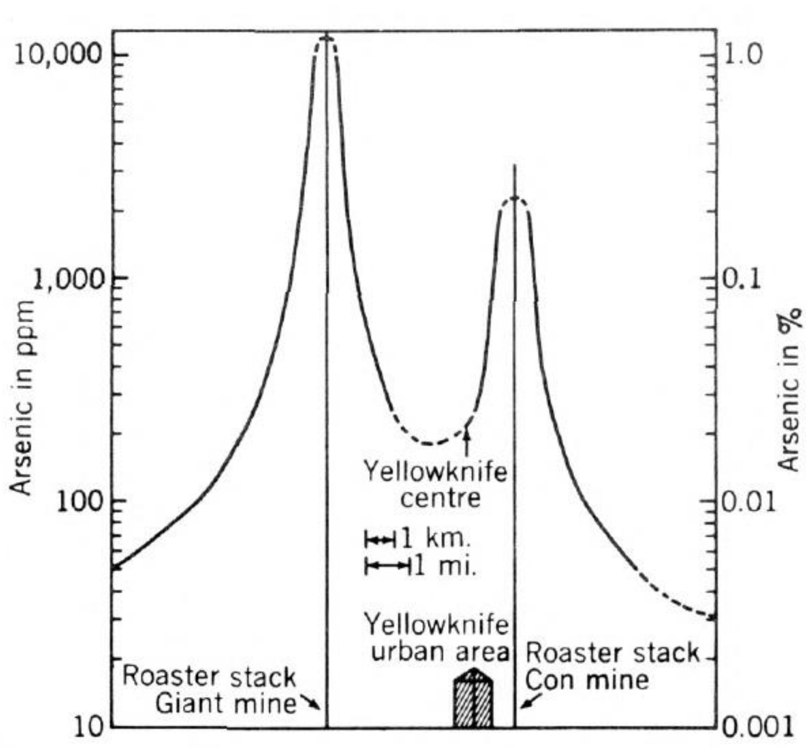

Figure 3-51 Profile of arsenic in surface soils and lichens around point sources of contamination in Yellowknife. Reproduced from Hocking et al. (1978).

Hocking *et al.* proposed that the arsenic concentration in the combined soil lichen and surface soils (A0) could be 90% empirically described by the equation:

$$A = \frac{1650}{x^2} + \frac{550}{y^2} + 25 \quad \text{[Eq 3-1]}$$

Eq 3-1 - Arsenic concentration as predicted by Hocking et al. (1978). Concentration is modelled based on distances from the Giant and Con roasters, where x represents the distance from the Giant roaster, and y the distance from the Con roaster.

Assuming the PHL samples collected in 2015 are approximately representative of the combined soil lichen and A0 soil horizon collected by Hocking *et al.* (1978), Table I in Appendix I was created to illustrate the relative percent difference that exists between measured As concentraions in PH samples and As content predicted by Eq 3-1. The predicted As concentrations calculated using Hocking's equation were generally much higher than the actual measured values collected in 2015. This could be due to a number of reasons including - a high degree of local variability in near surface soils, various degrees of vegetation cover at sites and differences in the distribution of vegetation throughout the study area between 1978 and present day, a greater volume of soil collected in PHL samples (0 to 5 cm) leading to dilution of arsenic concentrations, or the re-working and transport of As post airborne deposition. For the 125 samples from which PHL samples could be extracted (122 cores, 3 grabs with depth control), 23 samples (18%) had a relative percent difference between the measured concentration and that predicted from Hocking's equation of less than 20%.

For a study completed by Hutchinson *et al.* (1982), soils were collected from 24 sites around Yellowknife using aluminum cores, much like the method used for collecting soil cores in this study. Soils were obtained from 0-2, 2-4, and 4-6 cm depths. Sites for the study were selected based on accessibility and similarity of exposure. Exposed granitic outcrops were selected as high elevation areas that were uninfluenced by drainage, and would represent direct aerial deposition of arsenic, once again like the approach used in in this study.

Surface soil arsenic results were mapped against distance from the nearest contamination source to create best estimates of isopleths around the City of Yellowknife. Concentrations were highest in the top 0 to 4 cm of soil, and decreased with depth, indicating loading from an atmospheric source. Prevailing wind direction was also noted as a strong influence in the distribution of airborne As in the region. Arsenic concentrations were found to decrease with distance from the contaminant sources at the Giant and Con mines, much like in other studies completed in the area. Soil concentrations greater than 50 ppm were found to occur at distances of 10 to 15 km from each of the mine sites. Hutchinson *et al.* (1982) report that Yellowknife falls within the 500 to 1500 ppm isopleth zone, which is higher than values reported by Hocking *et al.* (1978), who predicted Yellowknife town isopleths decreased to 200 ppm. Both Yellowknife Dene First Nation communities in the area, Ndilǫ and Dettah, fell within the 100 to 500 ppm isopleths in the Hutchinson *et al.* (1981) study. This estimate was similar to values measured in soils collected from 2015; recent Ndilǫ results reported in this thesis indicate As concentrations ranging from 130 to 280 ppm (n = 5).

Kerr (2006), undertook an extensive surficial geology and drift prospecting investigation, spanning over nine 1:50,000 NTS map sheets (85J/8, 9, 16; 85I/4, 5, 12, 13; 85O/I; and 85P/4). As part of his investigation, 70 leaf-litter and 72 humus samples, along with 12 spruce bark and 2 Labrador tea samples, were collected for a biogeochemistry study in the region. The highest concentrations of Au and As in humus were found near the Giant and Con mines, in addition to areas along the east shore of Yellowknife Bay, with Au ranging from 100 ppb to 989 ppb and As ranging from 300 ppm to 1100 ppm As. These ranges are similar to those found in the Bypass

Road, Ndilǫ, Dettah Road, however, results from this study suggest lower element concentrations also exist in these areas. Five kilometers west of Giant and Con in granitic terrain, humus concentrations were lower but still anomalous (9 to 92 ppb Au, 109 to 253 ppm As). Other significant anomalies occurred at some sites outside of the Yellowknife area, where volcanic rock outcrops were present to the east of Yellowknife Bay. Elemental concentrations in leaf litter were generally lower than for humus in many regional samples outside of Yellowknife. Where humus anomalies were preset, leaf litter concentrations were also notable.

Table 3-13 Estimated background values for leaf litter and humus underlain by granite, metasediments and volcanics; the three maqjor rock types throughout the current study area. Estimated values were reported by Kerr (2006). He notes that these are preliminary estimated values for Au, As, and Sb due to the lack of biogeochemical data collected from unmineralized zones beyond the influence of Con and Giant.

Sample type	**Granite**			**Metasediments**			**Volcanics**		
	Au (ppb)	**As (ppm)**	**Sb (ppm)**	**Au (ppb)**	**As (ppm)**	**Sb (ppm)**	**Au (ppb)**	**As (ppm)**	**Sb (ppm)**
Leaf-litter	1 to 2	1 to 4	0.1 to 0.3	0 to 2	0 to 4	0.0 to 0.2	3 to 20	8 to 30	0.5 to 4.5
Humus	1 to 2	4 to 8	0.2 to 0.4	1 to 4	3 to 10	0.1 to 0.6	4 to 49	16 to 79	4 to 7.7

Kerr (2006), noted that naturally occurring elevated metal values within the city of Yellowknife are not unexpected due to an abundance of outcropping mineralized zones. He also acknowledged that anthropogenic contamination is likely present in all samples collected within the Con and Giant mine areas. Humus data within 10 km of the mine sites is considerably anomalous when compared to estimated background levels (Table 3-13). Kerr (2006) estimated that the imprint of contamination extended within at least a 10 km radius of the city, which was confirmed by the presence of As_2O_3 at a site almost 26 km from the Giant Mine roaster (MIR-OSG-01PH). Airborne anthropogenic contaminants that fall to the ground persist in near-surface soils (Bromstad *et al.* 2017). Those that are dissolved in groundwater can be taken up by plant roots and sequestered in tree and shrub tissues or humus (Bowell, et al. 2014). Kerr (2006) found that the highest concentrations of metals occurred closest to the mine sites and decreased with increased distance from the sources of contamination. In conclusion, Kerr (2006) decided that no distinct geochemical signatures could be attributed to specific lithologies. This was partly due to the thickness and nature of the overburden on which the vegetation was growing, but also a result of anthropogenic contamination.

Mackenzie Bromstad investigated the impact of roaster emissions in soils collected on the Giant Mine property as part of her MSc thesis at Queen's (Bromstad, 2011). Bromstad also completed a technical report for soil samples collected from the property for Golder Associates in 2015, and summarized the previous work in addition to Lori Wrye's work in Bromstad *et al.* (2017). Bromstad *et al.* (2017) found that near-surface, undisturbed, soils on the mine property contained up to 7700 mg/kg arsenic, with the highest concentrations occuring in soil pockets on bedrock outcrops. It was also concluded that the most common arsenic hosts in soils were arsenic trioxide and roaster-generated iron oxides (maghemite and hematite) (Bromstad *et al.* 2017); these results coincide with what was determined from the analysis completed for this thesis.

The high degree of variability in soils throughout the Yellowknife area makes predicting the future presence of As in near surface soils challenging. Future work focused on soil pore waters and the mobility of As in the near surface environment such as the transport between geographically distinct regions, and downward mobility in various terrain types, would be necessary to make accurate predictions on the persistence of As in the environment surrounding Giant and Con Mines.

Chapter Four: Conclusions and Future Work

4.1 Conclusions

4.1.1 Total Arsenic Distribution

Total arsenic concentrations in PHL soils collected for this study ranged from 1.5 to 3400 mg/kg in parent samples collected within 30 km of the City of Yellowknife (Table 3-2; Figure 3-20). The highest total As concentrations were reported in the Bypass Road target area, west of the Giant Mine property (max = 3400 mg/kg, median = 550 mg/kg). Total As concentrations decreased with increasing distance from the sources of contamination, with the lowest concentrations reported at distances greater than 20 km from the Giant Mine roaster (Figure 3-23; Table 3-3). The median for total measured As concentrations dropped from 130 mg/kg at distances less than 10 km from the roaster to 22.5 mg/kg at distances greater than 10 km. East of the Giant roaster, opposite to the primary downwind direction, median total As concentrations were 23 mg/kg, the lowest reported median total As concentration out of the four possible directions (Figure 3-25).

In addition to distance and direction, the influence of terrain type on the distribution of As throughout the study area was also investigated (Figure 3-26). Previous research completed by Wrye (2008) and Bromstad (2011) indicated the highest As concentrations are typically found in outcrop soil pockets. These shallow soil pockets are topographically restricted, located at relatively higher elevations (on rock outcrops), ideal for capturing and retaining roaster stack emissions. Arsenic-bearing emissions deposited on surrounding exposed bedrock can be washed into these soil pockets where further mobility is restricted due to the underlying rock outcrop, resulting in relatively elevated As concentrations. The median total As for outcrop soil pockets sampled for this study was 94 mg/kg. Peat soils also reported relatively high As concentrations (median =95.5 mg/kg). It is suggested that further work be completed specifically on peat soils around the Yellowknife area, to determine why these terrain areas appear to be so heavily impacted by roaster emissions. Forest soil samples were reported the lowest median total As concentrations (median = 34 mg/kg), as expected; the forest canopy likely restricted the deposition of roaster emissions in forest soils, as As-bearing dust settled in the canopy. Kerr (2006) reported finding elevated total As concentrations in black spruce bark and Labrador tea samples relative to leaf litter and humus sampled from the same location. For the samples collected in this study, forest samples were found to be significantly different than outcrop and peat samples. The distribution of total As in forest-outcrop and outcrop samples was also reported as being significantly different, thus indicating that forest cover does impact the distribution of As-emissions throughout the study area.

4.1.2 Influence of Grain Size

A selection of samples were sieved to < 2 mm to test the influence of grain size (Figure 3-28) on total As concentrations. The goal of this procedure was to determine whether the majority of As existed in the < 2 mm size fraction, which is typically used when comparing results to environmental and human health risk guidelines. Sieving more samples may be required to definitively conclude the influence of grain size on total As in near surface soils, as only 58% of sample reported higher total As concentrations in the sieved fraction.

The size of As_2O_3 dust grains from roaster emissions did have an influence on the distance emissions travelled, with smaller As_2O_3 grain size ranges (0.87 to 13.5 microns versus

0.87 to 45 microns from closer sites) reported for sample sites located at further distances from the Giant Mine roaster (Figure 3-29).

4.1.3 Arsenic and Other Elements

Previous research completed by Kerr (2006) and Bromstad *et al.* (2017) reported high correlations for total As, Sb and Au concentrations in soils collected around the Yellowknife region. Similar correlations were reported for the data collected in this study; total As versus total Au concentrations had a weaker correlation (R^2 = 0.6581) than total As and total Sb results (R^2 = 0.8053) (Figure 3-31). The use of Sb/Au ratios for determining the age of As in near surface soils was applied by Bromstad *et al.*(2017), and appears to be a valid means of dating As emissions only in soils proximal to the Giant Mine roaster. The Sb/Au ratio is not an accurate method for dating the influence of emissions in off-lease soils (Figure 3-30). This is most likely due to the relatively high density of Au particles compared to As_2O_3 and roaster-generated Fe-oxide particles, leading them to preferentially fall out of suspension, settling closest to the source of contamination.

4.1.4 Arsenic Phases in Near Surface Samples

SEM and AM methods were used to identify 10 As-bearing phases in a selection of grab and PHL samples. In all but one sample analyzed via SEM/AM, the modal percentage of As-bearing phases was less than 10% (Figure 3-33). Common rock forming minerals (quartz, feldspars, micas, and other silicates) as well as organic matter, comprised the bulk of the volume in near surface YK area soils.

The most common As-bearing phases identified in soils throughout the study area included: As-bearing Fe-oxides and Fe-oxide mixes (98% of samples), organic Fe-oxide mixes with As (98% of samples), As_2O_3 (82%) and As-bearing Mn-oxides (60% of samples). As-bearing pyrite was also present in 90% of samples, however to a much lesser extent than the four primary As-bearing phases listed above. The maximum number of As-bearing pyrite grains found in one sample was 44, while the maximum number of As-bearing Fe-oxides and Fe-oxide mixes found in one sample was 21103.

Arsenic trioxide grains were identified in all target areas sampled for this study. Despite not occurring in all samples analyzed by SEM/AM, the distribution of As_2O_3 over the entire study area indicates that the contamination from ore processing operations in Yellowknife is wide spread and highly variable with the distribution of total As and the occurrence of As_2O_3 unevenly distributed in near surface soils. Arsenic trioxide grains were identified in samples with a range of total As concentrations (min = 8.1 mg/kg, max = 3400 mg/kg, median = 210 mg/kg) and at a range of distances. Two grains of As_2O_3 were identified in one sample collected on the Mirage Islands located approximately 26 km to the south of the Giant Mine roaster. This indicates that soils need to be collected at further distances from the point sources of contamination in order to definitively determine the true extent of influence from past mining activities in throughout the Yellowknife region.

4.1.5 Arsenic Phases in Down Core Samples

The bottom 5 cm of 37 core samples were subsampled and submitted for total elemental analysis to confirm the impact of roaster stack emission on Yellowknife area soils. Bromstad *et al.* (2017) reported a decrease in total As concentration in samples at depth, and the same trend was seen in core samples collected for this study. Total arsenic concentrations in down core samples ranged from 1.6 to 1200 mg/kg, with a median of 18.5 mg/kg.

For the 11 down core samples analyzed using SEM/AM, As-bearing phases comprised less than 3% of the modal mineralogy in all DC samples (Figure 3-46). Only 6 of the 10 As-bearing phases were identified in down core samples; these included Fe-oxides and Fe-oxide mixes, organics with Fe-oxides, Mn-oxide mixes, arsenopyrite, As-bearing pyrite and As_2O_3 (arsenolite) (Table 3-10, Figure 3-47). Arsenic trioxide was identified in one outcrop down core sample (TX-OSC-145 DC). This sample also had an increase in total As concentration at depth and may have actually been disturbed prior to collection (Figure 3-44). The primary As-bearing hosts in DC samples varied, but Fe-oxides (and Fe-oxide mixes), and organics with Fe-oxides were the dominant As-bearing hosts identified in these samples (Figure 3-47). Arsenic is known to co-precipitate with Fe, Mn and Al-oxide minerals; thus, it is to be expected that these phases would be present in more evolved soil horizons at depth.

4.1.6 Estimating Regional Background As Concentrations

Background arsenic concentrations in the Yellowknife area have been an ongoing topic of debate. As mentioned previously in section 3.2.1 earlier studies (eg. Hocking *et al.* 1978, Hutchinson *et al*. 1982, Kerr 2006, St. Onge 2007) investigating soils in the area estimated background concentrations ranging anywhere between 0 to 300 mg/kg total As depending on bedrock geology. The current suggested background As concentration for Yellowknife area soils is 150 mg/kg (GNWT, 2003). The results from this study indicate that this value is likely far too high an estimate for background concentrations, with median total As-concentrations decreasing from 130 mg/kg to 22.5 mg/kg and finally 8.1 mg/kg for samples collected at respective distances of 0 to 10 km, 10 to 20 km and 20 to 30 km from the Giant roaster.

Residential and industrial remediation guidelines developed for the Yellowknife area were based on the estimated background concentration of 150 mg/kg, in addition to limited public exposure to arsenic contaminated soils (GNWT, 2003). Arsenic concentrations are elevated in the PHL and in easily assessable areas, such as the Bypass Road, the community of Ndilǫ, the Dettah Road, and even the Martin Lake target area which is a popular fishing spot and hosts several hiking trails. Results from this study indicate that the background value for total As in Yellowknife area soils needs to be revisited, in addition to the current suggested remediation guidelines (residential = 160 mg/kg, industrial = 340 mg/kg). The residents of Yellowknife should not have to worry about, and live amongst, elevated arsenic concentrations in soils resulting from roasting operations.

4.2 Recommendations for Future Work

While completing this study, numerous ways to enhance the understanding of As in Yellowknife area soils were identified. A list of recommendations for future work are outlined below:

- To truly understand and identify the extent of As contamination in Yellowknife area soils as a result of past mining activities, samples will need to be collected at distances greater than 30 km from the sources of contamination (Giant and Con Mines). Recent work completed by MacDonald *et al.* (2016) suggests that the influence of As contamination from Giant could extend to distances up to 430 km from the roaster stack. This hypothesis should be confirmed by implementing an extensive soil survey collecting samples within 500 km from Yellowknife and completing detailed mineralogy on those soils to see if As_2O_3 is present in the near surface environment. The presence of As_2O_3 would indicate that roaster stack emissions travelled far beyond the anticipated area of influence (between 20 and 30 km).

- Collecting additional samples at further distances from Giant and Con will also aid in the determination of a reasonable background concentration for As around the Yellowknife area. Numerous samples need to be collected in areas devoid of contamination from past mining activities to truly understand an acceptable range of natural As in rocks throughout the NWT, and more specifically in the regions surrounding the YGB.
- If given the opportunity to return to Yellowknife and complete this study again it would be interesting to complete a detailed transect to the west of Giant Mine in the predominant downwind direction. If samples could be collected in one controlled terrain type (preferably outcrop soil pockets), every 1 km up to a distance of at least 200 km from the Giant roaster a gradient defining the influence of contamination could be determined.
- The influence of grain size on As distribution and total As concentration in soils could also be investigated further by sieving additional soil samples to determine if a larger fraction of As-bearing phases is contained in the < 2 mm size fraction. Smaller particles are easily involuntarily ingested or inhaled and present a greater health risk than larger more visible grains (Bailey 2017).
- Detailed analysis of down core soil samples would be beneficial to further understand how the As profile evolves with depth. A selection of core samples could be sub-sectioned from the top to base of the entire core at higher resolution (every 1 or 2 cm) to see in greater detail how As concentrations vary with depth. It would be interesting to see if or how As is being transported down core, and if natural soil forming processes are influencing the distribution of As-bearing phases at depth. Additional down core studies

at sites with deep soil profiles, where a C horizon exists would also aid in the determination of a more appropriate estimated background As concentration.

- To gain better understanding of the persistence of As_2O_3 in Yellowknife area soils, a smaller scale study should be completed for a selection sites in which pore water samples are collected in conjunction with soil samples. This would allow for a better understanding of how As is dissolving, mobilizing, and remaining within the near surface. To implement this study a handful of soil pockets, and or forested canopy areas should be selected. From these smaller study environments multiple soil cores and pore water samples should be collected and analyzed for total and dissolved As concentrations. The phases and oxidation states of As in the smaller controlled study area (outcrop pocket, or 10 by 10 m section of forested canopy area) should also be measured to truly understand how As is evolving and reacting within the near surface environment.

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Appendix A: Soil Sample Data and Field Sample Notes

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
BPR-FCSC-02	Bypass Road	P	July 20, 2015	18	5.0	FCSC	Core	PH	272	62.49902	-114.3858	1.51	257	7.53	353	Granitoid	Groundcover: forester area with pine and coniferous tree species; Soil: clay rich, very compacted, damp, base of core cold to touch; Site Details: soil was very buoyant, difficulty inserting drive head
BPR-FCSC-02	Bypass Road	P	July 20, 2015	18	5.0	FCSC	Core	DC	272	62.49902	-114.3858	1.51	257	7.53	353	Granitoid	Groundcover: forester area with pine and coniferous tree species; Soil: clay rich, very compacted, damp, base of core cold to touch; Site Details: soil was very buoyant, difficulty inserting drive head
BPR-FCSC-02 D	Bypass Road	SS	July 20, 2015	18	5.0	FCSC	Core	PH	272	62.49902	-114.3858	1.51	257	7.53	353	Granitoid	Groundcover: forester area with pine and coniferous tree species; Soil: clay rich, very compacted, damp, base of core cold to touch; Site Details: soil was very buoyant, difficulty inserting drive head
BPR-FCSC-02 D	Bypass Road	SS	July 20, 2015	18	5.0	FCSC	Core	DC	272	62.49902	-114.3858	1.51	257	7.53	353	Granitoid	Groundcover: forester area with pine and coniferous tree species; Soil: clay rich, very compacted, damp, base of core cold to touch; Site Details: soil was very buoyant, difficulty inserting drive head
BPR-FCSC-14	Bypass Road	P	July 25, 2015	28.1	2.1	FCSC	Core	PH	266	62.48734	-114.39119	2.39	227	6.29	349	Granitoid	Groundcover: leaf litter, branches, pine needles, small green plants; Soil: clay rich, very consolidated, colour transitions from dark, blackish-brown at top of core to light, tan brown at base, base of core was cold upon removal; Site Details: forest canopy, trees approximately 30 ft in height
BPR-FCSC-14	Bypass Road	LD	July 25, 2015	28.1	2.1	FCSC	Core	PH	266	62.48734	-114.39119	2.39	227	6.29	349	Granitoid	Groundcover: leaf litter, branches, pine needles, small green plants; Soil: clay rich, very consolidated, colour transitions from dark, blackish-brown at top of core to light, tan brown at base, base of core was cold upon removal; Site Details: forest canopy, trees approximately 30 ft in height
BPR-FCSC-14	Bypass Road	P	July 25, 2015	28.1	2.1	FCSC	Core	DC	266	62.48734	-114.39119	2.39	227	6.29	349	Granitoid	Groundcover: leaf litter, branches, pine needles, small green plants; Soil: clay rich, very consolidated, colour transitions from dark, blackish-brown at top of core to light, tan brown at base, base of core was cold upon removal; Site Details: forest canopy, trees approximately 30 ft in height
BPR-FCSC-17	Bypass Road	P	July 26, 2015	8	3.5	FCSC	Core	PH	265	62.47317	-114.41261	4.29	221	5.15	333	Volcanic	Groundcover: leaf litter, roots, broken branches, pine needles, small pines and new growth beneath larger trees, Site Details: hit roots almost immediately, trees approximately 30 to 40 ft in height, lots of dead branches, trees do not appear very healthy
BPR-FCSC-21	Bypass Road	P	July 26, 2015	27	3.0	FCSC	Core	PH	273	62.50709	-114.37536	1.09	300	8.37	357	Granitoid	Groundcover: thin layer of soft carpet like moss, small shrubs, lichen, small green trees scattered around forest floor; Soil: top 10 cm primarily moss and small roots, soil beneath moss is dark and rich in organics, at base of core soil transitions to a light, tan colour; Site Details: small forested valley between two granite outcrops, core very difficult to remove and cold to touch upon removal, soils could be damp or close to permafrost at depth
BPR-FCSC-21	Bypass Road	P	July 26, 2015	27	5.0	FCSC	Core	DC	273	62.50709	-114.37536	1.09	300	8.37	357	Granitoid	Groundcover: thin layer of soft carpet like moss, small shrubs, lichen, small green trees scattered around forest floor; Soil: top 10 cm primarily moss and small roots, soil beneath moss is dark and rich in organics, at base of core soil transitions to a light, tan colour; Site Details: small forested valley between two granite outcrops, core very difficult to remove and cold to touch upon removal, soils could be damp or close to permafrost at depth
BPR-FENC-09	Bypass Road	P	July 25, 2015	15.8	1.7	PSC	Core	PH	272	62.49789	-114.38715	1.61	253	7.41	352	Granitoid	Groundcover: Long grass; Soil: water saturated, collapsed peat material, cold; Site Details: collapsed peat land close to BPR - PSC - 07, very wet
BPR-FENC-18	Bypass Road	P	July 26, 2015	9.5	2.2	PSC	Core	PH	265	62.47323	-114.41094	4.23	221	5.12	334	Volcanic	Groundcover: moss, amalgamated wet, light, orangey-brown long grass; Soil: water saturated, fenland, water filled tube when pushed approximately 5 cm below moss surface; Site Details: very wet, tall grasses surrounding collapsed fen area, water was very cold, difficult to get a core
BPR-FENC-18	Bypass Road	LD	July 26, 2015	9.5	2.2	PSC	Core	PH	265	62.47323	-114.41094	4.23	221	5.12	334	Volcanic	Groundcover: moss, amalgamated wet, light, orangey-brown long grass; Soil: water saturated, fenland, water filled tube when pushed approximately 5 cm below moss surface; Site Details: very wet, tall grasses surrounding collapsed fen area, water was very cold, difficult to get a core
BPR-MFENC-22	Bypass Road	P	July 26, 2015	20.2	1.6	OSC	Core	PH	272	62.50947	-114.36731	0.98	327	8.63	360	Volcanic	Groundcover: tall grass, thick layer of dry, carpet like moss, moss didn't break apart easily; Soil: dark black, organic rich soil at surface transitions into light brown, sandy soil at depth, sandy soils not as consolidated as other sandy soils in forested areas, less clay material; Site Details: grass field area located near the North Pond on the Giant Mine Property, dead tree stumps scattered throughout field
BPR-MFENC-22	Bypass Road	P	July 26, 2015	20.2	5.0	OSC	Core	DC	272	62.50947	-114.36731	0.98	327	8.63	360	Volcanic	Groundcover: tall grass, thick layer of dry, carpet like moss, moss didn't break apart easily; Soil: dark black, organic rich soil at surface transitions into light brown, sandy

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	soil at depth, sandy soils not as consolidated as other sandy soils in forested areas, less clay material; Site Details: grass field area located near the North Pond on the Giant Mine Property, dead tree stumps scattered throughout field
BPR-MFENC-22 S	Bypass Road	S	July 26, 2015	20.2	1.6	OSC	Core	PH	272	62.50947	-114.36731	0.98	327	8.63	360	Volcanic	Groundcover: tall grass, thick layer of dry, carpet like moss, moss didn't break apart easily; Soil: dark black, organic rich soil at surface transitions into light brown, sandy soil at depth, sandy soils not as consolidated as other sandy soils in forested areas, less clay material; Site Details: grass field area located near the North Pond on the Giant Mine Property, dead tree stumps scattered throughout field
BPR-OSC-01	Bypass Road	P	July 20, 2015	14.5	4.7	OSC	Core	PH	272	62.49878	-114.38444	1.45	255	7.49	353	Granitoid	Groundcover: yellowish-green moss, lichen, small brush; Site Details: large soil pocket, hit refusal close to surface
BPR-OSC-01 D	Bypass Road	SS	July 20, 2015	14.5	4.7	OSC	Core	PH	272	62.49878	-114.38444	1.45	255	7.49	353	Granitoid	Groundcover: yellowish-green moss, lichen, small brush; Site Details: large soil pocket, hit refusal close to surface
BPR-OSC-10	Bypass Road	P	July 25, 2015	6.5	2.7	OSC	Core	PH	269	62.4893	-114.38974	2.19	229	6.49	350	Volcanic	Groundcover: thin layer of hard, dry, carpet like moss, grass and some shrubs, moss easily separated from soil beneath; Site Details: Topographically high outcrop across from Giant Mine Property off of Bypass Road
BPR-OSC-16	Bypass Road	P	July 26, 2015	27.7	4.4	OSC	Core	PH	265	62.47274	-114.41301	4.34	221	5.12	333	Volcanic	Groundcover: moss, small cedars and pine trees growing in soil pocket, short leafy bush, broken tree branches, and some leaf litter; Soil: beneath moss, the top few centimeters of soil is dark to medium brown in colour, roots throughout, bottom of core consists of finer and more consolidated, lighter, tan coloured soil; Site Details: dirty stained shirt found 15 m away in bush after sample was taken, moss appeared intact and soil pocket did not look disturbed
BPR-OSC-16	Bypass Road	P	July 26, 2015	27.7	4.4	OSC	Core	DC	265	62.47274	-114.41301	4.34	221	5.12	333	Volcanic	Groundcover: moss, small cedars and pine trees growing in soil pocket, short leafy bush, broken tree branches, and some leaf litter; Soil: beneath moss, the top few centimeters of soil is dark to medium brown in colour, roots throughout, bottom of core consists of finer and more consolidated, lighter, tan coloured soil; Site Details: dirty stained shirt found 15 m away in bush after sample was taken, moss appeared intact and soil pocket did not look disturbed
BPR-OSC-20	Bypass Road	P	July 26, 2015	20.5	2.8	OSC	Core	PH	272	62.50627	-114.37127	0.87	302	8.27	359	Granitoid	Groundcover: dry, carpet like moss, moss is harder and more compacted than in other soil pockets on same outcrop; Soil: dark brown soil directly beneath moss transitions into orangey-brown colour at surface, base of core was dark brown and cool; Site Details: large soil pocket atop large granite outcrop across from the Giant Mine headframe and located close to Pocket Lake
BPR-OSC-20 S	Bypass Road	S	July 26, 2015	20.5	2.8	OSC	Core	PH	272	62.50627	-114.37127	0.87	302	8.27	359	Granitoid	Groundcover: dry, carpet like moss, moss is harder and more compacted than in other soil pockets on same outcrop; Soil: dark brown soil directly beneath moss transitions into orangey-brown colour at surface, base of core was dark brown and cool; Site Details: large soil pocket atop large granite outcrop across from the Giant Mine headframe and located close to Pocket Lake
BPR-OSC-91	Bypass Road	P	August 8, 2015	13.5	4.5	OSC	Core	PH	272	62.50635	-114.37142	0.88	303	8.28	358	Granitoid	Groundcover: grass and moss, some lichen; Soil: dark black, organic rich soil; Site Details: large granite outcrop across from Giant Mine headframe, deep soil pocket, dry, dead trees all over outcrop and within soil pockets
BPR-OSC-92	Bypass Road	P	August 8, 2015	12.5	5.0	OSC	Core	PH	272	62.50684	-114.37189	0.93	305	8.34	358	Granitoid	Groundcover: long grass and moss; Soil: dark black, organic rich soil, similar to soil pocket where BPR - OSC - 91 was obtained; Site Details: large granite outcrop across from Giant Mine headframe, hit refusal, shallow soil pocket, top of soil surface in this soil pocket was slightly dryer and dustier, lighter coloured granites
BPR-OSC-92 D	Bypass Road	SS	August 8, 2015	12.5	5.0	OSC	Core	PH	272	62.50684	-114.37189	0.93	305	8.34	358	Granitoid	Groundcover: long grass and moss; Soil: dark black, organic rich soil, similar to soil pocket where BPR - OSC - 91 was obtained; Site Details: large granite outcrop across from Giant Mine headframe, hit refusal, shallow soil pocket, top of soil surface in this soil pocket was slightly dryer and dustier, lighter coloured granites
BPR-OSC-92 S	Bypass Road	S	August 8, 2015	12.5	5.0	OSC	Core	PH	272	62.50684	-114.37189	0.93	305	8.34	358	Granitoid	Groundcover: long grass and moss; Soil: dark black, organic rich soil, similar to soil pocket where BPR - OSC - 91 was obtained; Site Details: large granite outcrop across from Giant Mine headframe, hit refusal, shallow soil pocket, top of soil surface in this soil

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	pocket was slightly dryer and dustier, lighter coloured granites
BPR-OSC-93	Bypass Road	P	August 8, 2015	11.4	4.4	OSC	Core	PH	272	62.50677	-114.37099	0.89	306	8.33	359	Granitoid	Groundcover: green grass and some moss, no trees in soil pocket; Soil: dark black, organic rich soil; Site Details: outcrop pocket between light and pink granites across from Giant Mine headframe, no trees in soil pocket, but some growing near-by
BPR-OSC-93 D	Bypass Road	SS	August 8, 2015	11.4	4.4	OSC	Core	PH	272	62.50677	-114.37099	0.89	306	8.33	359	Granitoid	Groundcover: green grass and some moss, no trees in soil pocket; Soil: dark black, organic rich soil; Site Details: outcrop pocket between light and pink granites across from Giant Mine headframe, no trees in soil pocket, but some growing near-by
BPR-OSC-94	Bypass Road	P	August 8, 2015	13.8	4.2	OSC	Core	PH	272	62.50727	-114.37107	0.92	309	8.39	359	Granitoid	Groundcover: long, green grass with moss cover beneath, dead branches, patches of dead grass and grey-black, dried, cracked moss; Soil: dark black, organic rich soil; Site Details: large soil pocket, granite outcrop across from Giant Mine headframe
BPR-OSG-11	Bypass Road	P	July 25, 2015	-	-	OSG	Grab	ND	268	62.48937	-114.3897	2.18	230	6.50	350	Volcanic	Grab Sample; Groundcover: thin layer of moss, little vegetation, no grass of small shrubs in outcrop; Soil: dry, dusty, medium to fine grained dark brown soil; Site Details: small outcrop soil pocket
BPR-OSG-11	Bypass Road	LD	July 25, 2015	-	-	OSG	Grab	ND	268	62.48937	-114.3897	2.18	230	6.50	350	Volcanic	Grab Sample; Groundcover: thin layer of moss, little vegetation, no grass of small shrubs in outcrop; Soil: dry, dusty, medium to fine grained dark brown soil; Site Details: small outcrop soil pocket
BPR-OSG-13	Bypass Road	P	July 25, 2015	-	-	OSG	Grab	ND	268	62.48883	-114.39187	2.31	230	6.46	349	Granitoid	Grab Sample; Groundcover: thin, dry, carpet like moss, dark grey-green in colour, appeared to be covered in a dust or ash like substance (Large fire close to Yellowknife in 2015); Soil: thin soil layer, roots dispersed throughout;
BPR-OSG-15	Bypass Road	P	July 26, 2015	3	-	OSG	Grab	ND	264	62.4727	-114.41241	4.32	221	5.10	333	Volcanic	Grab Sample; Soil: bright-red stained soil pocket, red, dusty soil layer 1 mm in thickness overlying dark, brown, silty soil beneath, depth of soil approximately 3 cm; Site Details: very small soil pocket, equal in diameter to a circle made with arms, overcast, warm, breezy day
BPR-OSG-15 D	Bypass Road	SS	July 26, 2015	3	-	OSG	Grab	ND	264	62.4727	-114.41241	4.32	221	5.10	333	Volcanic	Grab Sample; Soil: bright-red stained soil pocket, red, dusty soil layer 1 mm in thickness overlying dark, brown, silty soil beneath, depth of soil approximately 3 cm; Site Details: very small soil pocket, equal in diameter to a circle made with arms, overcast, warm, breezy day
BPR-OSG-95	Bypass Road	P	August 8, 2015	5 to 6	-	OSG	Grab	ND	271	62.50683	-114.37151	0.91	305	8.34	358	Granitoid	Groundcover: dry, cracked moss, approximately 1 cm thick; Soil: dark brown, dry, dusty, silty soil; Site Details: very dry soil pocket in granite outcrops across from Giant Mine headframe
BPR-OSG-95 D	Bypass Road	SS	August 8, 2015	5 to 6	-	OSG	Grab	ND	271	62.50683	-114.37151	0.91	305	8.34	358	Granitoid	Groundcover: dry, cracked moss, approximately 1 cm thick; Soil: dark brown, dry, dusty, silty soil; Site Details: very dry soil pocket in granite outcrops across from Giant Mine headframe
BPR-OSG-95 S	Bypass Road	S	August 8, 2015	5 to 6	-	OSG	Grab	ND	271	62.50683	-114.37151	0.91	305	8.34	358	Granitoid	Groundcover: dry, cracked moss, approximately 1 cm thick; Soil: dark brown, dry, dusty, silty soil; Site Details: very dry soil pocket in granite outcrops across from Giant Mine headframe
BPR-PSC-07	Bypass Road	P	July 25, 2015	19	5.0	PSC	Core	PH	272	62.4976	-114.38683	1.60	252	7.38	352	Granitoid	Groundcover: thick moss; Soil: light orangish-brown, amalgamated fibrous material (peat), at base of orangish-brown peat a dark moist soil layer is present; Site Details: peat land just off the Bypass Road
BPR-PSC-12	Bypass Road	P	July 25, 2015	18.5	5.0	PSC	Core	PH	269	62.48904	-114.39113	2.26	230	6.47	349	Granitoid	Groundcover: moss and reindeer lichen; Soil: less consolidated than BPR - PSC - 07
BPR-PSC-158	Bypass Road	P	August 20, 2015	27	5.0	PSC	Core	PH	269	62.49632	-114.38502	1.56	246	7.22	353	Granitoid	Groundcover: moss and reindeer lichen, some long grass patches; Soil: orangish-brown fibrous peat; Site Details: large peatland off Bypass Road, sample taken in slightly depressed area surrounding by elevated peat, not saturated
BPR-PSC-159	Bypass Road	P	August 20, 2015	38	5.0	PSC	Core	PH	269	62.49595	-114.38563	1.61	245	7.19	352	Granitoid	Groundcover: mostly grass with some lichen, moss cover beneath grass; Soil: peat is less fluffy and more compacted than other samples taken in this peatland; Site Details: close to collapsed peat or fenland area where lysimeter was installed (lysimeter destroyed)
BPR-PSC-160	Bypass Road	P	August 20, 2015	38 to 40	5.0	PSC	Core	PH	269	62.49613	-114.38476	1.56	245	7.20	353	Granitoid	Groundcover: moss, bulges of lichen covered areas surrounding samples; Soil: peat is tougher than in other areas of peatland off Bypass Road; Site Details: dead trees nearby
BPR-PSC-160 D	Bypass Road	SS	August 20, 2015	38 to 40	5.0	PSC	Core	PH	269	62.49613	-114.38476	1.56	245	7.20	353	Granitoid	Groundcover: moss, bulges of lichen covered areas surrounding samples; Soil: peat is tougher than in other areas of peatland off Bypass Road; Site Details: dead trees nearby
BPR-PSC-161	Bypass Road	P	August 20, 2015	38.5	5.0	PSC	Core	PH	269	62.49646	-114.384	1.51	245	7.23	353	Granitoid	Groundcover: patches of lichen and areas with no lichen cover, sample taken in area barren of lichen; Soil: light, fibrous, orangey-brown peat underlain by dark brown, moist

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	soil, dark brown soil transitioned into light, fibrous peat again; Site Details: elevated mushy peat area in large peatland off Bypass Road
BPR-PSC-161 D	Bypass Road	SS	August 20, 2015	38.5	5.0	PSC	Core	PH	269	62.49646	-114.384	1.51	245	7.23	353	Granitoid	Groundcover: patches of lichen and areas with no lichen cover, sample taken in area barren of lichen; Soil: light, fibrous, orangey-brown peat underlain by dark brown, moist soil, dark brown soil transitioned into light, fibrous peat again; Site Details: elevated mushy peat area in large peatland off Bypass Road
BPR-PSC-161B	Bypass Road	P	August 20, 2015	38.5	5.0	PSC	Core	DC	269	62.49646	-114.384	1.51	245	7.23	353	Granitoid	Groundcover: patches of lichen and areas with no lichen cover, sample taken in area barren of lichen; Soil: light, fibrous, orangey-brown peat underlain by dark brown, moist soil, dark brown soil transitioned into light, fibrous peat again; Site Details: elevated mushy peat area in large peatland off Bypass Road
BPR-PSC-161B D	Bypass Road	SS	August 20, 2015	38.5	5.0	PSC	Core	DC	269	62.49646	-114.384	1.51	245	7.23	353	Granitoid	Groundcover: patches of lichen and areas with no lichen cover, sample taken in area barren of lichen; Soil: light, fibrous, orangey-brown peat underlain by dark brown, moist soil, dark brown soil transitioned into light, fibrous peat again; Site Details: elevated mushy peat area in large peatland off Bypass Road
BPR-PSC-161C	Bypass Road	P	August 20, 2015	38.5	5.0	PSC	Core	DC	269	62.49646	-114.384	1.51	245	7.23	353	Granitoid	Groundcover: patches of lichen and areas with no lichen cover, sample taken in area barren of lichen; Soil: light, fibrous, orangey-brown peat underlain by dark brown, moist soil, dark brown soil transitioned into light, fibrous peat again; Site Details: elevated mushy peat area in large peatland off Bypass Road
BPR-PSC-161C D	Bypass Road	SS	August 20, 2015	38.5	5.0	PSC	Core	DC	269	62.49646	-114.384	1.51	245	7.23	353	Granitoid	Groundcover: patches of lichen and areas with no lichen cover, sample taken in area barren of lichen; Soil: light, fibrous, orangey-brown peat underlain by dark brown, moist soil, dark brown soil transitioned into light, fibrous peat again; Site Details: elevated mushy peat area in large peatland off Bypass Road
BPR-PSC-19	Bypass Road	P	July 26, 2015	24.5	5.0	PSC	Core	PH	265	62.47337	-114.41058	4.20	221	5.13	334	Volcanic	Groundcover: thick moss; Soil: light brown, fluffy, peat material at top of core, darker more compacted soil at boundary between peat and permafrost, dark moist soil is likely representative of the active layer above the permafrost, permafrost hit at 38 to 40 cm depth
BPR-PSG-08	Bypass Road	P	July 25, 2015	19 to 25	-	PSG	Grab	DC	271	62.4976	-114.38683	1.60	252	7.38	352	Granitoid	Grab sample; Soil: dark, moist soil layer beneath dryer, fibrous peat layer; Site Details: sample taken at same location as BPR - PSC - 07
BPR-PSG-08 D	Bypass Road	SS	July 25, 2015	19 to 25	-	PSG	Grab	DC	271	62.4976	-114.38683	1.60	252	7.38	352	Granitoid	Grab sample; Soil: dark, moist soil layer beneath dryer, fibrous peat layer; Site Details: sample taken at same location as BPR - PSC - 07
BPR-PSG-12.1	Bypass Road	P	July 25, 2015	10	-	PSG	Grab	ND	269	62.48904	-114.39113	2.26	230	6.47	349	Granitoid	Grab Sample; Groundcover: moss and reindeer lichen; Soil: less consolidated than BPR-OSC-07; Field Duplicate
BPR-PSG-19.1	Bypass Road	P	July 26, 2015	10	-	PSG	Grab	ND	265	62.47337	-114.41058	4.20	221	5.13	334	Volcanic	Grab Sample; Upper 10cm of peat; See BPR - PSC - 19 for full description; Field Duplicate
BPR-PSG-19.1	Bypass Road	LD	July 26, 2015	10	-	PSG	Grab	ND	265	62.47337	-114.41058	4.20	221	5.13	334	Volcanic	Grab Sample; Upper 10cm of peat; See BPR - PSC - 19 for full description; Field Duplicate
BPR-PSG-19.2	Bypass Road	P	July 26, 2015	30 to 40	-	PSG	Grab	DC	265	62.47337	-114.41058	4.20	221	5.13	334	Volcanic	Grab Sample; Active layer sample at BPR - PSC - 19 sample location, Soil: dark, blackish-brown in colour, cold, approximately 7.5 cm above permafrost and therefore extends from a depth of 30.5 or 32.5 cm to 38 or 40 cm
BPR-PSG-19.2	Bypass Road	LD	July 26, 2015	30 to 40	-	PSG	Grab	DC	265	62.47337	-114.41058	4.20	221	5.13	334	Volcanic	Grab Sample; Active layer sample at BPR - PSC - 19 sample location, Soil: dark, blackish-brown in colour, cold, approximately 7.5 cm above permafrost and therefore extends from a depth of 30.5 or 32.5 cm to 38 or 40 cm
DETR-FCOSC-35	Dettah Road	P	August 3, 2015	9	3.7	FCOSC	Core	PH	227	62.43983	-114.30721	7.37	160	3.21	74	Sedimentary	Groundcover: thick leaf litter, some had to be removed so core could be taken; Site Details: hit refusal, large soil pocket with numerous birch trees between two large outcrop ridges, birch trees approximately 18 to 24ft in height, dead birch stumps near sample location
DETR-FCOSC-35	Dettah Road	P	August 3, 2015	9	3.7	FCOSC	Core	DC	227	62.43983	-114.30721	7.37	160	3.21	74	Sedimentary	Groundcover: thick leaf litter, some had to be removed so core could be taken; Site Details: hit refusal, large soil pocket with numerous birch trees between two large outcrop ridges, birch trees approximately 18 to 24ft in height, dead birch stumps near sample location
DETR-FCSC-31	Dettah Road	P	July 29, 2015	13	2.5	FCSC	Core	PH	221	62.41273	-114.3083	10.24	166	3.70	125	Sedimentary	Groundcover: small green shrubs, leaf litter, small sticks, willow trees, greyish- white cotton like fluff from invasive tree species; Site Details: willow cluster behind Dettah community garden, area likely disturbed, sample obtained with Fred Sangris and Mary Black

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
DETR-FCSC-31 S	Dettah Road	S	July 29, 2015	13	2.5	FCSC	Core	PH	221	62.41273	-114.3083	10.24	166	3.70	125	Sedimentary	Groundcover: small green shrubs, leaf litter, small sticks, willow trees, greyish- white cotton like fluff from invasive tree species; Site Details: willow cluster behind Dettah community garden, area likely disturbed, sample obtained with Fred Sangris and Mary Black
DETR-FCSC-32	Dettah Road	P	July 29, 2015	15	2.9	FCSC	Core	PH	234	62.48198	-114.29777	3.78	126	6.62	33	Sedimentary	Groundcover: leaf litter, small green plants (5 to 10 cm in height), willow and pine trees; Site Details: sample taken from the edge of a beaver trapping pond used frequently by the Dene First Nations
DETR-FCSC-34	Dettah Road	P	August 3, 2015	12	2.3	FCSC	Core	PH	228	62.45935	-114.29949	5.59	148	4.63	49	Sedimentary	Groundcover: dry, yellowish-green moss, leaf litter, some pine needles; Site Details: pine and birch trees approximately 4 m in height
DETR-FCSC-34 S	Dettah Road	S	August 3, 2015	12	2.3	FCSC	Core	PH	228	62.45935	-114.29949	5.59	148	4.63	49	Sedimentary	Groundcover: dry, yellowish-green moss, leaf litter, some pine needles; Site Details: pine and birch trees approximately 4 m in height
DETR-FCSC-38	Dettah Road	P	August 3, 2015	36	2.3	FCSC	Core	PH	230	62.44015	-114.30966	7.30	160	3.10	73	Sedimentary	Groundcover: leaf litter, pine needle, small bear berries, no moss in sample area; Soil: dark brown, organic rich later with high root content at top of core, light tan, sandy soil at base of core, deep core, cold to touch; Site Details: very large pine and birch trees 30 to 40 ft in height, more pine trees than birch trees
DETR-FCSC-38	Dettah Road	P	August 3, 2015	36	5.0	FCSC	Core	DC	230	62.44015	-114.30966	7.30	160	3.10	73	Sedimentary	Groundcover: leaf litter, pine needle, small bear berries, no moss in sample area; Soil: dark brown, organic rich later with high root content at top of core, light tan, sandy soil at base of core, deep core, cold to touch; Site Details: very large pine and birch trees 30 to 40 ft in height, more pine trees than birch trees
DETR-FCSC-38 D	Dettah Road	SS	August 3, 2015	36	5.0	FCSC	Core	DC	230	62.44015	-114.30966	7.30	160	3.10	73	Sedimentary	Groundcover: leaf litter, pine needle, small bear berries, no moss in sample area; Soil: dark brown, organic rich later with high root content at top of core, light tan, sandy soil at base of core, deep core, cold to touch; Site Details: very large pine and birch trees 30 to 40 ft in height, more pine trees than birch trees
DETR-FENC-30	Dettah Road	P	July 29, 2015	7	0.7	PSC	Core	PH	228	62.46164	-114.29724	5.44	146	4.89	47	Sedimentary	Groundcover: dry, carpet like moss, approximately 1 cm thick, amalgamated, dead, grey-brown long grass; Soil: damp, dark brownish-black, organic rich soil beneath grass, heavily rooted, high moisture content; Site Details: lots of compression in core
DETR-OSC-37	Dettah Road	P	August 3, 2015	12.5	3.7	OSC	Core	PH	230	62.4404	-114.30876	7.29	160	3.15	73	Sedimentary	Groundcover: thick layer of moss in some areas, sample taken where moss was thinnest; Soil: dark, reddish-brown in colour and heavily rooted at top of core, sample was dark black and moist at base of core; Site Details: outcrop pocket close to Con Mine, can see headframe from sample location, hit refusal
DETR-OSG-33	Dettah Road	P	August 3, 2015	-	-	OSG	Grab	ND	230	62.45966	-114.30067	5.53	148	4.61	48	Sedimentary	Grab Sample; Groundcover: pine needles, bear berries; Site Details: large soil pocket, hit rock almost immediately with core, took grab sample instead, sparse birch and pine trees within soil pocket
DETR-OSG-36	Dettah Road	P	August 3, 2015	9	-	OSG	Grab	ND	228	62.43999	-114.30786	7.35	160	3.18	74	Sedimentary	Grab Sample; Approximate Depth: 9cm; Groundcover: long grass, very dry, carpet like moss; Soil: moist, dark, heavily rooted soil; Site Details: small, dry soil pocket located high up on outcrop, can see Con Mine headframe from outcrop
DETR-OSG-36 D	Dettah Road	SS	August 3, 2015	9	-	OSG	Grab	ND	228	62.43999	-114.30786	7.35	160	3.18	74	Sedimentary	Grab Sample; Approximate Depth: 9cm; Groundcover: long grass, very dry, carpet like moss; Soil: moist, dark, heavily rooted soil; Site Details: small, dry soil pocket located high up on outcrop, can see Con Mine headframe from outcrop
DETR-OSG-36 D	Dettah Road	LD	August 3, 2015	9	-	OSG	Grab	ND	228	62.43999	-114.30786	7.35	160	3.18	74	Sedimentary	Grab Sample; Approximate Depth: 9cm; Groundcover: long grass, very dry, carpet like moss; Soil: moist, dark, heavily rooted soil; Site Details: small, dry soil pocket located high up on outcrop, can see Con Mine headframe from outcrop
DETR-PSC-29	Dettah Road	P	July 29, 2015	31	5.0	PSC	Core	PH	228	62.46154	-114.29716	5.45	146	4.88	48	Sedimentary	Groundcover: thick deeply rooted, green and spongy moss; Soil: dark, organic rich soil, heavily rooted, beneath soil was peat like, light tan, fibrous soil
YK67-FCSC-05	Dettah Road	P	July 24, 2015	10.5	3.0	FCSC	Core	PH	238	62.48757	-114.30204	3.25	120	7.04	28	Sedimentary	Groundcover: leaf litter, pine needs, roots; Soil: top of core is organic rich and dark brown in colour, at 12 cm depth soil transitions from dry, loosely consolidated material to more compact, slightly moist, finer, tan soil; Site Details: forested canopy cover, trees approximately 25 ft in height
YK67-FENC-03	Dettah Road	P	July 24, 2015	7.5	1.0	PSC	Core	PH	238	62.48798	-114.30344	3.17	120	7.05	28	Sedimentary	Groundcover: heavily vegetated with long grass and reeds; Soil: water saturated; Site Details: fenland approximately 10 m from YK-67, difficult to take core sample, water filled core hole upon removal, smelled strongly of sulfur
YK67-OSC-06	Dettah Road	P	July 24, 2015	12.5	4.3	OSC	Core	PH	234	62.48778	-114.29835	3.41	118	7.15	30	Sedimentary	Groundcover: carpet like moss, leaf litter, tree bark, small roots, very dry long grass; Soil: dark black, organic rich, heavily rooted soil beneath leaf litter; Site Details: trees on

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	outcrop appear very unhealthy, trees are small (1 to 3 m in height) and sparse
YK67-PSC-04	Dettah Road	P	July 24, 2015	30.5	5.0	PSC	Core	PH	238	62.48806	-114.30338	3.17	120	7.06	28	Sedimentary	Groundcover: grass and lichen; Soil: light, orangish-brown, fibrous peat material, dark soil layer directly beneath moss; Site Details: peatland area near research lake YK-67
HW3-FCOSC-126	Highway 3	P	August 16, 2015	13.2	2.9	FCOSC	Core	PH	175	62.50656	-114.79603	22.54	271	23.56	290	Granitoid	Groundcover: moss, some grey lichen, pine needles, dead branches, very few cranberry bushes; Soil: dark black and moist; Site Details: gently sloping outcrop off the side of Hwy. 3, black spruce and pine trees (8 to 10 m in height) growing in vicinity of sample
HW3-FCOSC-129	Highway 3	P	August 16, 2015	13.2	3.0	FCOSC	Core	PH	197	62.47881	-114.72945	19.29	262	19.35	285	Granitoid	Groundcover: leaf and pine needle litter, some dead sticks and reindeer lichen, dead birch trees; Soil: dark, organic rich soil at top of core transitions to light beige, silty sand at depth; Site Details: birch (4 to 5 m in height), black spruce (10 to 15 m in height, some very tall), and Jack pines (3 to 7 m), next to no soil in outcrop pocket, trees need very little soil to grow
HW3-FCSC-124	Highway 3	P	August 16, 2015	12.5	3.8	FCSC	Core	PH	162	62.51921	-114.87568	26.68	274	27.88	290	Granitoid	Groundcover: leaf litter, bear berries, small green and reddish leafy plants (10 to 17 cm tall), some pine needles; Soil: light sandy soil at base of core; Site Details: birch and black spruce (5 to 9 m in height), forested area located between two granite outcrops
HW3-FCSC-124	Highway 3	LD	August 16, 2015	12.5	3.8	FCSC	Core	PH	162	62.51921	-114.87568	26.68	274	27.88	290	Granitoid	Groundcover: leaf litter, bear berries, small green and reddish leafy plants (10 to 17 cm tall), some pine needles; Soil: light sandy soil at base of core; Site Details: birch and black spruce (5 to 9 m in height), forested area located between two granite outcrops
HW3-FCSC-125	Highway 3	P	August 16, 2015	18.5	3.0	FCSC	Core	PH	162	62.52011	-114.87619	26.72	274	27.94	290	Granitoid	Groundcover: labrador tea, small willows, leaf litter, some long grass and moss cover; Soil = dark black and moist, soil was very cold (ground was cold); Site Details: Jack pines and other unknown coniferous trees (short fan like needles, skinny branches, 1cm long cones)
HW3-FCSC-125	Highway 3	LD	August 16, 2015	18.5	3.0	FCSC	Core	PH	162	62.52011	-114.87619	26.72	274	27.94	290	Granitoid	Groundcover: labrador tea, small willows, leaf litter, some long grass and moss cover; Soil = dark black and moist, soil was very cold (ground was cold); Site Details: Jack pines and other unknown coniferous trees (short fan like needles, skinny branches, 1cm long cones)
HW3-FCSC-130	Highway 3	P	August 16, 2015	18.5	3.0	FCSC	Core	PH	197	62.48016	-114.7291	19.26	263	19.37	286	Granitoid	Groundcover: lots of leaf litter, long grass, little to no moss, some labrador tea; Soil: heavily rooted; Site Details: birch and willow tree canopy cover, trees 6 to 7 m in height closest to road, 10 to 12 m in height further away from road
HW3-FCSC-131	Highway 3	P	August 16, 2015	10	1.7	FCSC	Core	PH	198	62.48036	-114.72901	19.25	263	19.37	286	Granitoid	Groundcover: fireweed in seeding stages (fluff everywhere), very long grass (waist to chest height); Soil: medium brown, full of roots; Site Details: second sample taken in same area as sample HW3 - FCSC - 130, took sample further away from road, not directly under tree cover, sample taken in field of fireweed upon a slightly elevated plateau near a small pond and collapsed peat area, tall birch trees still in vicinity, willows were 3 to 4m in height
HW3-FCSC-131	Highway 3	LD	August 16, 2015	10	1.7	FCSC	Core	PH	198	62.48036	-114.72901	19.25	263	19.37	286	Granitoid	Groundcover: fireweed in seeding stages (fluff everywhere), very long grass (waist to chest height); Soil: medium brown, full of roots; Site Details: second sample taken in same area as sample HW3 - FCSC - 130, took sample further away from road, not directly under tree cover, sample taken in field of fireweed upon a slightly elevated plateau near a small pond and collapsed peat area, tall birch trees still in vicinity, willows were 3 to 4m in height
HW3-FCSC-132	Highway 3	P	August 16, 2015	15.5	1.9	FCSC	Core	PH	230	62.46022	-114.59109	12.89	249	11.94	285	Granitoid	Groundcover: cranberries and bear berries on forest floor; Site Details: new growth (pines, willows, spruce), willow trees, black spruce and birch trees (4 to 6 m tall)
HW3-FCSC-132	Highway 3	P	August 16, 2015	15.5	1.9	FCSC	Core	DC	230	62.46022	-114.59109	12.89	249	11.94	285	Granitoid	Groundcover: cranberries and bear berries on forest floor; Site Details: new growth (pines, willows, spruce), willow trees, black spruce and birch trees (4 to 6 m tall)
HW3-FCSC-134	Highway 3	P	August 16, 2015	23.5	4.2	FCSC	Core	PH	230	62.46161	-114.58871	12.72	249	11.87	286	Granitoid	Groundcover: moss, reindeer lichen, cranberry bushes, dead branches (birch), and sticks, minimal leaves around core location, some pine needles, however mostly just moss; Soil: light beige, silty sand, core cool to touch upon removal; Site Details: willows and Jack pines growing in vicinity (3 to 4 m in height)
HW3-FCSC-134	Highway 3	P	August 16, 2015	23.5	4.2	FCSC	Core	DC	230	62.46161	-114.58871	12.72	249	11.87	286	Granitoid	Groundcover: moss, reindeer lichen, cranberry bushes, dead branches (birch), and sticks, minimal leaves around core location, some pine needles, however mostly just moss; Soil: light beige, silty sand, core cool to touch upon removal; Site Details: willows and Jack pines growing in vicinity (3 to 4 m in height)
HW3-FCSC-135	Highway 3	P	August 16, 2015	24	2.3	FCSC	Core	PH	253	62.46588	-114.50322	8.51	242	7.95	298	Granitoid	Groundcover: labrador tea, cranberry bushes, lots of leaf litter, some pine needles; Soil: light beige, sandy soil beneath

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	organic-rich, brown topsoil layer; Site Details: tall birch trees and black spruce (10 to 15 m in height), some smaller pines (5 to 6 m)
HW3-FCSC-135	Highway 3	P	August 16, 2015	24	5.0	FCSC	Core	DC	253	62.46588	-114.50322	8.51	242	7.95	298	Granitoid	Groundcover: labrador tea, cranberry bushes, lots of leaf litter, some pine needles; Soil: light beige, sandy soil beneath organic-rich, brown topsoil layer; Site Details: tall birch trees and black spruce (10 to 15 m in height), some smaller pines (5 to 6 m)
HW3-OSC-123	Highway 3	P	August 16, 2015	13.5	2.9	OSC	Core	PH	162	62.51923	-114.87617	26.71	274	27.90	290	Granitoid	Groundcover: long grass with moss beneath; Site Details: spruce or small spiky bush with long needles, willow, small birch tree (all vegetation less than 2 m in height), area looks like it may not be completely undisturbed upon further investigation - broken rock fragments could be evidence of blasting near-by, minimal broken and fractured rocks where core was taken
HW3-OSC-128	Highway 3	P	August 16, 2015	14.3	2.8	OSC	Core	PH	197	62.47908	-114.72833	19.23	262	19.30	286	Granitoid	Groundcover: moss, long grass, willow tree, some fireweed; Soil: dark black, water saturated; Site Details: water filled core hole upon removal, top of water sitting at 8 cm depth in hole, hit refusal
HW3-OSC-133	Highway 3	P	August 16, 2015	14.2	3.1	OSC	Core	PH	253	62.46141	-114.58902	8.51	242	7.95	298	Granitoid	Groundcover: long grass, moss (very dry), lichen, some leaf litter and pine needles; Soil: dark brown, organic-rich soil, moist to base of core; Site Details: two trees (approximately 1 m in height) located just above sample location - one birch and one dying spruce,
HW3-OSC-133 D	Highway 3	SS	August 16, 2015	14.2	3.1	OSC	Core	PH	253	62.46141	-114.58902	8.51	242	7.95	298	Granitoid	Groundcover: long grass, moss (very dry), lichen, some leaf litter and pine needles; Soil: dark brown, organic-rich soil, moist to base of core; Site Details: two trees (approximately 1 m in height) located just above sample location - one birch and one dying spruce,
HW3-OSC-136	Highway 3	P	August 16, 2015	25.1	4.5	OSC	Core	PH	253	62.4657	-114.5033	8.52	242	7.95	298	Granitoid	Groundcover: pine needles, bear berries, some dry moss sporadically spread throughout soil pocket; Soil: very dry, not well consolidated, relatively coarser than other sandy soils seen along Hwy. 3 today, light beige, sandy soil, medium to fine grained; Site Details: multiple trees were growing in this outcrop soil pocket
HW3-OSC-136	Highway 3	P	August 16, 2015	25.1	5.0	OSC	Core	DC	253	62.4657	-114.5033	8.52	242	7.95	298	Granitoid	Groundcover: pine needles, bear berries, some dry moss sporadically spread throughout soil pocket; Soil: very dry, not well consolidated, relatively coarser than other sandy soils seen along Hwy. 3 today, light beige, sandy soil, medium to fine grained; Site Details: multiple trees were growing in this outcrop soil pocket
HW3-OSC-136	Highway 3	LD	August 16, 2015	25.1	5.0	OSC	Core	DC	253	62.4657	-114.5033	8.52	242	7.95	298	Granitoid	Groundcover: pine needles, bear berries, some dry moss sporadically spread throughout soil pocket; Soil: very dry, not well consolidated, relatively coarser than other sandy soils seen along Hwy. 3 today, light beige, sandy soil, medium to fine grained; Site Details: multiple trees were growing in this outcrop soil pocket
HW3-OSG-127	Highway 3	P	August 16, 2015	25.5	-	OSG	Grab	ND	175	62.50637	-114.79627	22.55	271	23.56	290	Granitoid	Grab Sample; Approximate depth: 25.5 cm; Groundcover: long grass, very thick moss cover (unable to cut through with aluminum core tube); Soil: dark black (rich in organics) beneath moss, damp (rained a lot yesterday); Site Details: one small dead birch tree in soil pocket (1.5 to 2 m in height), broken rock fragments scattered around areas nearby sample site - evidence of blasting when new highway was built?
INGT-FCOSC-139	Ingraham Trail	P	August 16, 2015	10.8	1.8	FCOSC	Core	PH	214	62.52982	-114.17035	10.07	72	14.86	43	Sedimentary	Groundcover: reindeer lichen, small shrubs (look similar to blueberry bushes), some long grass, labrador tea; Soil: base of core looks more like peat; Site Details: black spruce trees and small birch trees growing in soil pocket, sample taken on same outcrop as INGT - OSC- 138
INGT-FCOSC-141	Ingraham Trail	P	August 16, 2015	24	3.2	FCOSC	Core	PH	214	62.53709	-114.14514	11.56	70	16.34	44	Sedimentary	Groundcover: thick leaf litter (decomposing birch leaves), bear berries; Soil: light yellowish-brown, fine-grained, dry, silty, soil, above yellowish-brown silty sand the soil is more orangish-brown in colour, Site Details: birch trees growing in soil pocket (2 to 4 m in height)
INGT-FCOSC-141	Ingraham Trail	P	August 16, 2015	24	3.2	FCOSC	Core	DC	214	62.53709	-114.14514	11.56	70	16.34	44	Sedimentary	Groundcover: thick leaf litter (decomposing birch leaves), bear berries; Soil: light yellowish-brown, fine-grained, dry, silty, soil, above yellowish-brown silty sand the soil is more orangish-brown in colour, Site Details: birch trees growing in soil pocket (2 to 4 m in height)
INGT-FCOSC-42	Ingraham Trail	P	August 3, 2015	20	2.0	FCOSC	Core	PH	214	62.54088	-114.09079	14.33	73	18.67	50	Sedimentary	Groundcover: moss; Soil: thin soil cover, high degree of compression due to moss; Site Details: sample taken lower down on slope of outcrop where INGT - FCOSG - 41 was retrieved, more trees growing on slope of outcrop, across from Madeline Lake Day Use Area

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
INGT-FCOSC-42	Ingraham Trail	P	August 3, 2015	20	2.0	FCOSC	Core	DC	214	62.54088	-114.09079	14.33	73	18.67	50	Sedimentary	Groundcover: moss; Soil: thin soil cover, high degree of compression due to moss; Site Details: sample taken lower down on slope of outcrop where INGT - FCOSG - 41 was retrieved, more trees growing on slope of outcrop, across from Madeline Lake Day Use Area
INGT-FCOSC-49	Ingraham Trail	P	August 5, 2015	7.1	4.7	FCOSC	Core	PH	253	62.52288	-114.32159	2.95	38	10.39	13	Volcanic	Groundcover: bear berries; Site Details: shallow soil cover, hit refusal quickly, densely forested outcrop with pine and birch trees approximately 4 m in height
INGT-FCOSG-140	Ingraham Trail	P	August 16, 2015	14.5	-	FCOSG	Grab	ND	214	62.53068	-114.17072	10.08	72	14.92	43	Sedimentary	Grab Sample; Approximate Depth: 14.5 cm; Groundcover: bear berries, cranberry bushes, leaf litter, and sticks; Soil: too many small rocks pieces to get a core; Site Details: black spruce and birch trees (5 to 6 m in height), sample taken lower down on the same outcrop as sample INGT - OSC - 138 and INGT- FCOSC - 139.
INGT-FCOSG-41	Ingraham Trail	P	August 3, 2015	-	-	FCOSG	Grab	ND	214	62.54018	-114.09053	14.32	73	18.63	50	Sedimentary	Grab Sample; Groundcover: moss; Soil: thin soil cover, high degree of compression due to moss; Site Details: high outcrop across from Madeline Lake Day Use Area, refusal hit very quickly
INGT-FCOSG-46	Ingraham Trail	P	August 5, 2015	-	-	FCOSG	Grab	ND	265	62.52185	-114.34027	2.37	22	10.10	8	Volcanic	Grab Sample; Groundcover: pine needles; Site Details: medium sized soil pocket, 20 to 30 ft pine trees
INGT-FCOSG-46 D	Ingraham Trail	SS	August 5, 2015	-	-	FCOSG	Grab	ND	265	62.52185	-114.34027	2.37	22	10.10	8	Volcanic	Grab Sample; Groundcover: pine needles; Site Details: medium sized soil pocket, 20 to 30 ft pine trees
INGT-FCSC-122	Ingraham Trail	P	August 15, 2015	18	2.9	FCSC	Core	PH	214	62.53698	-114.14383	11.62	71	16.38	45	Sedimentary	Groundcover: labrador tea, leaf litter, some lichen; Site Details: birch trees and small juniper bushes at the base of an outcrop
INGT-FCSC-122 D	Ingraham Trail	SS	August 15, 2015	18	2.9	FCSC	Core	PH	214	62.53698	-114.14383	11.62	71	16.38	45	Sedimentary	Groundcover: labrador tea, leaf litter, some lichen; Site Details: birch trees and small juniper bushes at the base of an outcrop
INGT-FCSC-28	Ingraham Trail	P	July 29, 2015	23.5	3.4	FCSC	Core	PH	230	62.50805	-114.29009	3.51	79	9.35	25	Sedimentary	Groundcover: leaf litter, cranberries and bear berries; Soil: cold within core upon removal
INGT-FCSC-28	Ingraham Trail	P	July 29, 2015	23.5	5.0	FCSC	Core	DC	230	62.50805	-114.29009	3.51	79	9.35	25	Sedimentary	Groundcover: leaf litter, cranberries and bear berries; Soil: cold within core upon removal
INGT-FCSC-40	Ingraham Trail	P	August 3, 2015	15	2.6	FCSC	Core	PH	213	62.55647	-114.01171	18.73	71	22.92	53	Granitoid	Groundcover: leaf litter, baby spruce trees; Soil: light, sandy soil, lots of compression; Site Details: Sample taken in small forested patch at base of large granite outcrop outside Prelude Campground access road, birch and pine trees approximately 20ft in height
INGT-FCSC-40 D	Ingraham Trail	SS	August 3, 2015	15	2.6	FCSC	Core	PH	213	62.55647	-114.01171	18.73	71	22.92	53	Granitoid	Groundcover: leaf litter, baby spruce trees; Soil: light, sandy soil, lots of compression; Site Details: Sample taken in small forested patch at base of large granite outcrop outside Prelude Campground access road, birch and pine trees approximately 20ft in height
INGT-FCSC-45	Ingraham Trail	P	August 5, 2015	25	2.1	FCSC	Core	PH	265	62.52249	-114.33339	2.58	28	10.22	10	Volcanic	Groundcover: leaves, small green pine trees, labrador tea, small dead branches; Soil: heavily rooted, core cool to touch upon removal; Site Details: pine trees approximately 8 to 15 ft in height, young trees in area, forest borders a fenland
INGT-FCSC-45	Ingraham Trail	P	August 5, 2015	25	5.0	FCSC	Core	DC	265	62.52249	-114.33339	2.58	28	10.22	10	Volcanic	Groundcover: leaves, small green pine trees, labrador tea, small dead branches; Soil: heavily rooted, core cool to touch upon removal; Site Details: pine trees approximately 8 to 15 ft in height, young trees in area, forest borders a fenland
INGT-FCSC-50	Ingraham Trail	P	August 5, 2015	29	2.9	FCSC	Core	PH	258	62.52193	-114.32543	2.75	37	10.24	12	Volcanic	Groundcover: leaves, pine needles, pinecones, small sticks (cleared away prior to taking sample); Soil: clayey compacted soil at base of core, lots of roots in upper few centimeters, base of core cool to touch upon removal; Site Details: sample located at base of large outcrop
INGT-FCSC-50	Ingraham Trail	LD	August 5, 2015	29	2.9	FCSC	Core	PH	258	62.52193	-114.32543	2.75	37	10.24	12	Volcanic	Groundcover: leaves, pine needles, pinecones, small sticks (cleared away prior to taking sample); Soil: clayey compacted soil at base of core, lots of roots in upper few centimeters, base of core cool to touch upon removal; Site Details: sample located at base of large outcrop
INGT-FCSC-50	Ingraham Trail	P	August 5, 2015	29	5.0	FCSC	Core	DC	258	62.52193	-114.32543	2.75	37	10.24	12	Volcanic	Groundcover: leaves, pine needles, pinecones, small sticks (cleared away prior to taking sample); Soil: clayey compacted soil at base of core, lots of roots in upper few centimeters, base of core cool to touch upon removal; Site Details: sample located at base of large outcrop
INGT-FENC-51	Ingraham Trail	P	August 5, 2015	30	5.0	PSC	Core	PH	156	62.51316	-114.30907	2.76	64	9.52	18	Sedimentary	Groundcover: tall grass, cat tails; Soil: water saturated peat or fen land; Site Details: dead tree stumps and fallen trees scattered throughout area, water filler core hole instantly upon removal
INGT-FENC-51 D	Ingraham Trail	SS	August 5, 2015	30	5.0	PSC	Core	PH	156	62.51316	-114.30907	2.76	64	9.52	18	Sedimentary	Groundcover: tall grass, cat tails; Soil: water saturated peat or fen land; Site Details: dead tree stumps and fallen trees scattered throughout area, water filler core hole instantly upon removal

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
INGT-FENG-43	Ingraham Trail	P	August 5, 2015	-	-	PSG	Grab	ND	261	62.52275	-114.3328	2.62	29	10.26	10	Volcanic	Grab Sample; Groundcover: long grass, moss; Soil: water saturated, heavily vegetated fenland soil; Site Details: fully saturated fenland
INGT-FENG-43 D	Ingraham Trail	SS	August 5, 2015	-	-	PSG	Grab	ND	261	62.52275	-114.3328	2.62	29	10.26	10	Volcanic	Grab Sample; Groundcover: long grass, moss; Soil: water saturated, heavily vegetated fenland soil; Site Details: fully saturated fenland
INGT-OSC-137	Ingraham Trail	P	August 16, 2015	9.2	4.5	OSC	Core	PH	214	62.53054	-114.17172	10.03	72	14.87	43	Sedimentary	Groundcover: bear berries; Soil: orangish-brown in colour; Site Details: one small patch of birch trees (3 to 4 m in height) growing in soil pocket
INGT-OSC-138	Ingraham Trail	P	August 16, 2015	13.5	2.2	OSC	Core	PH	214	62.53001	-114.17126	10.04	72	14.84	43	Sedimentary	Groundcover: thick (approximately 20 cm uncompressed), dark brown moss, some pine needles and reindeer lichen; Soil: silty sand, base of core appears to be a mix of dark, blackish-brown and medium, orangish-brown soils; Site Details: small willow trees in pocket and some small pine trees nearby
INGT-OSC-142	Ingraham Trail	P	August 16, 2015	14.5	4.2	OSC	Core	PH	214	62.53683	-114.14421	11.59	71	16.35	45	Sedimentary	Groundcover: long grass and lichen; Site Details: tiny soil pocket with some ferns, hens and chicks, close to GSC survey site, top of outcrop where sample INGT - FCOSC - 141 was taken
INGT-OSC-142 D	Ingraham Trail	SS	August 16, 2015	14.5	4.2	OSC	Core	PH	214	62.53683	-114.14421	11.59	71	16.35	45	Sedimentary	Groundcover: long grass and lichen; Site Details: tiny soil pocket with some ferns, hens and chicks, close to GSC survey site, top of outcrop where sample INGT - FCOSC - 141 was taken
INGT-OSC-39	Ingraham Trail	P	August 3, 2015	14.3	3.6	OSC	Core	PH	213	62.55805	-114.01021	18.86	71	23.08	53	Granitoid	Groundcover: thick, spongy, dry, light yellowish-tan moss, labrador tea; Soil: sample taken in area with thinner, greener moss, bottom of core damp and dark brownish-black in colour; Site Details: near Prelude Lake Campground, large mica crystals within granite outcrop, unhealthy trees in area, hot, dry, smoky day
INGT-OSC-39	Ingraham Trail	LD	August 3, 2015	14.3	3.6	OSC	Core	PH	213	62.55805	-114.01021	18.86	71	23.08	53	Granitoid	Groundcover: thick, spongy, dry, light yellowish-tan moss, labrador tea; Soil: sample taken in area with thinner, greener moss, bottom of core damp and dark brownish-black in colour; Site Details: near Prelude Lake Campground, large mica crystals within granite outcrop, unhealthy trees in area, hot, dry, smoky day
INGT-OSC-48	Ingraham Trail	P	August 5, 2015	8.5	4.0	OSC	Core	PH	252	62.52157	-114.32074	2.87	41	10.25	13	Volcanic	Groundcover: long grass, thin layer of dry, carpet like moss; Site Details: same outcrop as INGT - OSG - 47, small pine tree and 3 small willows growing in soil pocket
INGT-OSC-52	Ingraham Trail	P	August 5, 2015	16.5	2.8	OSC	Core	PH	227	62.50259	-114.2752	4.21	89	9.17	31	Mafic	Groundcover: thick layer of leaf litter (some leaves cleared away to take core), juniper bushes, small green plants; Soil: dark brown, dry, silty; Site Details: couch, fire pits and cans at top of outcrop, one of the highest ridges in the area
INGT-OSC-52	Ingraham Trail	LD	August 5, 2015	16.5	2.8	OSC	Core	PH	227	62.50259	-114.2752	4.21	89	9.17	31	Mafic	Groundcover: thick layer of leaf litter (some leaves cleared away to take core), juniper bushes, small green plants; Soil: dark brown, dry, silty; Site Details: couch, fire pits and cans at top of outcrop, one of the highest ridges in the area
INGT-OSG-47	Ingraham Trail	P	August 5, 2015	6 to 7	-	OSG	Grab	ND	252	62.52147	-114.32074	2.86	41	10.24	14	Volcanic	Grab Sample; Groundcover: dry, broken up moss, grass; Site Details: very shallow, small soil pocket on top of ridge overlooking the Yellowknife River
INGT-OSG-47	Ingraham Trail	LD	August 5, 2015	6 to 7	-	OSG	Grab	ND	252	62.52147	-114.32074	2.86	41	10.24	14	Volcanic	Grab Sample; Groundcover: dry, broken up moss, grass; Site Details: very shallow, small soil pocket on top of ridge overlooking the Yellowknife River
INGT-OSG-47 S	Ingraham Trail	LD	August 5, 2015	6 to 7	-	OSG	Grab	ND	252	62.52147	-114.32074	2.86	41	10.24	14	Volcanic	Grab Sample; Groundcover: dry, broken up moss, grass; Site Details: very shallow, small soil pocket on top of ridge overlooking the Yellowknife River
INGT-OSG-47 S	Ingraham Trail	S	August 5, 2015	6 to 7	-	OSG	Grab	ND	252	62.52147	-114.32074	2.86	41	10.24	14	Volcanic	Grab Sample; Groundcover: dry, broken up moss, grass; Site Details: very shallow, small soil pocket on top of ridge overlooking the Yellowknife River
INGT-PSG-44	Ingraham Trail	P	August 5, 2015	-	-	PSG	Grab	ND	261	62.52274	-114.3329	2.62	29	10.26	10	Volcanic	Grab Sample; Soil: peat with little to no structure, moss and water throughout; Site Details: little depth control due to peat collapsing
BC20-FCSC-163	Martin Lake and Nearby Previous Research Areas	P	August 24, 2015	20.5	2.4	FCSC	Core	PH	272	62.50056	-114.39091	1.74	264	7.73	351	Granitoid	Groundcover: moss and some lichen; Soil: wet, clay rich, light tan brown at depth; Site Details: small willows and spruce trees (1 to 6 m in height), close to edge of research lake BC - 20, raining, tried to take outcrop soil sample, but soil was too saturated and fell out of core tube
BC20-FCSC-163	Martin Lake and Nearby Previous Research Areas	P	August 24, 2015	20.5	2.5	FCSC	Core	DC	272	62.50056	-114.39091	1.74	264	7.73	351	Granitoid	Groundcover: moss and some lichen; Soil: wet, clay rich, light tan brown at depth; Site Details: small willows and spruce trees (1 to 6 m in height), close to edge of research lake BC - 20, raining, tried to take outcrop soil sample, but soil was too saturated and fell out of core tube
BC20-FCSC-163 D	Martin Lake and Nearby Previous Research Areas	SS	August 24, 2015	20.5	2.4	FCSC	Core	PH	272	62.50056	-114.39091	1.74	264	7.73	351	Granitoid	Groundcover: moss and some lichen; Soil: wet, clay rich, light tan brown at depth; Site Details: small willows and spruce trees (1 to 6 m in height), close to edge of research lake BC - 20, raining, tried to take outcrop soil sample, but soil was too saturated and fell out of core tube

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
BC20-PSC-164.1	Martin Lake and Nearby Previous Research Areas	P	August 24, 2015	24	5.0	PSC	Core	PH	272	62.49954	-114.39414	1.92	261	7.65	350	Granitoid	Groundcover: moss and lichen; Soil: elevated peat land, spongy; Site Details: sample taken in a peat land beside research lake BC-20
BC20-PSC-164.1	Martin Lake and Nearby Previous Research Areas	LD	August 24, 2015	24	5.0	PSC	Core	PH	272	62.49954	-114.39414	1.92	261	7.65	350	Granitoid	Groundcover: moss and lichen; Soil: elevated peat land, spongy; Site Details: sample taken in a peat land beside research lake BC-20
HL- OSC-165	Martin Lake and Nearby Previous Research Areas	P	August 24, 2015	22.1	3.8	OSC	Core	PH	270	62.49469	-114.39379	2.05	246	7.12	349	Granitoid	Groundcover: reindeer lichen; Soil: transitions from dark brown, organic rich soil at the surface to a light orangey-brown, silty soil at the base; Site Details: low on outcrop, close to forested area
HL-OSC-165	Martin Lake and Nearby Previous Research Areas	P	August 24, 2015	22.1	3.8	OSC	Core	DC	270	62.49469	-114.39379	2.05	246	7.12	349	Granitoid	Groundcover: reindeer lichen; Soil: transitions from dark brown, organic rich soil at the surface to a light orangey-brown, silty soil at the base; Site Details: low on outcrop, close to forested area
ML-FCOSC-97	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	7.7	5.0	FCOSC	Core	PH	282	62.54141	-114.41016	5.16	328	12.38	350	Granitoid	Groundcover: pine needles and some leaf litter, cranberry bushes, dead twigs; Soil: very dry, light tan, silty sand, primarily roots and organic material in upper few centimeters; Site Details: jack pine trees in vicinity (approximately 3 to 4 m in height)
ML-FCOSC-97 S	Martin Lake and Nearby Previous Research Areas	S	August 9, 2015	7.7	5.0	FCOSC	Core	PH	282	62.54141	-114.41016	5.16	328	12.38	350	Granitoid	Groundcover: pine needles and some leaf litter, cranberry bushes, dead twigs; Soil: very dry, light tan, silty sand, primarily roots and organic material in upper few centimeters; Site Details: jack pine trees in vicinity (approximately 3 to 4 m in height)
ML-FCOSG-105	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	-	-	FCOSG	Grab	ND	276	62.52934	-114.4346	5.00	307	11.38	342	Granitoid	Grab Sample; Groundcover: cranberry bushes, lichen, juniper bush; Soil: dark brown soil, very dry, slightly more compacted; Soil Details: jack pines in area look unhealthy, sample taken at base of a jack pine
ML-FCOSG-96	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	10	-	FCOSG	Grab	ND	282	62.54159	-114.41029	5.18	328	12.40	350	Granitoid	Grab Sample; Approximate depth of 10 cm; Groundcover: pine needles, pinecones, dead twigs; Soil: very dry, dusty soil, lots of roots in upper few centimeters; Site Details: edge of Martin Lake, Jack pines growing on outcrop
ML-FCSC-100	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	11.5	2.4	FCSC	Core	PH	280	62.53787	-114.41068	4.84	325	12.00	349	Granitoid	Groundcover: cranberry bushes, leaf litter, labrador tea, soft pale leafy plants, long grass; Soil: lots of compression; Site Details: hit refusal, sample taken at base of large outcrop, jack pine and birch trees growing in area providing shade
ML-FCSC-102	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	26	1.7	FCSC	Core	PH	278	62.53349	-114.42841	5.06	314	11.73	344	Granitoid	Groundcover: moss, juniper bushes, some reindeer lichen, lots of dead, fallen tree branches and trees, some labrador tea and bear berries; Soil = dark to medium brown in colour, sample was obtained where moss was the thinnest, core was cold and was covered in moisture upon its removal; Site Details: small valley at the base of two granite outcrops, Jack pines approximately 6 to 8 m in height
ML-FCSC-102	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	26	5.0	FCSC	Core	DC	278	62.53349	-114.42841	5.06	314	11.73	344	Granitoid	Groundcover: moss, juniper bushes, some reindeer lichen, lots of dead, fallen tree branches and trees, some labrador tea and bear berries; Soil = dark to medium brown in colour, sample was obtained where moss was the thinnest, core was cold and was covered in moisture upon its removal; Site Details: small valley at the base of two granite outcrops, Jack pines approximately 6 to 8 m in height
ML-FCSC-102 NR	Martin Lake and Nearby Previous Research Areas	SS	August 9, 2015	26	1.7	FCSC	Core	PH	278	62.53349	-114.42841	5.06	314	11.73	344	Granitoid	Groundcover: moss, juniper bushes, some reindeer lichen, lots of dead, fallen tree branches and trees, some labrador tea and bear berries; Soil = dark to medium brown in colour, sample was obtained where moss was the thinnest, core was cold and was covered in moisture upon its removal; Site Details: small valley at the base of two granite outcrops, Jack pines approximately 6 to 8 m in height
ML-OSC-103	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	8.5	4.4	OSC	Core	PH	278	62.53314	-114.42727	4.99	314	11.68	345	Granitoid	Groundcover: pine needles, some reindeer lichen (relatively sparse); Soil: very dry and silty; Site Details: Jack pines were growing in the pocket (approximately 3 m in height)
ML-OSC-103 S	Martin Lake and Nearby Previous Research Areas	S	August 9, 2015	8.5	4.4	OSC	Core	PH	278	62.53314	-114.42727	4.99	314	11.68	345	Granitoid	Groundcover: pine needles, some reindeer lichen (relatively sparse); Soil: very dry and silty; Site Details: Jack pines were growing in the pocket (approximately 3 m in height)
ML-OSC-98	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	20.7	3.3	OSC	Core	PH	280	62.53825	-114.41071	4.88	326	12.04	349	Granitoid	Groundcover: grass, thin layer of moss beneath grass; Soil: blackish-brown, moist, organic rich soil; Site Details: deep soil pocket between two rock units (appears to be granites and YGB), large quartz vein running parallel to soil pocket
ML-OSC-98	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	20.7	3.5	OSC	Core	DC	280	62.53825	-114.41071	4.88	326	12.04	349	Granitoid	Groundcover: grass, thin layer of moss beneath grass; Soil: blackish-brown, moist, organic rich soil; Site Details: deep soil pocket between two rock units (appears to be granites and YGB), large quartz vein running parallel to soil pocket

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
ML-OSC-98 D	Martin Lake and Nearby Previous Research Areas	SS	August 9, 2015	20.7	3.5	OSC	Core	DC	280	62.53825	-114.41071	4.88	326	12.04	349	Granitoid	Groundcover: grass, thin layer of moss beneath grass; Soil: blackish-brown, moist, organic rich soil; Site Details: deep soil pocket between two rock units (appears to be granites and YGB), large quartz vein running parallel to soil pocket
ML-OSG-101	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	9.5	-	OSG	Grab	ND	278	62.53368	-114.42891	5.10	314	11.76	344	Granitoid	Grab Sample; Approximate depth: 9.5 cm Groundcover: leaf litter, cranberry bushes, small pine like shrubs, dry, yellowish long grass, some dry moss; Soil: dry
ML-OSG-104.1	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	6.5	-	OSG	Grab	ND	276	62.52919	-114.43391	4.97	307	11.35	342	Granitoid	Grab Sample; Approximate Depth: 0 to 6.5 cm; Groundcover: dry pine needs, leaf litter; Soil: dark brown, coarse, organic rich; Site Details: top of sample, ML OSG - 104.2 taken in the same location
ML-OSG-104.2	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	6.5 to 13	-	OSG	Grab	ND	276	62.52919	-114.43391	4.97	307	11.35	342	Granitoid	Grab Sample; Approximate Depth: 6.5 to 13 cm; Groundcover: dry pine needles, leaf litter; Soil: light tan, silty sand, dry and dusty; Site Details: tried to take core, soil fell out of core tube
ML-OSG-99	Martin Lake and Nearby Previous Research Areas	P	August 9, 2015	6 to 7	-	OSG	Grab	ND	280	62.53813	-114.41148	4.89	325	12.03	349	Granitoid	Grab Sample; Approximate depth: 6 to 7 cm; Groundcover: pine needles, patches of reindeer lichen; Soil: dry, dark brown; Site Details: small soil pocket, granite and YGB outcrops on either side of soil pocket, small jack pines growing in area
ML-OSG-99 NR	Martin Lake and Nearby Previous Research Areas	SS	August 9, 2015	6 to 7	-	OSG	Grab	ND	280	62.53813	-114.41148	4.89	325	12.03	349	Granitoid	Grab Sample; Approximate depth: 6 to 7 cm; Groundcover: pine needles, patches of reindeer lichen; Soil: dry, dark brown; Site Details: small soil pocket, granite and YGB outcrops on either side of soil pocket, small jack pines growing in area
NWC1-FCOSC-83	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	11.5	3.6	FCOSC	Core	PH	267	62.53754	-114.48769	7.78	300	13.28	332	Granitoid	Groundcover: lichen, thick moss, cloud berries; Soil: organic-rich, medium brown colour, some roots; Site Details: surrounded by black spruce trees
NWC1-FCSC-82	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	15	3.7	FCSC	Core	PH	267	62.53813	-114.48792	7.82	301	13.34	332	Granitoid	Groundcover: moss, labrador tea, bear berries; Soil: dark brown in colour, some roots, slightly damp; Site Details: hazel/alder trees and black spruce
NWC1-FCSC-82	Martin Lake and Nearby Previous Research Areas	LD	August 7, 2015	15	3.7	FCSC	Core	PH	267	62.53813	-114.48792	7.82	301	13.34	332	Granitoid	Groundcover: moss, labrador tea, bear berries; Soil: dark brown in colour, some roots, slightly damp; Site Details: hazel/alder trees and black spruce
NWC2-FCSC-81	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	10	3.7	FCSC	Core	PH	257	62.53564	-114.52564	9.42	293	14.12	325	Granitoid	Groundcover: labrador tea, black spruce; Soil: organic-rich, dark brown, lots of roots, top of soil core appears to be drier and has a high root content
NWC2-OSG-78	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	-	-	OSG	Grab	ND	258	62.53593	-114.52535	9.42	293	14.14	325	Granitoid	Grab Sample; Groundcover: grass, moss (thin, carpet like) and small amount of lichen; Soil: dark brown, root matter
NWC2-OSG-79	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	-	-	OSG	Grab	ND	258	62.53604	-114.5255	9.43	293	14.15	325	Granitoid	Grab Sample; Groundcover: moss - very dry, fell off sample when trying to put it into whirlpak bag; Soil: lighter in colour, dryer and less root contents than sample NWC2 - OSG - 78; Site Details: Jack pine growing in soil pocket
NWC2-OSG-79 D	Martin Lake and Nearby Previous Research Areas	SS	August 7, 2015	-	-	OSG	Grab	ND	258	62.53604	-114.5255	9.43	293	14.15	325	Granitoid	Grab Sample; Groundcover: moss - very dry, fell off sample when trying to put it into whirlpak bag; Soil: lighter in colour, dryer and less root contents than sample NWC2 - OSG - 78; Site Details: Jack pine growing in soil pocket
NWC2-OSG-79 NR	Martin Lake and Nearby Previous Research Areas	SS	August 7, 2015	-	-	OSG	Grab	ND	258	62.53604	-114.5255	9.43	293	14.15	325	Granitoid	Grab Sample; Groundcover: moss - very dry, fell off sample when trying to put it into whirlpak bag; Soil: lighter in colour, dryer and less root contents than sample NWC2 - OSG - 78; Site Details: Jack pine growing in soil pocket
NWC2-OSG-80	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	-	-	OSG	Grab	ND	258	62.53595	-114.52521	9.41	293	14.14	325	Granitoid	Grab Sample; Groundcover: dead pine needles, cranberries, lichen; Soil: light coloured (beige/taupe), fine grained, roots in upper 2 to 3 cm; Site Details: pine trees
NWC3-FCOSC-85	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	8.2	2.8	FCOSC	Core	PH	260	62.50624	-114.50716	7.72	273	10.96	319	Granitoid	Soil: very dry, heavily rooted; Site Details: forested soil pocket
NWC3-OSG-84	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	-	-	OSG	Grab	ND	259	62.50642	-114.50699	7.71	273	10.97	319	Granitoid	Grab Sample; Groundcover: dominated by moss, some lichen, some grass; Soil: dark brown, organic-rich (lots of roots), very dry; Site Details: two pine trees in vicinity, shallow soil pocket, moss fell off top of soil sample while trying to put in whirl pak bag
NWC3-OSG-84	Martin Lake and Nearby Previous Research Areas	LD	August 7, 2015	-	-	OSG	Grab	ND	259	62.50642	-114.50699	7.71	273	10.97	319	Granitoid	Grab Sample; Groundcover: dominated by moss, some lichen, some grass; Soil: dark brown, organic-rich (lots of roots), very dry; Site Details: two pine trees in vicinity, shallow soil pocket, moss fell off top of soil sample while trying to put in whirl pak bag
NWC3-OSG-86	Martin Lake and Nearby Previous Research Areas	P	August 7, 2015	-	-	OSG	Grab	ND	259	62.50669	-114.5067	7.69	274	10.98	319	Granitoid	Grab Sample; Groundcover: dead pine needles; Soil: very thin, dry layer of soil, light to medium brown in colour, fine grained, silty; Site Details: pine and spruce trees within vicinity

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
NWC3-OSG-86 D	Martin Lake and Nearby Previous Research Areas	SS	August 7, 2015	-	-	OSG	Grab	ND	259	62.50669	-114.5067	7.69	274	10.98	319	Granitoid	Grab Sample; Groundcover: dead pine needles; Soil: very thin, dry layer of soil, light to medium brown in colour, fine grained, silty; Site Details: pine and spruce trees within vicinity
NWC3-OSG-86 S	Martin Lake and Nearby Previous Research Areas	S	August 7, 2015	-	-	OSG	Grab	ND	259	62.50669	-114.5067	7.69	274	10.98	319	Granitoid	Grab Sample; Groundcover: dead pine needles; Soil: very thin, dry layer of soil, light to medium brown in colour, fine grained, silty; Site Details: pine and spruce trees within vicinity
MIR-FCG-02	Mirage Islands	P	August 1, 2015	-	5.0	FCSG	Grab	PH	156	62.273329	-114.459912	25.97	192	18.27	195	Volcanic	Groundcover: lots of leaf litter (dry, greyish-brown), small pine cones, roots, twigs; Soil: very amalgamated - had to pull apart to separate, slightly more consolidated than MIR - OSG - 01
MIR-FCG-02 D	Mirage Islands	SS	August 1, 2015	-	5.0	FCSG	Grab	PH	156	62.273329	-114.459912	25.97	192	18.27	195	Volcanic	Groundcover: lots of leaf litter (dry, greyish-brown), small pine cones, roots, twigs; Soil: very amalgamated - had to pull apart to separate, slightly more consolidated than MIR - OSG - 01
MIR-FCG-02 D	Mirage Islands	LD	August 1, 2015	-	5.0	FCSG	Grab	PH	156	62.273329	-114.459912	25.97	192	18.27	195	Volcanic	Groundcover: lots of leaf litter (dry, greyish-brown), small pine cones, roots, twigs; Soil: very amalgamated - had to pull apart to separate, slightly more consolidated than MIR - OSG - 01
MIR-OSG-01	Mirage Islands	P	August 1, 2015	-	5.0	OSG	Grab	PH	156	62.273561	-114.460355	25.95	192	18.25	195	Volcanic	Groundcover: leaf litter (dark blackish-brown, falls off easily); Soil: crumbling, organic-rich, dry, heavily rooted, dark brown
MIR-PSG-03	Mirage Islands	P	August 1, 2015	-	5.0	PSG	Grab	PH	156	62.27267	-114.460739	26.05	192	18.35	195	Volcanic	Groundcover: bright green grass and moss; Soil: very green peat (light, lime or yellowish-green colour), fibrous grassy, saturated beige peat with roots throughout beneath light green layer;
MIR-PSG-03 D	Mirage Islands	SS	August 1, 2015	-	5.0	PSG	Grab	PH	156	62.27267	-114.460739	26.05	192	18.35	195	Volcanic	Groundcover: bright green grass and moss; Soil: very green peat (light, lime or yellowish-green colour), fibrous grassy, saturated beige peat with roots throughout beneath light green layer;
NDILO-FCSC-25	NdilQ	P	July 29, 2015	11.3	4.0	FCSC	Core	PH	156	62.47894	-114.33243	2.86	154	5.53	19	Volcanic	Groundcover: short berry bushes with orange-yellowish berries, pine cones and pine needles litter surface; Site Details: trees approximately 40 to 50 ft in height
NDILO-FCSC-25 S	NdilQ	S	July 29, 2015	11.3	4.0	FCSC	Core	PH	156	62.47894	-114.33243	2.86	154	5.53	19	Volcanic	Groundcover: short berry bushes with orange-yellowish berries, pine cones and pine needles litter surface; Site Details: trees approximately 40 to 50 ft in height
NDILO-FCSC-26	NdilQ	P	July 29, 2015	14.5	3.7	FCSC	Core	PH	156	62.47688	-114.33621	2.99	159	5.25	18	Volcanic	Groundcover: leaf litter; Site Details: near boardwalk in N'Dilo, young willow and birch trees in sample area, sample taken along water's edge, site did not look undisturbed
NDILO-OSC 27	NdilQ	P	July 29, 2015	6	4.3	OSC	Core	PH	156	62.47437	-114.34177	3.17	166	4.90	15	Volcanic	Groundcover: very dry, long grass overlying moss; Site Details: soil pocket located lower down on outcrop, small soil pocket, surrounded by homes in N'Dilo, some crawling vines planted in another soil pocket nearby on same outcrop, some degree of disturbance in sample sites around N'Dilo
NDILO-OSC-23	NdilQ	P	July 29, 2015	8	5.0	OSC	Core	PH	156	62.47534	-114.33455	3.18	159	5.12	19	Volcanic	Groundcover: pine needles, small pine cones, roots, dead branches, sticks; Soil: dry and heavily rooted; Site Details: sample taken in N'Dilo with Fred Sangris and Mary Black, site did not look undisturbed
NDILO-OSC-23 D	NdilQ	SS	July 29, 2015	8	5.0	OSC	Core	PH	156	62.47534	-114.33455	3.18	159	5.12	19	Volcanic	Groundcover: pine needles, small pine cones, roots, dead branches, sticks; Soil: dry and heavily rooted; Site Details: sample taken in N'Dilo with Fred Sangris and Mary Black, site did not look undisturbed
NDILO-OSC-23 S	NdilQ	S	July 29, 2015	8	5.0	OSC	Core	PH	156	62.47534	-114.33455	3.18	159	5.12	19	Volcanic	Groundcover: pine needles, small pine cones, roots, dead branches, sticks; Soil: dry and heavily rooted; Site Details: sample taken in N'Dilo with Fred Sangris and Mary Black, site did not look undisturbed
NDILO-OSC-24	NdilQ	P	July 29, 2015	6.3	3.1	OSC	Core	PH	156	62.47643	-114.33362	3.09	157	5.25	19	Mafic	Groundcover: moss; Site Details: small spruce trees approximately 3 m in height nearby
CHAN-FCSC-61	North of Giant Mine Property	P	August 6, 2015	14.5	3.2	FCSC	Core	PH	262	62.63334	-114.35625	14.60	0.2	22.41	1	Volcanic	Groundcover: cranberry bushes, labrador tea, emerald green moss (thin layer, not thick and mushy), some pine needles; Soil: very dry, dark, organic-rich, heavily rooted topsoil; Site Details: pine trees in area (approximately 4 m)
CHAN-OSG-60	North of Giant Mine Property	P	August 6, 2015	5.5 to 6	-	OSG	Grab	ND	263	62.63346	-114.35572	14.62	0.3	22.42	2	Volcanic	Grab Sample; Groundcover: reindeer lichen, pine needles, dry dead sticks; Soil: light, orangish-brown colour, very dry, silty sand, overlying organic-rich layer full of roots
CHAN-OSG-60 NR	North of Giant Mine Property	SS	August 6, 2015	5.5 to 6	-	OSG	Grab	ND	263	62.63346	-114.35572	14.62	0.3	22.42	2	Volcanic	Grab Sample; Groundcover: reindeer lichen, pine needles, dry dead sticks; Soil: light, orangish-brown colour, very dry, silty sand, overlying organic-rich layer full of roots
CHAN-PSC-59	North of Giant Mine Property	P	August 6, 2015	32	5.0	PSC	Core	PH	262	62.63351	-114.35482	14.62	0.5	22.43	2	Volcanic	Groundcover: small, low-lying leafy brush, dead trees; Site Details: willows growing in peat area
DUF-FCSC-55	North of Giant Mine Property	P	August 6, 2015	8.6	2.7	FCSC	Core	PH	259	62.65219	-114.46776	17.63	341	25.03	348	Granitoid	Groundcover: pine needles, thin organic layer; Soil: silty glacial till; Site details: Jack pines (5 to 6 m in height)
DUF-OSC-54	North of Giant Mine Property	P	August 6, 2015	13	2.9	OSC	Core	PH	259	62.65269	-114.46842	17.70	341	25.10	348	Granitoid	Groundcover: labrador tea, reindeer lichen, dead branches, cranberry bushes; Site Details: sample taken next to small pine tree

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
DUF-PSC-53	North of Giant Mine Property	P	August 6, 2015	33	5.0	PSC	Core	PH	260	62.65298	-114.46629	17.69	342	25.11	348	Granitoid	Groundcover: labrador tea, cloud berries, light white-green lichen on surface; Soil: fibrous peat
DUF-PSC-53	North of Giant Mine Property	LD	August 6, 2015	33	5.0	PSC	Core	PH	260	62.65298	-114.46629	17.69	342	25.11	348	Granitoid	Groundcover: labrador tea, cloud berries, light white-green lichen on surface; Soil: fibrous peat
HOML-FCSC-56	North of Giant Mine Property	P	August 6, 2015	26.5	4.1	FCSC	Core	PH	235	62.65708	-114.3046	17.45	9	25.25	7	Volcanic	Groundcover: leaf litter and dead branches; Soil: light brown, silty sandy till, lots of roots in the upper layers of soil; Site Details: Jack pines and some birch trees in area, sample taken in a small, narrow, low valley between two outcrop ridges, found trench in area - near or on TerraX Northbelt property?
HOML-FCSC-56	North of Giant Mine Property	P	August 6, 2015	26.5	5.0	FCSC	Core	DC	235	62.65708	-114.3046	17.45	9	25.25	7	Volcanic	Groundcover: leaf litter and dead branches; Soil: light brown, silty sandy till, lots of roots in the upper layers of soil; Site Details: Jack pines and some birch trees in area, sample taken in a small, narrow, low valley between two outcrop ridges, found trench in area - near or on TerraX Northbelt property?
HOML-FCSC-56 D	North of Giant Mine Property	SS	August 6, 2015	26.5	4.1	FCSC	Core	PH	235	62.65708	-114.3046	17.45	9	25.25	7	Volcanic	Groundcover: leaf litter and dead branches; Soil: light brown, silty sandy till, lots of roots in the upper layers of soil; Site Details: Jack pines and some birch trees in area, sample taken in a small, narrow, low valley between two outcrop ridges, found trench in area - near or on TerraX Northbelt property?
HOML-FCSC-56 D	North of Giant Mine Property	LD	August 6, 2015	26.5	4.1	FCSC	Core	PH	235	62.65708	-114.3046	17.45	9	25.25	7	Volcanic	Groundcover: leaf litter and dead branches; Soil: light brown, silty sandy till, lots of roots in the upper layers of soil; Site Details: Jack pines and some birch trees in area, sample taken in a small, narrow, low valley between two outcrop ridges, found trench in area - near or on TerraX Northbelt property?
HOML-OSG-57	North of Giant Mine Property	P	August 6, 2015	-	-	OSG	Grab	ND	236	62.65694	-114.30392	17.44	9	25.23	7	Volcanic	Grab Sample; Groundcover: bear berries, dead branches, pine needles, leaf litter; Soil: very shallow; Site Details: Jack pines (approximately 5 m in height), some new growth also present (4 plants)
HOML-OSG-57 S	North of Giant Mine Property	S	August 6, 2015	-	-	OSG	Grab	ND	236	62.65694	-114.30392	17.44	9	25.23	7	Volcanic	Grab Sample; Groundcover: bear berries, dead branches, pine needles, leaf litter; Soil: very shallow; Site Details: Jack pines (approximately 5 m in height), some new growth also present (4 plants)
HOML-PSC-58	North of Giant Mine Property	P	August 6, 2015	22.5	5.0	PSC	Core	PH	235	62.65597	-114.30308	17.34	9	25.13	8	Volcanic	Groundcover: short to medium green grass, cranberry bushes, some lichen; Soil: very dark, organic-rich, peat here is different than other fibrous peatland located next to Bypass Road - not fibrous
HOML-PSC-58	North of Giant Mine Property	P	August 6, 2015	17.5 to 22.	5.0	PSC	Core	DC	235	62.65597	-114.30308	17.34	9	25.13	8	Volcanic	Groundcover: short to medium green grass, cranberry bushes, some lichen; Soil: very dark, organic-rich, peat here is different than other fibrous peatland located next to Bypass Road - not fibrous
HOML-PSC-58 D	North of Giant Mine Property	SS	August 6, 2015	22.5	5.0	PSC	Core	PH	235	62.65597	-114.30308	17.34	9	25.13	8	Volcanic	Groundcover: short to medium green grass, cranberry bushes, some lichen; Soil: very dark, organic-rich, peat here is different than other fibrous peatland located next to Bypass Road - not fibrous
DUCK-FCSC-71	Southeast and East of Yellowknife	P	August 6, 2015	17	3.1	FCSC	Core	PH	215	62.4218	-114.24291	10.68	147	6.49	100	Volcanic	Groundcover: some moss - clumpy, soft, fluffy and green, labrador tea; Soil: dark brown, organic-rich soil - heavily rooted; Site Details: black spruce and birch trees (5 to 6 m)
DUCK-OSG-72	Southeast and East of Yellowknife	P	August 6, 2015	12	-	OSG	Grab	ND	215	62.42212	-114.24274	10.65	147	6.50	100	Volcanic	Grab Sample; Groundcover: juniper bushes, grass; Soil: dark brown, very dry; Site Details: one live spruce tree and one dead tree in soil pocket
DUCK-OSG-72 NR	Southeast and East of Yellowknife	SS	August 6, 2015	12	-	OSG	Grab	ND	215	62.42212	-114.24274	10.65	147	6.50	100	Volcanic	Grab Sample; Groundcover: juniper bushes, grass; Soil: dark brown, very dry; Site Details: one live spruce tree and one dead tree in soil pocket
EAST1-FCSC-69	Southeast and East of Yellowknife	P	August 6, 2015	15.5	5.0	FCSC	Core	PH	216	62.45919	-114.05475	16.25	107	16.35	79	Volcanic	Groundcover: dead birch bark, dead branches, cranberries; Soil: light tan, silty sand; Site Details: birch and black spruce trees growing in area (4 to 6 m)
EAST1-OSC-70	Southeast and East of Yellowknife	P	August 6, 2015	13.2	5.0	OSC	Core	PH	216	62.45923	-114.05435	16.27	107	16.38	79	Volcanic	Groundcover: long grass and soft green moss that looks like it is beginning to dry out; Site Details: small soil pocket
EAST1-OSC-70 D	Southeast and East of Yellowknife	SS	August 6, 2015	13.2	5.0	OSC	Core	PH	216	62.45923	-114.05435	16.27	107	16.38	79	Volcanic	Groundcover: long grass and soft green moss that looks like it is beginning to dry out; Site Details: small soil pocket
EAST2-FCSC-66	Southeast and East of Yellowknife	P	August 6, 2015	15.5	3.8	FCSC	Core	PH	215	62.44915	-114.08786	15.03	113	14.50	83	Volcanic	Groundcover: soft green moss (thin layers and balled-up, fluffy, chunks), small green plants, wild rose bushes, many dead sticks; Soil: very dark, organic and clay-rich soil, moist and cool; Site Details: black spruce growing in area, new growth, trees are very dry (numerous dead branches at their base), sample taken in area free of moss
EAST2-FCSC-66	Southeast and East of Yellowknife	P	August 6, 2015	15.5	3.8	FCSC	Core	DC	215	62.44915	-114.08786	15.03	113	14.50	83	Volcanic	Groundcover: soft green moss (thin layers and balled-up, fluffy, chunks), small green plants, wild rose bushes, many dead sticks; Soil: very dark, organic and clay-rich soil, moist and cool; Site Details: black spruce growing in area, new growth, trees are very

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	dry (numerous dead branches at their base), sample taken in area free of moss
EAST2-FCSC-66	Southeast and East of Yellowknife	LD	August 6, 2015	15.5	3.8	FCSC	Core	DC	215	62.44915	-114.08786	15.03	113	14.50	83	Volcanic	Groundcover: soft green moss (thin layers and balled-up, fluffy, chunks), small green plants, wild rose bushes, many dead sticks; Soil: very dark, organic and clay-rich soil, moist and cool; Site Details: black spruce growing in area, new growth, trees are very dry (numerous dead branches at their base), sample taken in area free of moss
EAST2-OSG-67	Southeast and East of Yellowknife	P	August 6, 2015	-	-	OSG	Grab	ND	215	62.4492	-114.08829	15.01	113	14.48	82	Volcanic	Grab Sample; Groundcover: grass and moss; Site Details: Jack pine growing in soil pocket, juniper bush next to sample location
EAST2-OSG-67 D	Southeast and East of Yellowknife	SS	August 6, 2015	-	-	OSG	Grab	ND	215	62.4492	-114.08829	15.01	113	14.48	82	Volcanic	Grab Sample; Groundcover: grass and moss; Site Details: Jack pine growing in soil pocket, juniper bush next to sample location
EAST2-PSC-68	Southeast and East of Yellowknife	P	August 6, 2015	25	5.0	PSC	Core	PH	215	62.44919	-114.08963	14.95	113	14.41	82	Volcanic	Groundcover: labrador tea, long grass and moss; Soil: very dark brown soil-rich peat, moist; Site Details: black spruce and alder trees
EAST2-PSC-68	Southeast and East of Yellowknife	LD	August 6, 2015	25	5.0	PSC	Core	PH	215	62.44919	-114.08963	14.95	113	14.41	82	Volcanic	Groundcover: labrador tea, long grass and moss; Soil: very dark brown soil-rich peat, moist; Site Details: black spruce and alder trees
MASL-OSC-65	Southeast and East of Yellowknife	P	August 6, 2015	13	3.1	OSC	Core	PH	215	62.40147	-114.14309	15.69	136	12.02	106	Granitoid	Groundcover: cranberries, labrador tea, and reindeer lichen; Site Details: soil sample taken in a lower depression between two thick moss-covered areas (moss made taking core difficult), Jack pines in area (3 to 4 m in height)
MASL-OSC-65	Southeast and East of Yellowknife	LD	August 6, 2015	13	3.1	OSC	Core	PH	215	62.40147	-114.14309	15.69	136	12.02	106	Granitoid	Groundcover: cranberries, labrador tea, and reindeer lichen; Site Details: soil sample taken in a lower depression between two thick moss-covered areas (moss made taking core difficult), Jack pines in area (3 to 4 m in height)
MASL-PSC-64	Southeast and East of Yellowknife	P	August 6, 2015	29 to 30	5.0	PSC	Core	PH	215	62.40157	-114.14432	15.64	136	11.96	106	Granitoid	Groundcover: reindeer moss, lots of labrador tea, some dead branches and trees sticking out of peatland
NWFAR1-FCSC-75	Southwest and West of Yellowknife	P	August 7, 2015	28.5	2.5	FCSC	Core	PH	179	62.57073	-114.78146	23.06	289	26.28	306	Granitoid	Groundcover: pine needles, bear berries in vicinity; Soil: silty sand with top organic-rich layer, looks like till, light sandy brown in colour
NWFAR1-FCSC-75	Southwest and West of Yellowknife	P	August 7, 2015	28.5	5.0	FCSC	Core	DC	179	62.57073	-114.78146	23.06	289	26.28	306	Granitoid	Groundcover: pine needles, bear berries in vicinity; Soil: silty sand with top organic-rich layer, looks like till, light sandy brown in colour
NWFAR1-OSG-76	Southwest and West of Yellowknife	P	August 7, 2015	-	-	OSG	Grab	ND	258	62.57103	-114.78151	9.43	293	14.15	325	Granitoid	Grab Sample; Groundcover: moss - very dry, fell off sample when trying to put it into whirlpak bag; Soil: lighter in colour, dryer and less root contents than sample NWC2 - OSG - 78; Site Details: Jack pine growing in soil pocket
NWFAR1-PSC-77	Southwest and West of Yellowknife	P	August 7, 2015	25.5	5.0	PSC	Core	PH	179	62.57064	-114.78195	23.08	289	26.30	306	Granitoid	Groundcover: thick moss; Soil: dark brown, organic-rich, very moist peat
NWFAR2-OSG-74	Southwest and West of Yellowknife	P	August 7, 2015	8	-	OSG	Grab	ND	240	62.57025	-114.5998	14.57	301	19.48	322	Granitoid	Groundcover: lichen, bear berries; Soil: dark brown at top, transitioned into a lighter orangish-brown soil at bottom of the grab site, silty sand, very dry
NWFAR2-PSC-73	Southwest and West of Yellowknife	P	August 7, 2015	16.5	5.0	PSC	Core	PH	239	62.57052	-114.60013	14.60	301	19.51	322	Granitoid	Groundcover: moss, grass and small plants; Soil: dark brown peat, wet; Site Details: willows growing within 30cm of the sample location
SW1-FCOSG-88	Southwest and West of Yellowknife	P	August 7, 2015	10	-	FCOSG	Grab	ND	243	62.41484	-114.5043	12.29	218	7.31	255	Granitoid	Grab Sample; Groundcover: cranberries and lichen, heavily vegetated Soil: very dry, light whitish-brown, coarse grained, heavily rooted
SW1-PSC-87	Southwest and West of Yellowknife	P	August 7, 2015	23	5.0	PSC	Core	PH	244	62.41517	-114.50481	12.28	218	7.33	255	Granitoid	Grab Sample; Groundcover: some moss, cranberries, cloud berries, labrador tea; Soil: dark brown, moist soil taken in peatland
SW3-FCOSG-90	Southwest and West of Yellowknife	P	August 7, 2015	-	-	FCOSG	Grab	ND	213	62.4032	-114.62701	17.70	232	13.75	257	Granitoid	Grab Sample; Groundcover: reindeer lichen, some moss; Soil: whitish-brown, coarse grained sand, extremely dry; Site Details: area densely forested, samples difficult to retrieve due to thin soil cover and roots, sample taken at base of a pine tree, difficult to find soil away from trees
SW3-PSC-89	Southwest and West of Yellowknife	P	August 7, 2015	13.5	5.0	PSC	Core	PH	212	62.40282	-114.62711	17.73	231	13.77	256	Granitoid	Groundcover: lichen and a few cranberry plants; Soil: orangish-brown, organic- rich, fibrous peat material
SW3-PSG-89.1	Southwest and West of Yellowknife	P	August 7, 2015	13.5 to 23.	5.0	PSG	Grab	DC	212	62.40282	-114.62711	17.73	231	13.77	256	Granitoid	Grab Sample; Peat sample taken directly below sample SW3 - PSC - 89.1
BERRY-FCOSC-62	TerraX Northbelt	P	August 6, 2015	19.5	3.4	FCOSC	Core	PH	246	62.61486	-114.30879	12.79	11	20.57	8	Volcanic	Groundcover: cranberry bushes, pine cones, juniper bush next to sample location; Soil: not very well consolidated; Site Details: black spruce trees make up the majority of the canopy, some birch trees growing further up on outcrop, other small plants also present
BERRY-FCOSC-62 S	TerraX Northbelt	S	August 6, 2015	19.5	3.4	FCOSC	Core	PH	246	62.61486	-114.30879	12.79	11	20.57	8	Volcanic	Groundcover: cranberry bushes, pine cones, juniper bush next to sample location; Soil: not very well consolidated; Site Details: black spruce trees make up the majority of the canopy, some birch trees growing further up on outcrop, other small plants

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	also present
BERRY-OSG-63	TerraX Northbelt	P	August 6, 2015	6	-	OSG	Grab	ND	245	62.61457	-114.3082	12.77	11	20.54	9	Volcanic	Grab Sample; Groundcover: labrador tea, reindeer moss, bear berries, juniper bush; Soil: dry, dark brown, silty; Site Details: black spruce tree
BERRY-OSG-63 D	TerraX Northbelt	SS	August 6, 2015	6	-	OSG	Grab	ND	245	62.61457	-114.3082	12.77	11	20.54	9	Volcanic	Grab Sample; Groundcover: labrador tea, reindeer moss, bear berries, juniper bush; Soil: dry, dark brown, silty; Site Details: black spruce tree
BERRY-OSG-63 S	TerraX Northbelt	LD	August 6, 2015	6	-	OSG	Grab	PH	245	62.61457	-114.3082	12.77	11	20.54	9	Volcanic	Grab Sample; Groundcover: labrador tea, reindeer moss, bear berries, juniper bush; Soil: dry, dark brown, silty; Site Details: black spruce tree
BERRY-OSG-63 S	TerraX Northbelt	S	August 6, 2015	6	-	OSG	Grab	PH	245	62.61457	-114.3082	12.77	11	20.54	9	Volcanic	Grab Sample; Groundcover: labrador tea, reindeer moss, bear berries, juniper bush; Soil: dry, dark brown, silty; Site Details: black spruce tree
LL-FCOSC-116	TerraX Northbelt	P	August 12, 2015	7	3.5	FCOSC	Core	PH	284	62.56839	-114.41002	7.86	340	15.34	352	Granitoid	Groundcover: leaf and pine litter, labrador tea, dead birch trees, cranberry bushes, Jack pines; Soil: dry, light beige and crumbly at the base of the core, top of core was dark brown and organic rich; Site Details: roots coming out bottom of the core
LL-FCOSC-121	TerraX Northbelt	P	August 12, 2015	12	3.7	FCOSC	Core	PH	284	62.56007	-114.40113	6.84	341	14.36	353	Granitoid	Groundcover: moss, lichen and cranberry bushes; Soil: dry, silty sand, light beige at the base, medium brown and organic-rich (roots) at the top; Site Details: dead spruce and pine trees at the base of the granite outcrop, tallest trees approximately 7 to 8 m, some smaller new growth as well
LL-OSC-106	TerraX Northbelt	P	August 11, 2015	10.2	3.9	OSC	Core	PH	284	62.56655	-114.4021	7.54	342	15.08	353	Volcanic	Groundcover: Jack pines, pine needles and some lichen; Soil: medium to light brown, silty, dry, lots of roots and organics throughout; Site Details: very little soil
LL-OSC-106 S	TerraX Northbelt	S	August 11, 2015	10.2	3.9	OSC	Core	PH	284	62.56655	-114.4021	7.54	342	15.08	353	Volcanic	Groundcover: jack pines, pine needles and some lichen; Soil: medium to light brown, silty, dry, lots of roots and organics throughout; Site Details: very little soil
LL-OSC-115	TerraX Northbelt	P	August 12, 2015	11.8	2.8	OSC	Core	PH	284	62.568	-114.40961	7.82	340	15.29	352	Granitoid	Groundcover: grass and moss - long grass is dry and dying, moss was green and squish, cranberry bushes, jack pines, two raised areas covered in lichen; Soil: dark brown, organic rich soil at top of core, light silty sand material at base of core; Site Details: near the portage between the lake connecting Landing Lake and Vital Lake, hit refusal - dented aluminum core
LL-OSC-118	TerraX Northbelt	P	August 12, 2015	15.3	4.1	OSC	Core	PH	284	62.55971	-114.39942	6.77	341	14.31	353	Granitoid	Groundcover: dead spruce needles, sparse, greyish-black, carpet like moss; Soil: dark to medium brown, dry (lost some sample out base of core); Site Details: black spruce trees growing in soil pocket
LL-OSC-118 D	TerraX Northbelt	SS	August 12, 2015	15.3	4.1	OSC	Core	PH	284	62.55971	-114.39942	6.77	341	14.31	353	Granitoid	Groundcover: dead spruce needles, sparse, greyish-black, carpet like moss; Soil: dark to medium brown, dry (lost some sample out base of core); Site Details: black spruce trees growing in soil pocket
LL-OSC-119	TerraX Northbelt	P	August 12, 2015	25.4	2.9	OSC	Core	PH	284	62.55829	-114.39898	6.62	341	14.15	353	Granitoid	Groundcover: moss and grass; Soil: dark, blackish-brown, moist, core cool upon removal; Site Details: outcrop where LL - OSC - 118 was taken, sample taken at higher elevation (top of outcrop)
LL-OSC-119	TerraX Northbelt	P	August 12, 2015	25.4	2.9	OSC	Core	DC	284	62.55829	-114.39898	6.62	341	14.15	353	Granitoid	Groundcover: moss and grass; Soil: dark, blackish-brown, moist, core cool upon removal; Site Details: outcrop where LL - OSC - 118 was taken, sample taken at higher elevation (top of outcrop)
LL-OSC-119 D	TerraX Northbelt	SS	August 12, 2015	25.4	2.9	OSC	Core	PH	284	62.55829	-114.39898	6.62	341	14.15	353	Granitoid	Groundcover: moss and grass; Soil: dark, blackish-brown, moist, core cool upon removal; Site Details: outcrop where LL - OSC - 118 was taken, sample taken at higher elevation (top of outcrop)
LL-OSC-120	TerraX Northbelt	P	August 12, 2015	17.5	2.9	OSC	Core	PH	284	62.55772	-114.39858	6.55	341	14.09	353	Granitoid	Groundcover: long grass and moss; Soil: dark, blackish-brown, very moist; Site Details: outcrop pocket on the same outcrop where LL - OSC - 118 and LL - OSC - 119 were retrieved, soil pocket on side of outcrop facing towards Giant Mine and YK, can see headframe in the distance from this location
LL-OSC-120	TerraX Northbelt	P	August 12, 2015	17.5	2.9	OSC	Core	DC	284	62.55772	-114.39858	6.55	341	14.09	353	Granitoid	Groundcover: long grass and moss; Soil: dark, blackish-brown, very moist; Site Details: outcrop pocket on the same outcrop where LL - OSC - 118 and LL - OSC - 119 were retrieved, soil pocket on side of outcrop facing towards Giant Mine and YK, can see headframe in the distance from this location
LL-PSC-117	TerraX Northbelt	P	August 12, 2015	16.5	5.0	PSC	Core	PH	284	62.56858	-114.41059	7.89	340	15.36	352	Granitoid	Groundcover: tall grass, yellowish-green moss, labrador tea also growing in vicinity; Site Details: peat land found behind granite outcrop
LL-PSG-117.1	TerraX Northbelt	P	August 12, 2015	12.5	5.0	PSG	Grab	DC	284	62.56858	-114.41059	7.89	340	15.36	352	Granitoid	Grab Sample; Approximate depth: 12.5 cm; Groundcover: tall grass, yellowish- green moss; Soil: light grey clay material (weathering granites - granite gravel); Site Details: taken from the bottom material of sample LL - PSC - 117, hit refusal due to small rocks
LL-PSG-117.1 D	TerraX Northbelt	SS	August 12, 2015	12.5	5.0	PSG	Grab	DC	284	62.56858	-114.41059	7.89	340	15.36	352	Granitoid	Grab Sample; Approximate depth: 12.5 cm; Groundcover: tall grass, yellowish- green moss; Soil: light grey clay material (weathering granites - granite gravel); Site

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Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
																	Details: taken from the bottom material of sample LL - PSC - 117, hit refusal due to small rocks
LL-PSG-117.2	TerraX Northbelt	P	August 12, 2015	22	-	PSG	Grab	DC	284	62.56858	-114.41059	7.89	340	15.36	352	Granitoid	Grab Sample; Groundcover: tall grass, yellowish-green moss; Soil: clay material beneath dark black peat; Site Details: depth from surface to clay material is 22 cm
LL-PSG-117.2 D	TerraX Northbelt	SS	August 12, 2015	22	-	PSG	Grab	DC	284	62.56858	-114.41059	7.89	340	15.36	352	Granitoid	Grab Sample; Groundcover: tall grass, yellowish-green moss; Soil: clay material beneath dark black peat; Site Details: depth from surface to clay material is 22 cm
TX-FCOSC-150	TerraX Northbelt	P	August 18, 2015	21.5	3.7	FCOSC	Core	PH	285	62.5733	-114.36004	7.93	359	15.73	1	Volcanic	Groundcover: reindeer lichen, some moss, leaf and pine needle litter, cranberry bushes; Soil: transitions from dark organics at top of core to light tan, sandy soil with some roots at base of core; Site Details: Jack pines and birch trees (10 to 12 m in height)
TX-FCOSC-150	TerraX Northbelt	LD	August 18, 2015	21.5	3.7	FCOSC	Core	PH	285	62.5733	-114.36004	7.93	359	15.73	1	Volcanic	Groundcover: reindeer lichen, some moss, leaf and pine needle litter, cranberry bushes; Soil: transitions from dark organics at top of core to light tan, sandy soil with some roots at base of core; Site Details: Jack pines and birch trees (10 to 12 m in height)
TX-FCOSC-150	TerraX Northbelt	P	August 18, 2015	21.5	5.0	FCOSC	Core	DC	285	62.5733	-114.36004	7.93	359	15.73	1	Volcanic	Groundcover: reindeer lichen, some moss, leaf and pine needle litter, cranberry bushes; Soil: transitions from dark organics at top of core to light tan, sandy soil with some roots at base of core; Site Details: Jack pines and birch trees (10 to 12 m in height)
TX-FCOSC-150	TerraX Northbelt	LD	August 18, 2015	21.5	5.0	FCOSC	Core	DC	285	62.5733	-114.36004	7.93	359	15.73	1	Volcanic	Groundcover: reindeer lichen, some moss, leaf and pine needle litter, cranberry bushes; Soil: transitions from dark organics at top of core to light tan, sandy soil with some roots at base of core; Site Details: Jack pines and birch trees (10 to 12 m in height)
TX-FCOSC-155	TerraX Northbelt	P	August 18, 2015	20	4.3	FCOSC	Core	PH	285	62.58169	-114.35513	8.86	1	16.67	2	Volcanic	Groundcover: pine needles, leaf litter, bear berries, juniper bushes; Soil: dark brown, organic-rich material at top of core, orangish-brown silty sand, very fine-grained soil at base of core; Site Details: Jack pines and birch trees (5 m in height)
TX-FCOSC-155	TerraX Northbelt	P	August 18, 2015	20	4.3	FCOSC	Core	DC	285	62.58169	-114.35513	8.86	1	16.67	2	Volcanic	Groundcover: pine needles, leaf litter, bear berries, juniper bushes; Soil: dark brown, organic-rich material at top of core, orangish-brown silty sand, very fine-grained soil at base of core; Site Details: Jack pines and birch trees (5 m in height)
TX-FCOSC-155	TerraX Northbelt	LD	August 18, 2015	20	4.3	FCOSC	Core	DC	285	62.58169	-114.35513	8.86	1	16.67	2	Volcanic	Groundcover: pine needles, leaf litter, bear berries, juniper bushes; Soil: dark brown, organic-rich material at top of core, orangish-brown silty sand, very fine-grained soil at base of core; Site Details: Jack pines and birch trees (5 m in height)
TX-FCOSC-155 D	TerraX Northbelt	SS	August 18, 2015	20	4.3	FCOSC	Core	PH	285	62.58169	-114.35513	8.86	1	16.67	2	Volcanic	Groundcover: pine needles, leaf litter, bear berries, juniper bushes; Soil: dark brown, organic-rich material at top of core, orangish-brown silty sand, very fine-grained soil at base of core; Site Details: Jack pines and birch trees (5 m in height)
TX-FCOSC-157	TerraX Northbelt	P	August 18, 2015	10	4.4	FCOSC	Core	PH	284	62.56975	-114.36405	7.54	357	15.33	1	Volcanic	Groundcover: lots of leaf litter, some pine needles, dead sticks and branches, Site Details: juniper bushes surround soil pocket, birch and Jack pines in vicinity (5 to 6 m in height), shallow soil pocket - hit refusal quickly
TX-FCSC-144	TerraX Northbelt	P	August 18, 2015	16.6	2.9	FCSC	Core	PH	282	62.55714	-114.36007	6.13	359	13.93	2	Volcanic	Groundcover: some leaf cover, no moss or lichen; Soil: dark, organic-rich soil at top of core, transitioned to a dry, light greyish-tan, fine, sandy material at dept; Site Details: FCSC area next to YGB outcrop & TerraX access road, some small green shrubs growing in vicinity, birch and black spruce (8 to 10 m in height)
TX-FCSC-144	TerraX Northbelt	P	August 18, 2015	16.6	2.9	FCSC	Core	DC	282	62.55714	-114.36007	6.13	359	13.93	2	Volcanic	Groundcover: some leaf cover, no moss or lichen; Soil: dark, organic-rich soil at top of core, transitioned to a dry, light greyish-tan, fine, sandy material at dept; Site Details: FCSC area next to YGB outcrop & TerraX access road, some small green shrubs growing in vicinity, birch and black spruce (8 to 10 m in height)
TX-FCSC-144 D	TerraX Northbelt	SS	August 18, 2015	16.6	2.9	FCSC	Core	DC	282	62.55714	-114.36007	6.13	359	13.93	2	Volcanic	Groundcover: some leaf cover, no moss or lichen; Soil: dark, organic-rich soil at top of core, transitioned to a dry, light greyish-tan, fine, sandy material at dept; Site Details: FCSC area next to YGB outcrop & TerraX access road, some small green shrubs growing in vicinity, birch and black spruce (8 to 10 m in height)
TX-FCSC-144 S	TerraX Northbelt	S	August 18, 2015	16.6	2.9	FCSC	Core	PH	282	62.55714	-114.36007	6.13	359	13.93	2	Volcanic	Groundcover: some leaf cover, no moss or lichen; Soil: dark, organic-rich soil at top of core, transitioned to a dry, light greyish-tan, fine, sandy material at dept; Site Details: FCSC area next to YGB outcrop & TerraX access road, some small green shrubs growing in vicinity, birch and black spruce (8 to 10 m in height)

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
TX-FCSC-148	TerraX Northbelt	P	August 18, 2015	10	3.0	FCSC	Core	PH	284	62.572	-114.35854	7.78	359	15.59	2	Volcanic	Groundcover: leaf litter; Soil: dark brown, organic-rich at top of core, transitions to a light tan, silty sand at depth; Site Details: birch trees growing in area (5 to 6 m in height)
TX-FCSC-154	TerraX Northbelt	P	August 18, 2015	12.2	2.7	FCSC	Core	PH	285	62.58157	-114.35494	8.85	1	16.66	2	Volcanic	Groundcover: leaf litter, some pine needles, bear berries, and juniper bushes; Site Details: forested area of birch and Jack pines (5 to 7 m in height), sample taken at the bottom of YGB outcrop next to a small dammed lake, wild roses also growing in the area, hit refusal quickly
TX-OSC-145	TerraX Northbelt	P	August 18, 2015	19.3	3.4	OSC	Core	PH	282	62.5574	-114.35962	6.16	359	13.96	2	Volcanic	Groundcover: leaf litter, bear berries, some long grass, dead sticks, wild raspberry bushes; Soil: light brown, dry, silty sand, very crumbly; Site Details: one willow (3 m in height) growing a few feet away
TX-OSC-145	TerraX Northbelt	P	August 18, 2015	19.3	3.4	OSC	Core	DC	282	62.5574	-114.35962	6.16	359	13.96	2	Volcanic	Groundcover: leaf litter, bear berries, some long grass, dead sticks, wild raspberry bushes; Soil: light brown, dry, silty sand, very crumbly; Site Details: one willow (3 m in height) growing a few feet away
TX-OSC-147	TerraX Northbelt	P	August 18, 2015	20	3.3	OSC	Core	PH	285	62.5722	-114.36123	7.81	358	15.61	1	Volcanic	Groundcover: moss (emerald green in colour, mushy), long green grass; Soil: dark black, organic-rich, moist, very heavy core; Site Details: difficulty removing core (damp), willow tree growing in soil pocket, lower down on same outcrop where TX - OSG - 146 was obtained
TX-OSC-151	TerraX Northbelt	P	August 18, 2015	22.5	4.2	OSC	Core	PH	285	62.57961	-114.36216	8.63	358	16.43	1	Volcanic	Groundcover: lichen and pine needles; Soil: orangish brown in colour, very compacted, lighter tan colour at the base, silty sand, very fine; Site Details: sample taken near the Crestaurum shear zone close to biogeochemical sample site #950310-247 (black spruce), nearby the trenches that Tom showed us
TX-OSC-153	TerraX Northbelt	P	August 18, 2015	9.5	3.2	OSC	Core	PH	285	62.57977	-114.36114	8.65	359	16.45	1	Volcanic	Groundcover: bear berries and lichen; Soil: dry, dusty; Site Details: sample taken within close proximity to biogeochemical sample site #950192-264 (juniper bush), small soil pocket, went further down on outcrop away from trenches - no evidence of blast rock, small juniper bush growing out of crack in rock above soil pocket
TX-OSG-143	TerraX Northbelt	P	August 18, 2015	6.5	-	OSG	Grab	ND	281	62.55715	-114.35976	6.13	359	13.93	2	Volcanic	Grab Sample; Approximate depth: 6.5 cm; Groundcover: no moss or lichen, some long grass, bear berries, small shrubs and juniper bushes; Soil: transitioned from dark brown at the surface to medium, orangish-brown at depth; Site Details: thin soil pockets in this area
TX-OSG-146	TerraX Northbelt	P	August 18, 2015	12.5	-	OSG	Grab	ND	284	62.57195	-114.36134	7.78	358	15.58	1	Volcanic	Grab Sample; Approximate depth (including moss cover): 12.5 cm; Groundcover: long grass, moss; Soil: dark brown, moist; Site Details: shallow soil pocket
TX-OSG-149	TerraX Northbelt	P	August 18, 2015	11	-	OSG	Grab	ND	285	62.57324	-114.36038	7.92	359	15.72	1	Volcanic	Grab Sample; Approximate depth: 11 cm; Groundcover: leaf litter, bear berries, small juniper bushes; Soil: transitions from dark organics to a dark reddish brown colour at depth before rock was hit; Site Details: 4 m birch about 4 ft away from sample site, spruce tree also in vicinity (10 to 12 m)
TX-OSG-149 D	TerraX Northbelt	SS	August 18, 2015	11	-	OSG	Grab	ND	285	62.57324	-114.36038	7.92	359	15.72	1	Volcanic	Grab Sample; Approximate depth: 11 cm; Groundcover: leaf litter, bear berries, small juniper bushes; Soil: transitions from dark organics to a dark reddish brown colour at depth before rock was hit; Site Details: 4 m birch about 4 ft away from sample site, spruce tree also in vicinity (10 to 12 m)
TX-OSG-152	TerraX Northbelt	P	August 18, 2015	5 to 6	-	OSG	Grab	ND	285	62.57967	-114.36222	8.64	358	16.44	1	Volcanic	Grab Sample; Groundcover: cranberry bushes; Soil: light, orangish-brown, silty sand; Site Details: sample taken near TerraX biogeochemical sample site #950311-246 (juniper bush)
TX-OSG-152 D	TerraX Northbelt	SS	August 18, 2015	5 to 6	-	OSG	Grab	ND	285	62.57967	-114.36222	8.64	358	16.44	1	Volcanic	Grab Sample; Groundcover: cranberry bushes; Soil: light, orangish-brown, silty sand; Site Details: sample taken near TerraX biogeochemical sample site #950311-246 (juniper bush)
TX-OSG-152 D	TerraX Northbelt	LD	August 18, 2015	5 to 6	-	OSG	Grab	ND	285	62.57967	-114.36222	8.64	358	16.44	1	Volcanic	Grab Sample; Groundcover: cranberry bushes; Soil: light, orangish-brown, silty sand; Site Details: sample taken near TerraX biogeochemical sample site #950311-246 (juniper bush)
TX-OSG-152 S	TerraX Northbelt	S	August 18, 2015	5 to 6	-	OSG	Grab	ND	285	62.57967	-114.36222	8.64	358	16.44	1	Volcanic	Grab Sample; Groundcover: cranberry bushes; Soil: light, orangish-brown, silty sand; Site Details: sample taken near TerraX biogeochemical sample site #950311-246 (juniper bush)
TX-OSG-156	TerraX Northbelt	P	August 18, 2015	9 to 10	-	OSG	Grab	ND	284	62.56937	-114.36363	7.50	357	15.29	1	Volcanic	Grab Sample; Approximate depth: 9 to 10 cm; Groundcover: soft green moss, long grass, wild rose bushes; Soil: dark black; Site Details: one juniper bush at edge of soil pocket, V-shaped soil pocket
TX-OSG-156 NR	TerraX Northbelt	SS	August 18, 2015	9 to 10	-	OSG	Grab	ND	284	62.56937	-114.36363	7.50	357	15.29	1	Volcanic	Grab Sample; Approximate depth: 9 to 10 cm; Groundcover: soft green moss, long grass, wild rose bushes; Soil: dark black; Site Details: one juniper bush at edge of soil pocket, V-shaped soil pocket

Table A: Soil sample data - Soil locations, distances and directions from Giant and Con roasters, sample notes taken in the field.

Sample ID	Area	QAQC	Date Sample Collected	Total Sample Depth (cm)	PHL Submitted for Analysis	Terrain	Sample Type	Depth Control	Elevation (masl)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Distance to Giant Mine Roaster (km)	Direction to Giant Mine Roaster (0-360°)	Distance to Con Mine Roaster (km)	Direction to Con Mine Roaster (0-360°)	Bedrock Geology	Sample Notes
VL-FCOSC-107	TerraX Northbelt	P	August 11, 2015	8.5	4.0	FCOSC	Core	PH	278	62.59188	-114.43683	10.80	338	18.15	349	Granitoid	Groundcover: cranberry bushes, abundance of leaf litter; Site Details: birch trees growing in pocket, thin layer of soil, approximately 3cm of the sample fell out the bottom of the core due to a rock
VL-FCOSG-112	TerraX Northbelt	P	August 12, 2015	9.4	-	FCOSG	Grab	ND	280	62.58694	-114.42799	10.12	339	17.52	350	Granitoid	Grab Sample; Approximate Depth: 0 to 9.4 cm; Groundcover: lots of pine needles, some lichen and moss, sparse cranberry bushes; Soil: thin soil cover, dry, decomposing organics; Site Details: sample taken near birch tree in hope of finding more soil
VL-FCOSG-112	TerraX Northbelt	LD	August 12, 2015	9.4	-	FCOSG	Grab	ND	280	62.58694	-114.42799	10.12	339	17.52	350	Granitoid	Grab Sample; Approximate Depth: 0 to 9.4 cm; Groundcover: lots of pine needles, some lichen and moss, sparse cranberry bushes; Soil: thin soil cover, dry, decomposing organics; Site Details: sample taken near birch tree in hope of finding more soil
VL-FCOSG-112 NR	TerraX Northbelt	SS	August 12, 2015	9.4	-	FCOSG	Grab	ND	280	62.58694	-114.42799	10.12	339	17.52	350	Granitoid	Grab Sample; Approximate Depth: 0 to 9.4 cm; Groundcover: lots of pine needles, some lichen and moss, sparse cranberry bushes; Soil: thin soil cover, dry, decomposing organics; Site Details: sample taken near birch tree in hope of finding more soil
VL-FCOSG-113	TerraX Northbelt	P	August 12, 2015	10	-	FCOSG	Grab	ND	280	62.58701	-114.42797	10.13	339	17.53	350	Granitoid	Grab Sample: Approximate Depth: 10 cm; Soil: decomposing organics; Site Details: sample taken in the same soil pocket as VL - OSG - 112, hit refusal
VL-FCOSG-114	TerraX Northbelt	P	August 12, 2015	13	-	FCOSG	Grab	ND	280	62.58688	-114.4281	10.11	339	17.52	350	Granitoid	Grab Sample: Approximate Depth: 13 cm; Soil: decomposing organics, leaf litter, roots; Site Details: sample taken in the same soil pocket as VL - OSG - 112, and VL - OSG - 113, hit refusal
VL-FCOSG-114 D	TerraX Northbelt	SS	August 12, 2015	13	-	FCOSG	Grab	ND	280	62.58688	-114.4281	10.11	339	17.52	350	Granitoid	Grab Sample: Approximate Depth: 13 cm; Soil: decomposing organics, leaf litter, roots; Site Details: sample taken in the same soil pocket as VL - OSG - 112, and VL - OSG - 113, hit refusal
VL-FCSC-108	TerraX Northbelt	P	August 11, 2015	12	4.3	FCSC	Core	PH	278	62.59182	-114.43756	10.80	337	18.15	348	Granitoid	Groundcover: cranberry bushes, labrador tea, moss, fungus or lichen (looks like a strange mushroom, curls up at the edges and is white to tan coloured on its underside); Site Details: birch and spruce trees (tall and short), height of tall trees approximately 10 to 12 m
VL-FCSC-111	TerraX Northbelt	P	August 12, 2015	26	3.3	FCSC	Core	PH	280	62.58751	-114.42719	10.16	339	17.58	350	Granitoid	Groundcover: leaf litter, moss, cranberries, other short plants; Soil: organic- rich, dark brown soil at top of core, very compacted, light beige, clay-rich soil at base of core; Site Details: small birch trees approximately 1.5ft away (2 to 4 m in height), black spruce and Jack pines (4 to 6 m in height)
VL-FCSC-111	TerraX Northbelt	P	August 12, 2015	26	5.0	FCSC	Core	DC	280	62.58751	-114.42719	10.16	339	17.58	350	Granitoid	Groundcover: leaf litter, moss, cranberries, other short plants; Soil: organic- rich, dark brown soil at top of core, very compacted, light beige, clay-rich soil at base of core; Site Details: small birch trees approximately 1.5ft away (2 to 4 m in height), black spruce and Jack pines (4 to 6 m in height)
VL-OSC-110	TerraX Northbelt	P	August 11, 2015	9.1	5.0	OSC	Core	PH	278	62.59507	-114.43552	11.10	339	18.48	349	Granitoid	Groundcover: lichen and pine needles; Soil: very dry, tons of broken rock pieces beneath the pine litter, thin soil layer, transitions from medium brown at the top (lots of pine needles and organics (roots)) to light tan at the soil - rock interface (silty sand); Site Details: large soil pocket with very little soil, Jack pines growing in vicinity approximately 2 to 6 m in height
VL-OSC-110 D	TerraX Northbelt	SS	August 11, 2015	9.1	5.0	OSC	Core	PH	278	62.59507	-114.43552	11.10	339	18.48	349	Granitoid	Groundcover: lichen and pine needles; Soil: very dry, tons of broken rock pieces beneath the pine litter, thin soil layer, transitions from medium brown at the top (lots of pine needles and organics (roots)) to light tan at the soil - rock interface (silty sand); Site Details: large soil pocket with very little soil, Jack pines growing in vicinity approximately 2 to 6 m in height
VL-OSC-110 S	TerraX Northbelt	S	August 11, 2015	9.1	5.0	OSC	Core	PH	278	62.59507	-114.43552	11.10	339	18.48	349	Granitoid	Groundcover: lichen and pine needles; Soil: very dry, tons of broken rock pieces beneath the pine litter, thin soil layer, transitions from medium brown at the top (lots of pine needles and organics (roots)) to light tan at the soil - rock interface (silty sand); Site Details: large soil pocket with very little soil, Jack pines growing in vicinity approximately 2 to 6 m in height
VL-OSG-109	TerraX Northbelt	P	August 11, 2015	7	-	OSG	Grab	ND	278	62.59125	-114.43928	10.78	337	18.10	348	Granitoid	Grab Sample; Approximate depth: 0 to 7cm; Groundcover: moss and lichen (approximately 3 cm in thickness); Soil: transitioned from medium brown to light tan at the base of the core; Site Details: hit refusal very early

Appendix B: Bulk Geochemistry and Total Carbon Results

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																													
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
BPR-FCSC-02	Bypass Road	5.44	0.088	5.35	0.092	24	330	130	<4.0	<20	<1.0	6500	57	14	36	25000	13	8800	480	<2.0	32	660	2600	<10	<2.0	240	21	870	<1.0	<2.0	800	<10	45	55
BPR-FCSC-02	Bypass Road	-	-	-	0.052	<1.0	29	120	0.45	<10	<0.60	3800	48	12	27	25000	6.4	7500	240	<0.50	27	400	1600	<1.0	<0.25	260	13	140	<1.0	<2.0	870	<5.0	45	36
BPR-FCSC-02 D	Bypass Road	5.27	0.081	5.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BPR-FCSC-02 D	Bypass Road	-	-	-	<0.05	<1.0	30	120	0.45	<10	<0.60	3700	48	12	28	24000	6.5	7100	240	<0.50	26	380	1700	<1.0	0.3	270	14	140	<1.0	<2.0	860	<5.0	44	35
BPR-FCSC-14	Bypass Road	47.3	0.189	47.1	0.24	73	500	120	<4.0	<20	<1.0	10000	<20	6.5	22	5100	22	1600	400	<2.0	9.5	740	590	<10	<2.0	160	28	1600	<1.0	<2.0	91	<10	<10	56
BPR-FCSC-14	Bypass Road	-	-	-	0.23	65	420	120	<4.0	<20	<1.0	11000	<20	7	22	5100	21	1600	410	<2.0	9.4	810	610	<10	<2.0	180	30	1700	<1.0	<2.0	92	<10	<10	59
BPR-FCSC-14	Bypass Road	0.694	0.041	0.653	0.014	<1.0	63	55	<4.0	<20	<1.0	2500	35	8.9	24	18000	<10	5300	190	<2.0	21	180	330	<10	<2.0	210	9	<500	<1.0	<2.0	520	<10	32	24
BPR-FCSC-17	Bypass Road	43.6	0.459	43.1	0.038	3.7	53	38	<4.0	<20	<1.0	17000	<20	<5.0	15	2700	<10	2700	430	<2.0	5.5	610	940	<10	<2.0	210	36	1400	<1.0	<2.0	64	<10	<10	65
BPR-FCSC-21	Bypass Road	-	-	-	0.11	31	140	76	<4.0	<20	<1.0	6900	<20	6.3	18	2800	13	1900	640	<2.0	8.3	480	900	<10	<2.0	86	22	900	<1.0	<2.0	23	<10	<10	48
BPR-FCSC-21	Bypass Road	-	-	-	<0.05	<1.0	42	50	0.33	<10	<0.60	2400	25	7.4	25	16000	5	4400	150	<0.50	15	380	940	<1.0	<0.25	180	8.7	56	<1.0	<2.0	590	<5.0	28	21
BPR-FENC-09	Bypass Road	42.2	0.205	42	0.03	19	250	43	<0.010	13	<0.60	11000	7.1	1.6	23	6400	7.8	2100	200	0.63	4.7	1000	260	<1.0	<0.25	160	37	3600	<1.0	<2.0	21	<5.0	4.6	38
BPR-FENC-18	Bypass Road	40.8	0.186	40.6	<0.01	3.9	120	36	<10	<140	<2.5	9200	<25	<10	19	2300	<15	2000	150	<5.0	<15	1400	960	<15	<5.0	310	36	3200	<10	<10	40	<25	<50	63
BPR-FENC-18	Bypass Road	-	-	-	<0.01	4.8	110	35	<10	<140	<2.5	9200	<25	<10	16	1900	<15	1900	110	<5.0	<15	1200	860	<15	<5.0	320	41	2900	<10	<10	46	<25	<50	60
BPR-MFENC-22	Bypass Road	38.4	0.629	37.8	0.25	93	470	65	<4.0	24	<1.0	26000	<20	<5.0	24	5100	31	3600	330	2.9	10	750	780	<10	<2.0	82	62	3400	<1.0	<2.0	39	<10	<10	85
BPR-MFENC-22	Bypass Road	-	-	-	<0.05	<1.0	29	34	0.2	<10	<0.60	3200	12	3	8.4	7100	<5.0	2100	62	<0.50	6.5	290	340	<1.0	<0.25	98	9.6	170	<1.0	<2.0	250	<5.0	12	8.9
BPR-MFENC-22 S	Bypass Road	38.4	0.629	37.8	0.37	130	570	70	0.073	30	0.6	35000	8.3	4	22	5500	36	4100	380	3.6	10	840	700	<1.0	0.31	110	65	4200	<1.0	<2.0	72	<5.0	8.5	85
BPR-OSC-01	Bypass Road	41.1	0.073	41.0	1	210	1800	180	<4.0	<20	<1.0	1300	<20	<5.0	24	7200	75	740	30	<2.0	11	3400	380	<10	<2.0	150	6.7	2900	<1.0	<2.0	52	12	<10	25
BPR-OSC-01 D	Bypass Road	-	-	-	0.97	180	1500	160	<4.0	<20	<1.0	1200	<20	<5.0	24	6400	66	690	27	<2.0	11	3300	340	<10	<2.0	130	6	2800	<1.0	<2.0	44	11	<10	22
BPR-OSC-10	Bypass Road	35.7	0.089	35.6	0.38	55	660	89	<4.0	<20	1.3	2700	<20	5	48	7800	37	1100	47	<2.0	15	1800	580	<10	<2.0	180	13	3100	<1.0	<2.0	37	<10	18	26

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																													
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
BPR-OSC-16	Bypass Road	-	-	-	0.054	19	1400	160	0.62	7.4	<0.60	4000	26	6.6	49	22000	19	2400	100	<0.50	19	870	640	<1.0	<0.25	170	27	1100	<1.0	<2.0	240	<5.0	21	38
BPR-OSC-16	Bypass Road	-	-	-	<0.025	<1.0	12	47	0.23	4.1	<0.60	1600	41	8.7	18	21000	6	6400	170	<0.50	23	350	490	<1.0	<0.25	140	5.6	<250	<1.0	<2.0	810	<5.0	37	31
BPR-OSC-20	Bypass Road	41.7	0.067	41.6	1	620	1300	95	<4.0	<20	<1.0	3800	<20	<5.0	27	10000	89	1800	110	<2.0	14	710	690	<10	<2.0	110	13	1600	<1.0	<2.0	84	<10	12	72
BPR-OSC-20 S	Bypass Road	41.7	0.067	41.6	0.85	650	1300	89	0.091	11	<0.60	3700	10	4.3	27	8400	95	1500	93	1	11	590	500	<1.0	0.69	100	12	1300	<1.0	<2.0	97	<5.0	11	55
BPR-OSC-91	Bypass Road	43.8	0.059	43.8	0.093	49	240	120	<4.0	<20	<1.0	2000	<20	<5.0	12	4400	14	470	37	<2.0	6.4	1500	190	<10	<2.0	96	12	2500	<1.0	<2.0	20	<10	<10	32
BPR-OSC-92	Bypass Road	44.5	0.058	44.5	0.35	240	600	160	<4.0	<20	<1.0	3200	<20	<5.0	17	6500	40	810	63	<2.0	7.7	880	320	<10	<2.0	120	15	1800	<1.0	<2.0	60	<10	<10	48
BPR-OSC-92 D	Bypass Road	-	-	-	0.32	220	630	150	<4.0	<20	<1.0	3300	<20	<5.0	17	6900	37	900	68	<2.0	7.9	980	420	<10	<2.0	140	14	1800	<1.0	<2.0	61	<10	<10	53
BPR-OSC-92 S	Bypass Road	44.5	0.058	44.5	0.55	250	650	180	0.19	<10	<0.60	3700	6.1	3.1	18	6100	44	880	70	2	8.3	860	370	<1.0	0.45	120	16	1800	<1.0	<2.0	72	<5.0	7	49
BPR-OSC-93	Bypass Road	38.6	0.063	38.6	0.96	300	2300	170	<4.0	<40	<1.0	1700	<20	<5.0	29	8900	67	1400	56	<2.0	10	2300	370	<10	<2.0	100	7.4	3300	<1.0	<2.0	91	<10	14	42
BPR-OSC-93 D	Bypass Road	38.6	0.063	38.6	0.79	300	2200	200	<4.0	<40	<1.0	1800	<20	<5.0	26	7300	60	1200	44	<2.0	9.2	2300	340	<10	<2.0	120	8.5	3300	<1.0	<2.0	76	<10	12	37
BPR-OSC-94	Bypass Road	45.5	0.063	45.4	0.19	130	840	75	<4.0	<20	<1.0	3500	<20	<5.0	14	5000	28	930	85	<2.0	6.2	1000	350	<10	<2.0	110	25	2000	<1.0	<2.0	46	<10	<10	56
BPR-OSG-11	Bypass Road	-	-	-	0.083	25	510	62	0.21	7.3	0.78	6100	42	11	91	31000	16	5100	320	3.6	22	2100	510	<1.0	0.33	450	9.4	600	<1.0	<2.0	900	<5.0	72	55
BPR-OSG-11	Bypass Road	-	-	-	0.072	21	610	60	<4.0	<20	<1.0	7900	45	11	88	33000	19	5700	360	3.6	24	2200	700	<10	<2.0	580	11	510	<1.0	<2.0	870	<10	74	61
BPR-OSG-11	Bypass Road	-	-	-	0.061	18	480	50	0.17	7.3	0.64	5900	41	10	77	29000	12	5300	290	3.1	22	1800	480	<1.0	0.27	450	7.4	400	<1.0	<2.0	1000	<5.0	70	47
BPR-OSG-11	Bypass Road	-	-	-	0.056	21	610	66	<4.0	<20	<1.0	8200	49	12	94	36000	18	6000	390	3.8	26	2300	730	<10	<2.0	630	12	580	<1.0	<2.0	900	<10	80	65
BPR-OSG-13	Bypass Road	-	-	-	0.068	28	590	66	<4.0	<20	<1.0	990	<20	<5.0	25	4200	13	700	39	<2.0	11	1600	310	<10	<2.0	130	5.8	2100	<1.0	<2.0	120	19	<10	40
BPR-OSG-15	Bypass Road	10.8	0.056	10.8	-	28	130	78	<4.0	<20	<1.0	4800	29	6.8	45	18000	46	4200	140	<2.0	17	1500	990	<10	<2.0	530	14	1080	<1.0	<2.0	450	<10	33	58
BPR-OSG-15 D	Bypass Road	-	-	-	0.24	27	110	80	0.11	4.8	<0.60	3300	27	5.7	42	15000	44	3600	120	0.69	15	1400	790	<1.0	0.35	240	11	1400	<1.0	<2.0	500	<5.0	29	52
BPR-OSG-95	Bypass Road	11.2	0.059	11.2	0.091	28	930	82	<4.0	<20	<1.0	910	<20	<5.0	31	12000	37	1300	53	<2.0	6.1	1500	710	<10	<2.0	87	6.2	600	<1.0	<2.0	28	98	17	41
BPR-OSG-95 D	Bypass Road	11.6	0.081	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																														
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
BPR-OSG-95 S	Bypass Road	11.2	0.059	11.2	0.12	34	870	85	0.34	<10	<0.60	1400	13	2.1	31	12000	35	1500	66	0.86	6.8	1700	660	1.2	0.4	96	7.8	1300	<1.0	<2.0	94	90	20	41
BPR-PSC-07	Bypass Road	-	-	-	0.1	44	490	50	<4.0	<20	<1.0	7900	<20	<5.0	8.1	2100	14	2000	110	<2.0	<5.0	740	1000	<10	<2.0	160	26	2200	<1.0	<2.0	35	<10	<10	24
BPR-PSC-12	Bypass Road	43.9	0.088	43.8	2.44	41	410	10	<4.0	<20	<1.0	4300	<20	<5.0	5.9	820	<10	780	39	<2.0	<5.0	380	500	<10	<2.0	230	13	1900	<1.0	<2.0	15	<10	<10	27
BPR-PSC-158	Bypass Road	43.5	0.156	43.4	0.56	140	900	50	<4.0	<20	<1.0	14000	<20	<5.0	20	5000	37	2200	86	<2.0	7.3	1200	720	<10	<2.0	120	37	6500	<1.0	<2.0	44	<10	<10	36
BPR-PSC-159	Bypass Road	-	-	-	0.2	77	130	52	<4.0	<20	<1.0	20000	<20	<5.0	12	2600	13	4100	180	3.5	<5.0	860	380	<10	<2.0	140	58	3900	<1.0	<2.0	23	<10	<10	40
BPR-PSC-160	Bypass Road	45.5	0.140	45.3	0.44	110	1000	30	<4.0	<20	<1.0	8600	<20	<5.0	18	4100	28	2100	68	<2.0	6	1200	690	<10	<2.0	110	26	3500	<1.0	<2.0	35	<10	<10	34
BPR-PSC-160 D	Bypass Road	45.6	0.140	45.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BPR-PSC-161	Bypass Road	-	-	-	0.13	68	3400	13	<4.0	<20	<1.0	33000	<20	<5.0	6.3	1200	<10	6700	51	<2.0	<5.0	570	880	<10	<2.0	320	55	26000	<1.0	<2.0	20	<10	<10	16
BPR-PSC-161 D	Bypass Road	-	-	-	0.038	60	4900	<5.0	<4.0	<20	<1.0	6900	<20	<5.0	<5.0	620	<10	11000	28	<2.0	<5.0	550	1600	<10	<2.0	570	15	11000	<1.0	<2.0	10	<10	<10	<15
BPR-PSC-161B	Bypass Road	-	-	-	<0.01	1.4	240	10	<4.0	<20	<1.0	11000	<20	<5.0	<5.0	150	<10	6500	54	<2.0	<5.0	210	390	<10	<2.0	100	27	2200	<1.0	<2.0	<10	<10	<10	24
BPR-PSC-161B D	Bypass Road	-	-	-	<0.01	1.5	220	14	<4.0	<20	<1.0	11000	<20	<5.0	<5.0	220	<10	5700	53	<2.0	<5.0	240	380	<10	<2.0	85	28	2200	<1.0	<2.0	<10	<10	<10	25
BPR-PSC-161C	Bypass Road	-	-	-	<0.01	2.5	1200	12	<4.0	<20	<1.0	5700	<20	<5.0	5.5	230	<10	5000	30	<2.0	<5.0	390	460	<10	<2.0	140	18	3600	<1.0	<2.0	<10	<10	<10	25
BPR-PSC-161C D	Bypass Road	-	-	-	<0.01	3	1100	10	<4.0	<20	<1.0	5600	<20	<5.0	5.7	230	<10	4900	29	<2.0	<5.0	380	460	<10	<2.0	130	18	3300	<1.0	<2.0	<10	<10	<10	21
BPR-PSC-19	Bypass Road	42.3	0.058	42.3	0.027	22	1400	7.2	<4.0	<20	<1.0	5500	<20	<5.0	<5.0	1600	<10	3900	100	<2.0	<5.0	1000	2900	<10	<2.0	2400	12	11000	<1.0	<2.0	26	<10	<10	32
BPR-PSG-08	Bypass Road	-	-	-	<0.01	<1.0	31	48	<10	<140	<2.5	19000	<25	<10	<10	2300	<15	2300	88	<5.0	<15	270	<140	<15	<5.0	<140	49	4000	<10	<10	<15	<25	<50	<25
BPR-PSG-08 D	Bypass Road	-	-	-	<0.01	<1.0	32	50	<10	<140	<2.5	19000	<25	<10	<10	2300	<15	2300	80	<5.0	<15	280	<140	<15	<5.0	<140	48	4000	<10	<10	<15	<25	<50	<25
BPR-PSG-12.1	Bypass Road	-	-	-	0.025	13	110	<5.0	<4.0	<20	<1.0	2200	<20	<5.0	<5.0	170	<10	630	27	<2.0	<5.0	160	180	<10	<2.0	86	7.2	700	<1.0	<2.0	<10	<10	<10	<15
BPR-PSG-19.1	Bypass Road	-	-	-	0.45	55	730	67	<10	<140	<2.5	4000	<25	<10	13	3300	24	840	44	<5.0	<15	710	1000	<15	<5.0	480	<15	4500	<10	<10	72	<25	<50	30
BPR-PSG-19.1	Bypass Road	-	-	-	0.17	52	680	56	<10	<140	<2.5	4200	<25	<10	11	2700	20	860	42	<5.0	<15	620	1000	<15	<5.0	500	<15	5100	<10	<10	75	<25	<50	30
BPR-PSG-19.2	Bypass Road	-	-	-	<0.01	<1.0	130	16	<4.0	<20	<1.0	3900	<20	<5.0	<5.0	370	<10	1300	38	<2.0	<5.0	370	360	<10	<2.0	210	12	2100	<1.0	<2.0	<10	<10	<10	27
BPR-PSG-19.2	Bypass Road	-	-	-	<0.01	<1.0	150	17	<4.0	<20	<1.0	4700	<20	<5.0	<5.0	410	<10	1500	44	<2.0	<5.0	450	380	<10	<2.0	240	14	2400	<1.0	<2.0	<10	<10	<10	30
DETR-FCOSC-35	Dettah Road	45.5	0.092	45.4	0.063	12	160	120	<4.0	<40	<1.0	4400	<20	<5.0	15	3600	<10	1500	170	<2.0	8.3	820	620	<10	<2.0	95	25	1200	<1.0	<2.0	69	<10	<10	69
DETR-FCOSC-35	Dettah Road	45.5	0.092	45.4	<0.01	12	59	130	<4.0	<40	<1.0	1400	<20	<5.0	14	5800	<10	690	32	<2.0	9.1	1000	650	<10	<2.0	80	14	1000	<1.0	<2.0	62	<10	<10	17
DETR-FCSC-31	Dettah Road	40.3	0.868	39.5	<0.01	1.2	18	38	<4.0	<40	2.6	27000	<20	<5.0	20	3000	<10	3300	150	<2.0	5.2	1300	1600	<10	<2.0	87	59	1400	<1.0	<2.0	64	<10	<10	310
DETR-FCSC-31 S	Dettah Road	40.3	0.868	39.5	0.012	<3.0	15	51	<0.03	64	3.9	39000	7.1	3	20	2600	<15	4100	190	<1.5	7.1	1600	1800	<3.0	<0.75	<225	85	2700	<3.0	<6.0	87	<15	5.6	450

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																																	
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
DETR-FCSC-32	Dettah Road	44.4	0.302	44.1	0.01	1.5	15	40	<4.0	31	<1.0	12000	<20	<5.0	10	2400	<10	4600	220	<2.0	<5.0	850	1600	<10	<2.0	1500	60	2200	<1.0	<2.0	60	<10	<10	63
DETR-FCSC-34	Dettah Road	46.3	0.116	46.2	0.11	25	270	63	<4.0	<20	<1.0	7000	<20	<5.0	18	2300	<10	2000	52	<2.0	6.8	520	810	<10	<2.0	100	29	1300	<1.0	<2.0	38	<10	<10	31
DETR-FCSC-34 S	Dettah Road	46.3	0.116	46.2	0.12	32	290	69	0.077	12	<0.60	10000	10	4.6	29	2600	8.8	2300	75	<0.50	7.7	640	670	<1.0	<0.25	93	32	1800	<1.0	<2.0	59	<5.0	6.2	32
DETR-FCSC-38	Dettah Road	44.2	0.194	44.0	0.049	6.8	46	180	<4.0	<20	<1.0	13000	<20	<5.0	13	1700	<10	1700	2600	<2.0	5	1500	3200	<10	<2.0	<75	30	1600	2.1	<2.0	45	<10	<10	150
DETR-FCSC-38	Dettah Road	-	-	-	<0.05	<1.0	5.4	28	0.24	<10	<0.60	1400	27	6.2	3.9	14000	<5.0	4200	110	<0.50	13	300	550	<1.0	<0.25	130	5.4	56	<1.0	<2.0	450	<5.0	27	16
DETR-FCSC-38 D	Dettah Road	-	-	-	<0.05	<1.0	6.2	30	0.24	<10	<0.60	1500	27	6.7	4.4	15000	<5.0	4400	120	<0.50	13	330	630	<1.0	<0.25	150	5.6	62	<1.0	<2.0	460	<5.0	28	17
DETR-FENC-30	Dettah Road	-	-	-	<0.025	1.7	87	84	0.052	27	<0.60	2200	20	6.1	29	6100	6.3	2100	120	0.63	12	2300	940	<1.0	<0.25	140	20	1700	<1.0	<2.0	150	<5.0	12	37
DETR-OSC-37	Dettah Road	42.7	0.059	42.7	0.18	27	220	180	<4.0	<20	<1.0	3300	<20	<5.0	7.7	6800	18	740	48	<2.0	14	2200	760	<10	<2.0	140	20	2980	<1.0	<2.0	23	<10	<10	23
DETR-OSG-33	Dettah Road	-	-	-	0.077	53	220	310	<4.0	<20	<1.0	7600	<20	13	28	5800	22	2000	540	<2.0	31	770	580	<10	<2.0	110	44	1400	<1.0	<2.0	120	<10	<10	75
DETR-OSG-36	Dettah Road	-	-	-	0.097	32	150	200	<4.0	20	2.3	4300	<20	5.1	27	4600	14	1200	36	<2.0	27	3000	770	<10	<2.0	140	24	4400	<1.0	<2.0	16	<10	13	130
DETR-OSG-36 D	Dettah Road	-	-	-	0.046	18	82	210	<4.0	<20	3	2900	42	5.1	54	5000	15	1200	37	<2.0	45	3400	600	<10	<2.0	120	17	3700	<1.0	<2.0	84	<10	22	150
DETR-OSG-36 D	Dettah Road	-	-	-	0.035	12	52	180	<4.0	<20	2.7	3800	<20	<5.0	19	4000	<10	790	22	<2.0	33	2500	670	<10	<2.0	110	21	3500	<1.0	<2.0	<10	<10	11	120
DETR-PSC-29	Dettah Road	-	-	-	0.12	1.7	41	28	<4.0	<20	<1.0	6700	<20	<5.0	8.8	4200	<10	4300	140	<2.0	6.2	710	3200	<10	<2.0	320	23	1100	<1.0	<2.0	130	<10	<10	37
YK67-FCSC-05	Dettah Road	41.9	0.190	41.7	0.035	7.1	26	92	<4.0	<20	<1.0	11000	<20	<5.0	14	7000	<10	2400	100	<2.0	14	720	1200	<10	<2.0	200	53	1400	<1.0	<2.0	62	<10	<10	27
YK67-FENC-03	Dettah Road	40.0	0.658	39.4	0.059	8.5	160	20	<4.0	58	<1.0	10000	<20	<5.0	30	3700	<10	2500	140	<2.0	25	760	400	<10	<2.0	200	44	7100	<1.0	<2.0	15	<10	<10	250
YK67-OSC-06	Dettah Road	36.8	0.119	36.7	0.04	9.2	62	170	<4.0	<20	1	2300	<20	20	130	4400	25	480	26	<2.0	180	3300	360	<10	<2.0	110	18	4300	<1.0	<2.0	31	<10	<10	33
YK67-PSC-04	Dettah Road	44.3	0.133	44.2	0.048	19	140	23	<4.0	<20	<1.0	4000	<20	<5.0	6.1	890	<10	1600	110	<2.0	<5.0	660	720	<10	<2.0	110	14	1400	<1.0	<2.0	14	<10	<10	65
HW3-FCOSC-126	Highway 3	-	-	-	<0.01	<1.0	22	130	<4.0	<20	<1.0	4600	<20	<5.0	10	10000	<10	1800	94	<2.0	9.9	720	790	<10	<2.0	100	31	660	<1.0	<2.0	68	<10	<10	30
HW3-FCOSC-129	Highway 3	-	-	-	0.014	2.5	33	250	<4.0	<20	<1.0	18000	<20	<5.0	16	6000	<10	5000	390	<2.0	10	500	880	<10	<2.0	150	40	600	<1.0	<2.0	170	<10	<10	36
HW3-FCSC-124	Highway 3	-	-	-	<0.01	1.6	12	190	<4.0	<20	<1.0	36000	<20	<5.0	12	8300	<10	13000	1200	<2.0	8.4	860	1800	<10	<2.0	150	49	1100	<1.0	<2.0	160	<10	11	100
HW3-FCSC-124	Highway 3	-	-	-	<0.01	1.4	10	180	<4.0	<20	<1.0	35000	<20	<5.0	11	7700	<10	12000	1100	<2.0	7.6	890	1800	<10	<2.0	140	48	1100	<1.0	<2.0	160	<10	10	100
HW3-FCSC-125	Highway 3	35.7	1.71	34.0	<0.01	<1.0	3.2	67	<4.0	<40	<1.0	55000	<20	<5.0	9.7	6100	<10	23000	210	<2.0	5.3	760	1500	<10	<2.0	270	120	1200	<1.0	<2.0	160	29	<10	68
HW3-FCSC-125	Highway 3	-	-	-	<0.01	<1.0	3.5	69	<4.0	<40	<1.0	56000	<20	<5.0	13	6500	<10	24000	210	<2.0	5.9	730	1500	<10	<2.0	280	120	1200	<1.0	<2.0	160	31	<10	71

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																													
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium2 0	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
HW3-FCSC-130	Highway 3	-	-	-	<0.01	<1.0	1.5	48	<4.0	<40	<1.0	16000	<20	<5.0	35	4900	<10	5100	820	<2.0	<5.0	890	1400	<10	<2.0	140	49	1200	<1.0	<2.0	160	<10	<10	72
HW3-FCSC-131	Highway 3	-	-	-	<0.01	<1.0	6.6	58	<4.0	<20	<1.0	13000	<20	<5.0	45	3900	<10	5000	300	<2.0	7.7	930	1300	<10	<2.0	140	58	1700	<1.0	<2.0	130	<10	11	53
HW3-FCSC-131	Highway 3	-	-	-	<0.01	<1.0	8.4	60	<4.0	21	<1.0	13000	<20	<5.0	19	4200	<10	5000	310	<2.0	7.6	1000	1300	<10	<2.0	160	59	1800	<1.0	<2.0	130	<10	<10	54
HW3-FCSC-132	Highway 3	42.1	0.168	41.9	<0.01	<1.0	14	81	<4.0	<20	<1.0	11000	<20	<5.0	12	7300	<10	2800	80	<2.0	5	950	1100	<10	<2.0	260	35	1600	<1.0	<2.0	45	<10	<10	19
HW3-FCSC-132	Highway 3	-	-	-	<0.01	<1.0	10	78	<4.0	<20	<1.0	1800	51	9.8	11	28000	<10	6500	150	<2.0	19	240	560	<10	<2.0	120	6.8	<500	<1.0	<2.0	1000	<10	49	32
HW3-FCSC-134	Highway 3	-	-	-	<0.025	4	49	110	0.1	8.3	<0.60	2900	8.2	1.9	20	4800	<5.0	970	110	<0.50	3.6	450	540	<1.0	<0.25	120	12	<250	<1.0	<2.0	120	<5.0	8.3	23
HW3-FCSC-134	Highway 3	-	-	-	<0.025	<1.0	4.8	23	0.27	6.4	<0.60	1100	12	3.4	15	8600	<5.0	1800	59	<0.50	6.8	290	260	<1.0	<0.25	120	4.4	<250	<1.0	<2.0	340	<5.0	18	8.8
HW3-FCSC-135	Highway 3	13.4	0.663	12.7	0.037	2.7	45	67	<4.0	<20	<1.0	23000	<20	<5.0	16	11000	13	11000	260	<2.0	11	590	1000	<10	<2.0	260	24	680	<1.0	<2.0	310	<10	18	46
HW3-FCSC-135	Highway 3	-	-	-	<0.05	<1.0	10	5.4	0.057	<10	<0.60	490	6.8	1.4	<2.0	3600	<5.0	1000	37	<0.50	2.8	35	160	<1.0	<0.25	<75	2	<50	<1.0	<2.0	310	<5.0	7.6	5
HW3-OSC-123	Highway 3	-	-	-	<0.01	2.3	19	76	<4.0	20	<1.0	16000	<20	<5.0	24	6300	<10	6500	330	<2.0	6.1	990	1100	<10	<2.0	92	27	1600	<1.0	<2.0	140	<10	<10	31
HW3-OSC-128	Highway 3	-	-	-	0.031	3.9	22	120	0.19	13	<0.60	8600	9	2.6	13	6700	7.4	4000	97	0.78	6.5	1400	1200	<1.0	<0.25	170	21	2700	<1.0	<2.0	160	<5.0	12	55
HW3-OSC-133	Highway 3	32.9	0.112	32.8	0.011	4.9	50	130	<4.0	<20	<1.0	6200	<20	<5.0	22	4900	<10	1300	59	<2.0	5.4	1700	730	<10	<2.0	140	26	2000	<1.0	<2.0	28	<10	<10	40
HW3-OSC-133 D	Highway 3	29.0	0.126	28.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HW3-OSC-136	Highway 3	4.77	0.105	4.66	0.028	2.1	94	50	0.17	3.9	<0.60	3500	17	3.5	11	10000	6.9	3300	140	<0.50	8	170	410	<1.0	<0.25	120	7.7	300	<1.0	<2.0	370	<5.0	20	28
HW3-OSC-136	Highway 3	-	-	-	<0.05	<1.0	3.7	11	0.26	<10	<0.60	540	23	3.8	3.9	12000	<5.0	3100	87	<0.50	9.2	150	300	<1.0	<0.25	76	2.2	61	<1.0	<2.0	360	<5.0	19	13
HW3-OSC-136	Highway 3	-	-	-	<0.05	<1.0	2.9	9.8	0.21	<10	<0.60	510	22	3.5	3	11000	<5.0	3100	86	<0.50	8.8	110	240	<1.0	<0.25	<75	2.5	50	<1.0	<2.0	310	<5.0	17	12
HW3-OSG-127	Highway 3	-	-	-	0.013	3.2	28	65	<4.0	<20	<1.0	5700	<20	<5.0	5	4100	<10	1900	63	<2.0	<5.0	1100	1100	<10	<2.0	87	17	1600	<1.0	<2.0	44	<10	<10	22
INGT-FCOSC-139	Ingraham Trail	-	-	-	<0.01	3.3	38	25	<4.0	<20	<1.0	1100	<20	<5.0	<5.0	680	<10	560	44	<2.0	<5.0	550	540	<10	<2.0	<75	5.1	930	<1.0	<2.0	22	<10	<10	15
INGT-FCOSC-141	Ingraham Trail	31.3	0.186	31.1	<0.01	1.5	23	300	<4.0	<20	<1.0	8000	<20	6.2	24	7200	<10	2500	410	<2.0	22	760	750	<10	<2.0	160	45	820	<1.0	<2.0	280	<10	15	76

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																														
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
INGT-FCOSC-141	Ingraham Trail	1.41	0.020	1.39	<0.01	<1.0	10	34	<4.0	<20	<1.0	700	28	5.6	34	12000	<10	2900	87	<2.0	17	100	540	<10	<2.0	150	<5.0	<500	<1.0	<2.0	590	<10	24	15
INGT-FCOSC-42	Ingraham Trail	38.2	0.242	37.9	<0.025	<1.0	12	85	0.13	13	<0.60	8400	17	4	35	6000	7.8	3000	480	<0.50	14	570	1700	<1.0	<0.25	220	23	<250	<1.0	<2.0	190	<5.0	12	85
INGT-FCOSC-42	Ingraham Trail	-	-	-	<0.025	<1.0	7.4	39	0.44	5.9	<0.60	1300	36	7.9	20	19000	6.2	5200	150	0.51	18	95	1000	<1.0	<0.25	160	6.8	<250	<1.0	<2.0	920	<5.0	37	25
INGT-FCOSC-49	Ingraham Trail	-	-	-	0.021	8.3	63	250	<4.0	<20	<1.0	10000	<20	19	18	5800	<10	2200	640	<2.0	13	870	980	<10	<2.0	110	42	910	<1.0	<2.0	38	<10	<10	54
INGT-FCOSG-140	Ingraham Trail	-	-	-	<0.01	1.2	30	180	<4.0	<20	<1.0	2100	53	7.2	6.5	15000	<10	5400	190	<2.0	18	520	1700	<10	<2.0	100	14	240	<1.0	<2.0	990	<10	38	57
INGT-FCOSG-41	Ingraham Trail	-	-	-	<0.01	1.3	12	94	<4.0	<20	<1.0	3000	<20	<5.0	6.1	3200	<10	950	220	<2.0	<5.0	820	1200	<10	<2.0	82	19	720	<1.0	<2.0	100	<10	<10	29
INGT-FCOSG-46	Ingraham Trail	-	-	-	0.081	25	240	480	<4.0	<20	<1.0	24000	<20	15	26	10000	19	4100	2800	<2.0	21	800	780	<10	<2.0	150	52	1300	1.1	<2.0	240	<10	18	210
INGT-FCOSG-46 D	Ingraham Trail	-	-	-	0.077	27	270	490	<4.0	<20	<1.0	22000	<20	20	25	11000	19	3500	3700	<2.0	22	800	740	<10	<2.0	140	48	1200	1.2	<2.0	280	<10	19	220
INGT-FCSC-122	Ingraham Trail	32.4	0.153	32.3	<0.01	1.9	15	260	<4.0	<40	<1.0	8400	<20	7.6	18	4900	<10	2800	1900	<2.0	11	980	1300	<10	<2.0	170	51	900	<1.0	<2.0	150	<10	<10	130
INGT-FCSC-122 D	Ingraham Trail	32.4	0.153	32.3	0.019	1.9	16	220	<4.0	<40	<1.0	7600	21	8.2	16	11000	<10	4300	1600	<2.0	15	840	1500	<10	<2.0	240	47	690	<1.0	<2.0	390	<10	19	130
INGT-FCSC-28	Ingraham Trail	39.0	0.108	38.9	0.037	8.6	220	75	<4.0	<20	<1.0	2500	<20	5.9	13	10000	<10	3000	100	<2.0	15	570	470	<10	<2.0	86	20	1000	<1.0	<2.0	230	<10	16	24
INGT-FCSC-28	Ingraham Trail	-	-	-	<0.05	<1.0	38	25	0.31	<10	<0.60	630	36	9.3	16	21000	6.2	4900	140	0.71	22	80	560	<1.0	<0.25	110	3.6	<50	<1.0	<2.0	620	<5.0	33	22
INGT-FCSC-40	Ingraham Trail	5.51	0.055	5.45	<0.01	<1.0	3.6	54	<4.0	<20	<1.0	4200	<20	<5.0	6.4	6700	<10	2200	550	<2.0	5.9	450	650	<10	<2.0	110	11	<500	<1.0	<2.0	280	<10	14	71
INGT-FCSC-40 D	Ingraham Trail	-	-	-	<0.01	<1.0	3.7	66	<4.0	<20	<1.0	5500	<20	<5.0	8.2	6200	<10	2400	790	<2.0	6	530	740	<10	<2.0	110	13	<500	<1.0	<2.0	240	<10	12	98
INGT-FCSC-45	Ingraham Trail	-	-	-	0.025	8.1	48	65	<4.0	24	1.7	18000	28	11	28	11000	20	7200	660	<2.0	27	1100	2400	<10	<2.0	240	40	1500	<1.0	<2.0	230	<10	24	150
INGT-FCSC-45	Ingraham Trail	-	-	-	<0.05	<1.0	2.7	92	0.58	11	<0.60	2900	35	9.2	12	20000	6.6	6000	200	0.59	18	430	1600	<1.0	<0.25	300	23	110	<1.0	<2.0	960	<5.0	39	37
INGT-FCSC-50	Ingraham Trail	-	-	-	0.031	5.3	27	120	<4.0	<20	<1.0	19000	<20	<5.0	18	4500	<10	3600	370	<2.0	12	850	1400	<10	<2.0	86	40	1300	<1.0	<2.0	110	<10	<10	36
INGT-FCSC-50	Ingraham Trail	-	-	-	0.021	5.4	26	120	<4.0	<20	<1.0	18000	<20	<5.0	18	5800	<10	3900	410	<2.0	12	780	1400	<10	<2.0	85	40	1200	<1.0	<2.0	120	<10	<10	39
INGT-FCSC-50	Ingraham Trail	-	-	-	<0.05	<1.0	25	28	0.29	<10	<0.60	1600	40	9.7	15	21000	<5.0	6300	160	<0.50	23	310	420	<1.0	<0.25	150	5.3	<50	<1.0	<2.0	590	<5.0	34	25
INGT-FENC-51	Ingraham Trail	21.7	0.204	21.5	<0.025	2.4	84	89	0.3	18	<0.60	8100	21	10	28	14000	8.3	5200	450	1.9	22	650	1500	<1.0	<0.25	590	39	3400	<1.0	<2.0	420	<5.0	25	200
INGT-FENC-51 D	Ingraham Trail	22.4	0.185	22.3	0.016	3.5	160	110	<4.0	<20	<1.0	9100	35	14	32	24000	16	7300	300	2.2	31	950	2100	<10	<2.0	570	48	5100	<1.0	<2.0	560	<10	40	230
INGT-FENG-43	Ingraham Trail	39.1	0.343	38.8	0.11	7.3	200	25	<4.0	25	<1.0	17000	<20	<5.0	15	3500	<10	3500	63	12	10	1200	600	<10	<2.0	330	49	8700	<1.0	<2.0	71	<10	<10	34
INGT-FENG-43 D	Ingraham Trail	-	-	-	0.12	6.5	200	16	<4.0	<20	<1.0	12000	<20	<5.0	12	2400	<10	2500	38	11	8.7	680	360	<10	<2.0	230	32	7300	<1.0	<2.0	64	<10	<10	28
INGT-OSC-137	Ingraham Trail	-	-	-	<0.01	3.6	30	420	<4.0	<20	<1.0	7300	<20	6.7	14	4600	<10	1900	270	<2.0	20	820	920	<10	<2.0	170	48	900	<1.0	<2.0	99	<10	<10	64
INGT-OSC-138	Ingraham Trail	-	-	-	<0.01	2.1	13	330	<4.0	<20	<1.0	4200	<20	<5.0	8.4	4700	<10	900	70	<2.0	16	1100	940	<10	<2.0	160	34	1200	<1.0	<2.0	24	<10	<10	43
INGT-OSC-142	Ingraham Trail	20.3	0.104	20.2	<0.01	1.3	16	100	<4.0	<40	<1.0	3500	53	<5.0	51	27000	14	2800	130	<2.0	26	1900	1000	<10	<2.0	82	16	1000	<1.0	<2.0	74	<10	39	56
INGT-OSC-142 D	Ingraham Trail	18.9	0.107	18.8	<0.01	6.3	16	110	<4.0	<40	<1.0	4100	55	5.2	53	27000	14	2800	150	<2.0	28	2100	1000	<10	<2.0	110	19	1100	<1.0	<2.0	100	<10	40	60

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																												
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesiu m20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
INGT-OSC-39	Ingraham Trail	46.4	0.037	46.4	0.027	1.2	21	37	<4.0	<20	<1.0	1400	<20	<5.0	<5.0	1800	<10	490	14	<2.0	<5.0	840	1400	<10	<2.0	<75	8.3	1100	<1.0	<2.0	20	<10	<10	16
INGT-OSC-39	Ingraham Trail	-	-	-	<0.01	1.4	21	34	<4.0	<20	<1.0	1300	<20	<5.0	<5.0	1600	<10	420	12	<2.0	<5.0	750	1100	<10	<2.0	<75	7.6	1100	<1.0	<2.0	16	<10	<10	<15
INGT-OSC-48	Ingraham Trail	44.7	0.084	44.6	0.023	5.2	46	56	<4.0	<20	<1.0	5100	<20	<5.0	8.7	3300	10	880	52	<2.0	7.2	2100	1100	<10	<2.0	120	17	2200	<1.0	<2.0	24	<10	<10	38
INGT-OSC-52	Ingraham Trail	-	-	-	0.021	4	47	130	<4.0	<20	<1.0	5700	<20	18	15	5600	<10	5500	670	<2.0	43	840	840	<10	<2.0	100	23	1300	<1.0	<2.0	110	<10	<10	53
INGT-OSC-52	Ingraham Trail	-	-	-	0.017	2.9	37	120	<4.0	<20	<1.0	6400	<20	15	17	5000	<10	5300	680	<2.0	41	840	790	<10	<2.0	110	23	1200	<1.0	<2.0	100	<10	<10	52
INGT-OSG-47	Ingraham Trail	-	-	-	<0.01	4.7	98	370	<4.0	<20	2.6	22000	55	21	90	32000	21	7300	1100	<2.0	74	21000	540	<10	<2.0	230	43	820	<1.0	<2.0	26	<10	23	290
INGT-OSG-47	Ingraham Trail	-	-	-	<0.01	4.4	99	390	<4.0	<20	2.6	24000	57	21	94	32000	22	6100	1100	<2.0	71	25000	480	<10	<2.0	240	45	850	<1.0	<2.0	23	<10	21	290
INGT-OSG-47 S	Ingraham Trail	-	-	-	<0.01	4.7	120	400	0.3	12	2.2	31000	50	23	94	29000	19	6100	1200	<0.50	74	20000	560	1.3	0.49	240	54	900	<1.0	<2.0	25	<10	23	300
INGT-OSG-47 S	Ingraham Trail	-	-	-	<0.01	4.4	120	390	0.31	13	2	33000	54	23	90	31000	19	7800	1100	<0.50	75	21000	570	1.7	0.42	250	55	800	1.4	<2.0	18	<10	26	300
INGT-PSG-44	Ingraham Trail	-	-	-	0.15	3.6	59	25	<4.0	38	<1.0	14000	<20	<5.0	8.2	1900	<10	2600	50	3.5	6.1	1000	580	<10	<2.0	110	39	7100	<1.0	<2.0	17	<10	<10	21
BC20-FCSC-163	Martin Lake and Nearby Previous Research Areas	40.2	0.293	39.9	0.16	83	110	58	<4.0	21	<1.0	17000	<20	<5.0	17	3800	22	4600	290	<2.0	8.8	870	830	<10	<2.0	170	40	2300	<1.0	<2.0	47	<10	<10	66
BC20-FCSC-163	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.05	<1.0	10	180	0.78	13	<0.60	4200	50	15	18	29000	10	9300	430	<0.50	25	190	2800	<1.0	<0.25	410	27	140	<1.0	<2.0	1200	<5.0	56	40
BC20-FCSC-163 D	Martin Lake and Nearby Previous Research Areas	-	-	-	0.16	40	81	55	<4.0	<20	<1.0	11000	<20	<5.0	13	2900	15	3500	200	<2.0	5.4	600	800	<10	<2.0	170	35	1400	<1.0	<2.0	28	<10	<10	52
BC20-PSC-164.1	Martin Lake and Nearby Previous Research Areas	-	-	-	0.41	150	480	38	<4.0	<20	<1.0	5800	<20	<5.0	11	3100	45	1700	48	<2.0	<5.0	550	1700	<10	<2.0	200	14	1700	<1.0	<2.0	28	<10	<10	26
BC20-PSC-164.1	Martin Lake and Nearby Previous Research Areas	-	-	-	0.48	160	470	51	<4.0	<20	<1.0	8400	<20	<5.0	15	3600	57	2200	67	<2.0	<5.0	710	2100	<10	<2.0	250	21	2000	<1.0	<2.0	39	<10	<10	31
HL- OSC-165	Martin Lake and Nearby Previous Research Areas	30.0	0.048	29.9	0.14	54	300	120	0.14	3.7	<0.60	1200	11	2.5	9.3	8300	17	1300	52	0.78	6.3	360	390	<1.0	0.31	83	11	700	<1.0	<2.0	190	<5.0	13	28
HL-OSC-165	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.025	3	96	69	0.47	6.8	<0.60	830	42	8.8	22	24000	11	6300	160	0.84	19	95	680	<1.0	<0.25	160	13	<250	<1.0	<2.0	940	<5.0	45	32
ML-FCOSC-97	Martin Lake and Nearby Previous Research Areas	42.6	0.083	42.5	0.052	18	400	230	<4.0	<20	<1.0	2100	<20	<5.0	29	5200	13	860	76	<2.0	19	680	960	<10	<2.0	100	16	790	<1.0	<2.0	110	<10	<10	51
ML-FCOSC-97 S	Martin Lake and Nearby Previous Research Areas	42.6	0.083	42.5	0.034	14	270	230	0.26	12	0.77	2400	6.3	4	20	3200	9.4	570	75	<0.50	14	610	680	<1.0	<0.25	86	15	900	<1.0	<2.0	74	<5.0	4	40
ML-FCOSG-105	Martin Lake and Nearby Previous Research Areas	-	-	-	0.068	24	230	120	<4.0	<20	<1.0	1600	<20	<5.0	8.8	1300	<10	570	70	<2.0	5.4	920	1300	<10	<2.0	<75	14	1100	<1.0	<2.0	22	<10	<10	19
ML-FCOSG-96	Martin Lake and Nearby Previous Research Areas	-	-	-	0.066	20	210	110	0.32	<10	0.67	3300	24	5.6	14	12000	12	3400	180	<0.50	15	620	880	<1.0	<0.25	81	15	900	<1.0	<2.0	370	<5.0	24	56
ML-FCSC-100	Martin Lake and Nearby Previous Research Areas	46.1	0.379	45.7	0.012	2.4	32	59	<4.0	<40	<1.0	14000	<20	<5.0	14	1200	<10	1600	1700	<2.0	<5.0	710	1400	<10	<2.0	<75	30	1200	<1.0	<2.0	12	<10	<10	250
ML-FCSC-102	Martin Lake and Nearby Previous Research Areas	48.4	0.141	48.3	0.015	3.4	29	45	<4.0	<20	<1.0	5800	<20	<5.0	57	1000	<10	820	320	<2.0	5.1	780	1200	<10	<2.0	<75	14	960	<1.0	<2.0	16	<10	<10	61
ML-FCSC-102	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.05	<1.0	14	47	0.45	<10	<0.60	1400	42	8.3	16	21000	6	5700	160	0.52	18	420	800	<1.0	<0.25	130	8.3	50	<1.0	<2.0	730	<5.0	42	26

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																														
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
ML-FCSC-102 NR	Martin Lake and Nearby Previous Research Areas	49.3	0.161	49.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ML-OSC-103	Martin Lake and Nearby Previous Research Areas	23.5	0.083	23.4	0.11	84	820	110	<4.0	<20	<1.0	2900	<20	<5.0	11	9000	25	1400	160	<2.0	10	830	300	<10	<2.0	76	10	830	<1.0	<2.0	110	<10	14	58
ML-OSC-103 S	Martin Lake and Nearby Previous Research Areas	23.5	0.083	23.4	0.2	95	900	150	0.39	5.3	<0.60	2700	23	5.7	22	12000	27	2400	180	<0.50	15	1100	310	<1.0	<0.25	110	11	<250	<1.0	<2.0	290	<5.0	22	67
ML-OSC-98	Martin Lake and Nearby Previous Research Areas	42.7	0.090	42.7	0.067	22	210	87	<4.0	<20	<1.0	3500	<20	<5.0	35	3800	<10	440	27	<2.0	12	2200	500	<10	<2.0	89	14	4400	<1.0	<2.0	22	<10	<10	43
ML-OSC-98	Martin Lake and Nearby Previous Research Areas	-	-	-	0.11	<1.0	29	25	0.22	<10	<0.60	3600	65	12	85	37000	17	8300	210	<0.50	22	780	210	<1.0	0.32	220	6.3	1500	<1.0	<2.0	1300	6.3	81	38
ML-OSC-98 D	Martin Lake and Nearby Previous Research Areas	-	-	-	0.073	<1.0	35	28	0.26	<10	<0.60	4100	72	14	99	44000	21	10000	250	<0.50	25	830	210	<1.0	0.35	220	8.6	1600	<1.0	<2.0	1400	7.5	97	45
ML-OSG-101	Martin Lake and Nearby Previous Research Areas	-	-	-	0.035	14	88	55	<4.0	<20	<1.0	11000	<20	<5.0	12	5100	<10	660	220	<2.0	<5.0	2800	300	<10	<2.0	<75	21	2400	<1.0	<2.0	43	<10	<10	99
ML-OSG-104.1	Martin Lake and Nearby Previous Research Areas	9.10	0.063	9.04	0.074	28	320	84	<4.0	<20	<1.0	1700	44	8.1	9.7	16000	14	4300	120	<2.0	20	390	390	<10	<2.0	80	9.5	470	<1.0	<2.0	480	<10	37	48
ML-OSG-104.2	Martin Lake and Nearby Previous Research Areas	-	-	-	0.012	6.7	140	58	<4.0	<20	<1.0	830	43	7.7	7	20000	<10	5500	110	<2.0	20	300	320	<10	<2.0	86	5.7	320	<1.0	<2.0	550	<10	39	46
ML-OSG-99	Martin Lake and Nearby Previous Research Areas	40.5	0.109	40.4	0.11	29	390	120	<4.0	<20	1	6400	<20	11	24	5300	24	1100	690	4.5	13	940	440	<10	<2.0	77	21	1500	<1.0	<2.0	64	<10	<10	110
ML-OSG-99 NR	Martin Lake and Nearby Previous Research Areas	44.5	0.106	44.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NWC1-FCOSC-83	Martin Lake and Nearby Previous Research Areas	45.8	0.041	45.7	0.017	14	69	57	<4.0	<40	<1.0	2000	<20	<5.0	12	3400	<10	280	17	<2.0	<5.0	860	350	<10	<2.0	150	15	1400	<1.0	<2.0	16	<10	<10	<15
NWC1-FCSC-82	Martin Lake and Nearby Previous Research Areas	45.4	0.100	45.3	0.089	26	250	42	<4.0	<20	<1.0	6000	<20	<5.0	<5.0	1600	<10	1100	80	<2.0	<5.0	540	610	<10	<2.0	<75	18	1200	<1.0	<2.0	19	<10	<10	16
NWC1-FCSC-82	Martin Lake and Nearby Previous Research Areas	-	-	-	0.1	27	270	45	<4.0	<20	<1.0	6300	<20	<5.0	5	1600	<10	1200	67	<2.0	<5.0	560	620	<10	<2.0	<75	19	1200	<1.0	<2.0	20	<10	<10	16
NWC2-FCSC-81	Martin Lake and Nearby Previous Research Areas	-	-	-	0.012	3.5	42	48	<4.0	<40	<1.0	7400	<20	<5.0	10	920	<10	890	120	<2.0	<5.0	760	940	<10	<2.0	120	28	1100	<1.0	<2.0	13	<10	<10	33
NWC2-OSG-78	Martin Lake and Nearby Previous Research Areas	-	-	-	0.022	6.5	59	120	<4.0	<20	<1.0	1600	<20	<5.0	13	5900	<10	410	24	<2.0	6.6	2500	580	<10	<2.0	100	11	2600	<1.0	<2.0	69	<10	<10	34
NWC2-OSG-79	Martin Lake and Nearby Previous Research Areas	3.66	0.035	3.62	<0.01	2.4	84	49	<4.0	<20	<1.0	850	20	<5.0	<5.0	18000	<10	3300	110	<2.0	8.9	400	260	<10	<2.0	140	5.6	260	<1.0	<2.0	530	<10	35	36
NWC2-OSG-79 D	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.01	2.4	93	50	<4.0	<20	<1.0	870	22	<5.0	<5.0	19000	<10	3100	100	<2.0	9	410	270	<10	<2.0	93	5.9	300	<1.0	<2.0	570	<10	31	37
NWC2-OSG-79 NR	Martin Lake and Nearby Previous Research Areas	2.97	0.033	2.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NWC2-OSG-80	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.01	2.7	31	27	<4.0	<20	<1.0	760	<20	<5.0	11	11000	<10	2800	73	<2.0	8	160	240	<10	<2.0	110	<5.0	260	<1.0	<2.0	420	<10	20	19
NWC3-FCOSC-85	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.01	<1.0	6.1	52	<4.0	<20	<1.0	8400	<20	<5.0	7.4	470	<10	1300	560	<2.0	<5.0	770	950	<10	<2.0	<75	26	990	<1.0	<2.0	<10	<10	<10	63
NWC3-OSG-84	Martin Lake and Nearby Previous Research Areas	-	-	-	0.011	16	150	180	<4.0	<20	<1.0	2900	<20	<5.0	14	6600	10	240	21	<2.0	5.6	2800	320	<10	<2.0	80	19	3500	<1.0	<2.0	40	<10	<10	40
NWC3-OSG-84	Martin Lake and Nearby Previous Research Areas	-	-	-	<0.01	16	59	180	<4.0	<20	<1.0	2800	<20	<5.0	14	5400	10	240	20	<2.0	7.6	2900	350	<10	<2.0	87	18	3800	<1.0	<2.0	30	<10	<10	39
NWC3-OSG-86	Martin Lake and Nearby Previous Research Areas	32.1	0.080	32.0	0.094	33	620	120	<4.0	<20	<1.0	3300	<20	<5.0	11	14000	16	1600	160	<2.0	7.1	2400	560	<10	<2.0	140	15	420	<1.0	<2.0	430	<10	19	55
NWC3-OSG-86 D	Martin Lake and Nearby Previous Research Areas	27.9	0.082	27.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NWC3-OSG-86 S	Martin Lake and Nearby Previous Research Areas	32.1	0.080	32.0	0.2	52	570	160	0.23	11	<0.60	3900	9.7	3.7	12	11000	23	1600	200	0.5	8.6	1800	540	<1.0	<0.25	94	22	900	<1.0	<2.0	360	<5.0	16	55
MIR-FCG-02	Mirage Islands	-	-	-	<0.025	<1.0	3.8	43	0.05	9.7	1	7400	<1.0	1.3	14	620	<5.0	950	160	0.67	4.8	1100	1200	<1.0	<0.25	90	24	1500	<1.0	<2.0	<5.0	<5.0	1.8	33
MIR-FCG-02 D	Mirage Islands	-	-	-	<0.025	<1.0	2.8	34	0.027	9.3	0.8	6800	<1.0	0.94	13	460	<5.0	860	82	0.62	4.3	1100	1400	<1.0	<0.25	<75	22	1400	<1.0	<2.0	<5.0	<5.0	1.2	24

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																												
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
MIR-FCG-02 D	Mirage Islands	-	-	-	<0.025	<1.0	2.6	32	0.025	14	0.76	6300	<1.0	0.87	17	400	<5.0	830	83	0.59	4	1000	1400	<1.0	<0.25	76	21	410	<1.0	<2.0	<5.0	<5.0	1.1	26
MIR-OSG-01	Mirage Islands	50.2	0.145	50.0	<0.025	2.4	8.1	73	<0.010	7.8	0.8	6100	<1.0	0.51	17	540	<5.0	920	150	0.55	2	740	920	<1.0	<0.25	<75	13	1400	<1.0	<2.0	<5.0	<5.0	1.2	47
MIR-PSG-03	Mirage Islands	-	-	-	<0.025	<1.0	2.9	11	<0.010	7.7	<0.60	2400	<1.0	<0.50	2.6	270	<5.0	1800	74	<0.50	2.8	840	5700	<1.0	<0.25	930	6.8	1600	<1.0	<2.0	<5.0	<5.0	<1.0	23
MIR-PSG-03 D	Mirage Islands	-	-	-	<0.025	<1.0	2.8	14	<0.010	15	<0.60	3300	<1.0	<0.50	2.2	520	<5.0	1300	41	<0.50	2.7	500	3400	<1.0	<0.25	620	10	<250	<1.0	<2.0	<5.0	<5.0	<1.0	17
NDILO-FCSC-25	Ndilǫ	46.3	0.468	45.9	0.24	51	280	37	<4.0	22	<1.0	13000	<20	<5.0	11	1700	19	2200	200	<2.0	6.9	920	1700	<10	<2.0	<75	39	1700	<1.0	<2.0	12	<10	<10	74
NDILO-FCSC-25 S	Ndilǫ	46.3	0.468	45.9	0.37	95	550	57	0.017	27	<0.60	22000	4	4.1	15	2300	31	2700	310	0.74	11	1000	1400	<1.0	<0.25	<75	55	1900	<1.0	<2.0	24	<5.0	3.7	82
NDILO-FCSC-26	Ndilǫ	42.6	0.387	42.2	0.09	16	170	31	<4.0	<20	<1.0	18000	<20	7.3	92	7800	14	2800	45	<2.0	22	1000	1100	<10	<2.0	300	53	3300	<1.0	<2.0	50	<10	13	130
NDILO-OSC 27	Ndilǫ	-	-	-	0.18	37	130	120	<4.0	<20	<1.0	13000	25	<5.0	47	11000	26	2500	93	<2.0	18	2300	750	<10	<2.0	160	19	2880	<1.0	<2.0	69	<10	15	74
NDILO-OSC-23	Ndilǫ	45.2	0.463	44.8	0.18	77	220	150	<4.0	<20	<1.0	17000	<20	<5.0	17	2100	22	1400	270	<2.0	6.8	1000	750	<10	<2.0	88	39	1500	<1.0	<2.0	20	<10	<10	140
NDILO-OSC-23 D	Ndilǫ	45.2	0.463	44.8	0.19	86	230	120	<4.0	<40	<1.0	17000	<20	<5.0	20	2300	24	1400	260	<2.0	5.5	850	650	<10	<2.0	81	32	1600	<1.0	<2.0	27	<10	<10	120
NDILO-OSC-23 S	Ndilǫ	45.2	0.463	44.8	0.21	96	200	130	0.014	9.1	<0.60	18000	6	3.3	23	2400	24	1500	250	0.62	7.1	800	570	<1.0	<0.25	98	32	1700	<1.0	<2.0	26	<5.0	4.8	110
NDILO-OSC-24	Ndilǫ	45.7	0.293	45.4	0.034	8.5	180	140	<4.0	<40	<1.0	13000	<20	<5.0	18	2500	<10	2100	1600	<2.0	9.4	1200	1500	<10	<2.0	76	27	1500	<1.0	<2.0	20	<10	<10	97
CHAN-FCSC-61	North of Giant Mine Property	44.7	0.094	44.6	<0.01	1.6	34	69	<4.0	<20	<1.0	7600	<20	5.4	29	3400	<10	1100	140	<2.0	9.3	940	1200	<10	<2.0	<75	22	1700	<1.0	<2.0	57	<10	<10	66
CHAN-OSG-60	North of Giant Mine Property	9.15	0.036	9.12	<0.01	2	41	150	<4.0	<20	<1.0	1900	41	32	74	32000	14	4900	220	<2.0	43	400	430	<10	<2.0	130	7	470	<1.0	<2.0	870	<10	67	140
CHAN-OSG-60 NR	North of Giant Mine Property	6.31	0.039	6.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHAN-PSC-59	North of Giant Mine Property	-	-	-	<0.01	1.5	29	22	<4.0	<20	<1.0	5900	<20	<5.0	6.9	740	<10	1100	61	<2.0	<5.0	430	1200	<10	<2.0	<75	18	1200	<1.0	<2.0	<10	<10	<10	22
DUF-FCSC-55	North of Giant Mine Property	-	-	-	<0.01	<1.0	4.9	18	<4.0	<20	<1.0	340	<20	<5.0	<5.0	4600	<10	1500	38	<2.0	<5.0	34	260	<10	<2.0	<75	<5.0	110	<1.0	<2.0	160	<10	11	<15
DUF-OSC-54	North of Giant Mine Property	45.2	0.066	45.1	0.015	6.5	52	69	<4.0	<40	<1.0	4100	<20	<5.0	6.9	810	<10	550	190	<2.0	<5.0	740	1000	<10	<2.0	85	18	950	<1.0	<2.0	13	<10	<10	45
DUF-PSC-53	North of Giant Mine Property	49.1	0.039	49.1	0.014	3.4	65	20	<4.0	<20	<1.0	1800	<20	<5.0	<5.0	400	<10	460	19	<2.0	<5.0	480	540	<10	<2.0	<75	5.7	890	<1.0	<2.0	<10	<10	<10	20
DUF-PSC-53	North of Giant Mine Property	-	-	-	0.01	2.5	44	14	<4.0	<20	<1.0	1300	<20	<5.0	<5.0	280	<10	350	13	<2.0	<5.0	350	450	<10	<2.0	<75	<5.0	730	<1.0	<2.0	<10	<10	<10	16
HOML-FCSC-56	North of Giant Mine Property	48.5	0.174	48.3	0.011	2.4	26	54	<4.0	<20	<1.0	8100	<20	13	85	2900	<10	710	39	<2.0	16	490	330	<10	<2.0	<75	15	1200	<1.0	<2.0	26	<10	<10	<15
HOML-FCSC-56	North of Giant Mine Property	-	-	-	<0.05	<1.0	24	210	1.6	18	<0.60	2700	82	45	1600	43000	14	10000	240	0.56	190	410	2600	<1.0	<0.25	280	22	330	<1.0	<2.0	1100	<5.0	69	51
HOML-FCSC-56 D	North of Giant Mine Property	-	-	-	<0.01	1.8	25	54	<4.0	<20	<1.0	7900	<20	12	85	2800	<10	720	41	<2.0	15	530	300	<10	<2.0	<75	15	1300	<1.0	<2.0	24	<10	<10	<15
HOML-FCSC-56 D	North of Giant Mine Property	-	-	-	<0.01	2.5	27	58	<4.0	<20	<1.0	8900	<20	14	100	3200	<10	760	49	<2.0	18	520	310	<10	<2.0	<75	16	1300	<1.0	<2.0	30	<10	<10	<15
HOML-OSG-57	North of Giant Mine Property	-	-	-	0.037	12	450	120	<4.0	<20	2.3	2700	50	34	300	200000	180	13000	1900	<2.0	38	660	740	<10	3.4	<75	7.3	960	<1.0	2.1	1000	<10	220	190
HOML-OSG-57 S	North of Giant Mine Property	-	-	-	<0.01	23	580	120	0.48	13	<0.60	3900	52	45	350	160000	220	12000	1700	0.79	43	810	910	<1.0	3.5	140	11	800	<1.0	2.2	1400	<20	230	200
HOML-PSC-58	North of Giant Mine Property	45.7	0.455	45.2	<0.01	1.3	19	24	<4.0	<20	<1.0	15000	<20	<5.0	<5.0	440	<10	1000	77	<2.0	<5.0	520	370	<10	<2.0	<75	17	1800	<1.0	<2.0	<10	<10	<10	45
HOML-PSC-58	North of Giant Mine Property	45.7	0.455	45.2	<0.01	<1.0	7.8	32	<4.0	<20	<1.0	29000	<20	<5.0	7.3	980	<10	1800	4	<2.0	<5.0	310	56	<10	<2.0	86	36	3900	<1.0	<2.0	49	<10	<10	19
HOML-PSC-58 D	North of Giant Mine Property	46.1	0.435	45.7	<0.01	1.8	23	45	<4.0	<20	<1.0	19000	<20	<5.0	6.8	590	<10	1300	130	<2.0	<5.0	590	420	<10	<2.0	<75	22	2700	<1.0	<2.0	12	<10	<10	75

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																												
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
DUCK-FCSC-71	Southeast and East of Yellowknife	47.0	0.321	46.7	<0.01	1.2	15	37	<4.0	<20	<1.0	15000	<20	<5.0	12	1000	<10	2400	150	<2.0	<5.0	830	1100	<10	<2.0	150	29	1100	<1.0	<2.0	18	<10	<10	50
DUCK-OSG-72	Southeast and East of Yellowknife	21.7	0.079	21.6	0.03	6.7	100	230	<4.0	<20	2.1	7300	25	27	47	21000	34	4200	2600	<2.0	31	860	600	<10	<2.0	120	27	960	<1.0	<2.0	450	<10	40	320
DUCK-OSG-72 NR	Southeast and East of Yellowknife	23.8	0.107	23.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EAST1-FCSC-69	Southeast and East of Yellowknife	-	-	-	<0.01	<1.0	21	160	<4.0	<20	<1.0	3800	54	17	11	23000	<10	7900	760	<2.0	27	380	890	<10	<2.0	87	13	310	<1.0	<2.0	710	<10	45	72
EAST1-OSC-70	Southeast and East of Yellowknife	39.1	0.407	38.6	<0.01	1.2	15	160	<4.0	<40	<1.0	22000	<20	7.4	44	9000	<10	3100	530	5.8	7.8	2000	960	<10	<2.0	110	27	2700	<1.0	<2.0	130	<10	19	45
EAST1-OSC-70 D	Southeast and East of Yellowknife	38.6	0.444	38.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EAST2-FCSC-66	Southeast and East of Yellowknife	48.4	0.257	48.2	0.015	3.5	52	19	<4.0	<20	<1.0	12000	<20	<5.0	7.4	680	<10	820	67	<2.0	<5.0	670	830	<10	<2.0	92	14	1300	<1.0	<2.0	16	<10	<10	28
EAST2-FCSC-66	Southeast and East of Yellowknife	3.49	0.106	3.39	<0.01	<1.0	4.6	240	<4.0	<20	<1.0	14000	49	14	40	36000	12	9600	490	<2.0	34	510	3700	<10	<2.0	530	49	<500	<1.0	<2.0	950	<10	54	64
EAST2-FCSC-66	Southeast and East of Yellowknife	3.61	0.145	3.46	<0.01	<1.0	4.5	240	<4.0	<20	<1.0	12000	50	15	36	37000	14	10000	560	<2.0	34	510	3800	<10	<2.0	550	47	<500	<1.0	<2.0	990	<10	55	66
EAST2-OSG-67	Southeast and East of Yellowknife	-	-	-	0.018	4.1	22	52	<4.0	<20	<1.0	25000	<20	5.7	28	2500	<10	870	170	<2.0	5.1	850	620	<10	<2.0	<75	21	4100	<1.0	<2.0	<10	<10	<10	24
EAST2-OSG-67 D	Southeast and East of Yellowknife	-	-	-	<0.01	1	26	110	<4.0	<20	<1.0	14000	<20	12	180	16000	<10	2200	79	<2.0	22	970	310	<10	<2.0	200	13	3400	<1.0	<2.0	540	<10	47	24
EAST2-PSC-68	Southeast and East of Yellowknife	-	-	-	0.014	2.2	20	66	<4.0	<20	<1.0	17000	<20	<5.0	7.6	770	<10	1600	34	<2.0	<5.0	830	600	<10	<2.0	130	49	3400	<1.0	<2.0	<10	<10	<10	<15
EAST2-PSC-68	Southeast and East of Yellowknife	-	-	-	0.01	1.9	15	51	<4.0	<20	<1.0	12000	<20	<5.0	5.8	520	<10	1200	17	<2.0	<5.0	560	400	<10	<2.0	99	29	2600	<1.0	<2.0	<10	<10	<10	<15
MASL-OSC-65	Southeast and East of Yellowknife	45.7	0.048	45.7	0.022	9.1	87	19	<4.0	<40	<1.0	2000	<20	<5.0	<5.0	460	<10	240	16	<2.0	<5.0	510	460	<10	<2.0	<75	21	930	<1.0	<2.0	11	<10	<10	17
MASL-OSC-65	Southeast and East of Yellowknife	-	-	-	0.028	8.7	96	20	<4.0	<40	<1.0	2100	<20	<5.0	<5.0	480	<10	250	17	<2.0	<5.0	540	480	<10	<2.0	<75	22	960	<1.0	<2.0	12	<10	<10	19
MASL-PSC-64	Southeast and East of Yellowknife	-	-	-	0.02	5.6	92	35	<4.0	<20	<1.0	3700	<20	<5.0	<5.0	560	<10	820	19	<2.0	<5.0	770	690	<10	<2.0	<75	11	1500	<1.0	<2.0	<10	<10	<10	35
NWFAR1-FCSC-75	Southwest and West of Yellowknife	-	-	-	<0.01	1.4	35	60	<4.0	<20	<1.0	7100	<20	<5.0	12	1500	<10	1600	190	<2.0	7.9	630	780	<10	<2.0	78	27	1300	<1.0	<2.0	51	<10	<10	45
NWFAR1-FCSC-75	Southwest and West of Yellowknife	-	-	-	<0.05	<1.0	4	37	0.33	<10	<0.60	1000	30	6.6	15	16000	<5.0	4300	120	<0.50	15	50	430	<1.0	<0.25	150	5.1	<50	<1.0	<2.0	820	<5.0	29	18
NWFAR1-OSG-76	Southwest and West of Yellowknife	3.66	0.035	3.62	0.022	3	53	170	<4.0	<20	<1.0	3600	<20	<5.0	8.9	3600	<10	570	39	<2.0	5.2	2500	730	<10	<2.0	150	25	2300	<1.0	<2.0	50	38	<10	51
NWFAR1-PSC-77	Southwest and West of Yellowknife	44.0	0.069	43.9	<0.01	<1.0	8.1	7.9	<4.0	<20	<1.0	1500	<20	<5.0	<5.0	280	<10	670	19	<2.0	<5.0	400	640	<10	<2.0	140	7.6	640	<1.0	<2.0	<10	<10	<10	<15
NWFAR2-OSG-74	Southwest and West of Yellowknife	-	-	-	<0.01	2.2	74	340	<4.0	<20	<1.0	2000	37	14	42	30000	22	4800	100	<2.0	32	550	800	<10	<2.0	160	24	340	<1.0	<2.0	370	<10	54	49
NWFAR2-PSC-73	Southwest and West of Yellowknife	-	-	-	<0.01	2.1	26	36	<4.0	<20	<1.0	8100	<20	<5.0	<5.0	2000	<10	1500	65	3.3	<5.0	1000	700	19	<2.0	160	40	3300	<1.0	<2.0	17	<10	<10	19
SW1-FCOSG-88	Southwest and West of Yellowknife	-	-	-	<0.01	2	37	94	<4.0	<20	<1.0	1500	25	5.7	12	18000	<10	4300	120	<2.0	12	240	490	<10	<2.0	130	14	260	<1.0	<2.0	550	<10	39	33
SW1-PSC-87	Southwest and West of Yellowknife	47.4	0.061	47.4	0.011	3.2	99	19	<4.0	<20	<1.0	5300	<20	<5.0	<5.0	760	<10	1200	11	<2.0	<5.0	480	720	<10	<2.0	86	25	2400	<1.0	<2.0	17	<10	<10	21
SW3-FCOSG-90	Southwest and West of Yellowknife	-	-	-	<0.01	<1.0	43	31	<4.0	<20	<1.0	1000	<20	<5.0	<5.0	7700	<10	1400	56	<2.0	<5.0	170	190	<10	<2.0	<75	6.5	120	<1.0	<2.0	180	<10	22	<15
SW3-PSC-89	Southwest and West of Yellowknife	47.9	0.037	47.9	0.02	2.8	30	14	<4.0	<20	<1.0	2400	<20	<5.0	<5.0	380	<10	750	30	<2.0	<5.0	580	680	<10	<2.0	110	16	1000	<1.0	<2.0	<10	<10	<10	<15
SW3-PSG-89.1	Southwest and West of Yellowknife	44.2	0.723	43.4	<0.01	<1.0	4.1	15	<4.0	<20	<1.0	17000	<20	<5.0	<5.0	380	<10	3100	16	<2.0	<5.0	390	180	<10	<2.0	<75	70	1100	<1.0	<2.0	10	<10	<10	<15
BERRY-FCOSC-62	TerraX Northbelt	50.5	0.450	50.1	<0.01	<1.0	6.1	13	<4.0	<40	<1.0	19000	<20	<5.0	13	250	<10	2000	140	<2.0	<5.0	720	530	<10	<2.0	<75	11	980	<1.0	<2.0	<10	<10	<10	59
BERRY-FCOSC-62	TerraX Northbelt	50.5	0.450	50.1	<0.025	<1.0	5.2	20	<0.010	20	<0.60	24000	2.1	<0.50	26	300	<5.0	2400	180	<0.50	1.4	790	550	<1.0	<0.25	120	14	<250	<1.0	<2.0	<5.0	<5.0	<1.0	80
BERRY-OSG-63	TerraX Northbelt	36.4	0.826	35.6	<0.01	11	84	97	<4.0	<20	2.9	34000	<20	16	81	24000	<10	4500	3000	<2.0	32	850	370	<10	<2.0	<75	18	2000	<1.0	<2.0	85	<10	24	500
BERRY-OSG-63 D	TerraX Northbelt	34.8	0.830	34.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																												
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
BERRY-OSG-63 S	TerraX Northbelt	-	-	-	<0.025	3.5	110	120	0.17	7.9	3.5	31000	14	25	110	27000	10	4800	3700	<0.50	40	820	380	<1.0	0.99	110	17	1100	<1.0	<2.0	110	<5.0	27	570
BERRY-OSG-63 S	TerraX Northbelt	36.4	0.826	35.6	<0.025	3.3	93	97	0.14	10	2.9	30000	11	20	88	25000	8.5	4400	3000	<0.50	33	720	420	<1.0	0.83	83	16	<250	<1.0	<2.0	87	<5.0	24	490
LL-FCOSC-116	TerraX Northbelt	48.3	0.079	48.2	0.027	4.9	69	92	<4.0	<20	<1.0	5400	<20	5.2	14	1800	<10	720	230	<2.0	6.2	820	840	<10	<2.0	91	22	1200	<1.0	<2.0	18	<10	<10	160
LL-FCOSC-121	TerraX Northbelt	48.6	0.098	48.5	0.019	7.6	110	65	<4.0	<20	<1.0	4400	<20	<5.0	9.8	810	<10	560	160	<2.0	<5.0	720	690	<10	<2.0	<75	16	1300	<1.0	<2.0	10	<10	<10	51
LL-OSC-106	TerraX Northbelt	17.5	0.051	17.4	0.072	26	200	190	<4.0	<20	<1.0	3400	<20	<5.0	12	14000	15	2000	140	12	7.7	660	520	<10	<2.0	83	15	1000	<1.0	<2.0	280	<10	25	68
LL-OSC-106 S	TerraX Northbelt	17.5	0.051	17.4	0.059	16	240	110	0.11	<10	<0.60	2500	20	3.3	15	16000	12	1900	110	15	7.7	740	440	<1.0	<0.25	88	12	900	<1.0	<2.0	360	<5.0	35	57
LL-OSC-115	TerraX Northbelt	45.3	0.089	45.2	0.035	7.3	69	100	<4.0	<40	<1.0	3200	<20	<5.0	12	5500	42	670	67	<2.0	6.4	1600	1300	<10	<2.0	100	17	1700	<1.0	<2.0	38	<10	<10	100
LL-OSC-118	TerraX Northbelt	43.6	0.078	43.5	0.037	14	120	210	<4.0	<20	<1.0	3600	<20	<5.0	17	6700	<10	380	28	<2.0	6	2400	630	<10	<2.0	120	17	2600	<1.0	<2.0	11	<10	<10	16
LL-OSC-118 D	TerraX Northbelt	-	-	-	0.013	7.6	88	140	<4.0	<20	<1.0	2800	<20	<5.0	9.5	7100	<10	460	38	<2.0	<5.0	2400	1300	<10	<2.0	120	13	2000	<1.0	<2.0	11	<10	<10	20
LL-OSC-119	TerraX Northbelt	-	-	-	0.039	9.6	95	110	0.23	6.4	4.4	5000	42	3.7	210	3100	10	1500	170	10	13	2600	670	<1.0	<0.25	150	27	4000	<1.0	<2.0	61	<5.0	20	650
LL-OSC-119	TerraX Northbelt	-	-	-	<0.05	<1.0	1.6	86	0.77	5.8	2.8	5300	30	7.9	160	13000	47	5800	190	6	19	1200	210	1.2	<0.25	160	27	1400	<1.0	<2.0	460	11	33	540
LL-OSC-119 D	TerraX Northbelt	-	-	-	0.068	12	110	120	0.24	6.2	4.2	5400	7.3	3.8	53	3400	12	950	130	10	9.2	3000	610	<1.0	<0.25	140	29	4600	<1.0	<2.0	41	<5.0	13	690
LL-OSC-120	TerraX Northbelt	40.6	0.134	40.5	0.03	10	59	99	<4.0	<20	17	2500	<20	<5.0	100	2600	91	480	47	3.8	11	3100	400	<10	<2.0	<75	11	3900	<1.0	<2.0	29	<10	20	800
LL-OSC-120	TerraX Northbelt	-	-	-	0.071	<1.0	2.5	110	0.45	<10	15	2600	7.4	3.1	98	2900	80	560	29	3	9.5	1700	140	<1.0	0.28	93	13	2300	<1.0	<2.0	46	5.1	21	970
LL-PSC-117	TerraX Northbelt	42.9	0.209	42.7	<0.01	<1.0	24	37	<4.0	<20	<1.0	7400	<20	<5.0	6.2	1800	<10	1500	260	2.1	<5.0	1000	1100	<10	<2.0	130	29	2200	<1.0	<2.0	12	<10	<10	64
LL-PSG-117.1	TerraX Northbelt	32.2	0.210	32.0	<0.01	3.6	43	120	<4.0	<20	<1.0	19000	25	12	51	20000	<10	4900	320	2.5	26	580	790	<10	<2.0	200	50	3600	<1.0	<2.0	350	<10	25	46
LL-PSG-117.1 D	TerraX Northbelt	27.7	0.246	27.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LL-PSG-117.2	TerraX Northbelt	-	-	-	<0.01	<1.0	19	64	<4.0	<20	<1.0	3000	43	12	30	21000	<10	7000	230	<2.0	28	500	1700	<10	<2.0	190	10	160	<1.0	<2.0	750	<10	39	42
LL-PSG-117.2 D	TerraX Northbelt	-	-	-	<0.01	<1.0	21	71	<4.0	<20	<1.0	3400	46	14	32	24000	<10	8200	260	<2.0	31	580	1800	<10	<2.0	210	11	190	<1.0	<2.0	850	<10	46	47
TX-FCOSC-150	TerraX Northbelt	-	-	-	0.04	10	53	170	<4.0	<20	<1.0	5200	<20	<5.0	19	3100	<10	980	490	<2.0	7.3	670	950	<10	<2.0	<75	11	980	<1.0	<2.0	74	<10	<10	40
TX-FCOSC-150	TerraX Northbelt	-	-	-	0.036	12	54	180	<4.0	<20	<1.0	4300	<20	<5.0	19	3500	<10	920	470	<2.0	7.7	630	900	<10	<2.0	<75	11	900	<1.0	<2.0	67	<10	<10	38
TX-FCOSC-150	TerraX Northbelt	-	-	-	<0.05	<1.0	18	30	0.45	<10	<0.60	1400	46	10	34	23000	5.2	5800	170	<0.50	24	270	500	<1.0	<0.25	130	5.8	57	<1.0	<2.0	690	<5.0	42	24
TX-FCOSC-150	TerraX Northbelt	-	-	-	<0.05	<1.0	18	30	0.45	<10	<0.60	1500	47	10	36	23000	5.2	5800	170	<0.50	24	300	410	<1.0	<0.25	130	6.3	62	<1.0	<2.0	740	<5.0	43	24
TX-FCOSC-155	TerraX Northbelt	42.7	0.343	42.4	0.034	11	78	120	<4.0	<40	<1.0	14000	<20	6.5	26	5400	<10	1700	1600	<2.0	19	670	710	<10	<2.0	<75	16	970	<1.0	<2.0	140	<10	<10	69

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																												
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
TX-FCOSC-155	TerraX Northbelt	42.7	0.343	42.4	0.011	2	7.1	80	<4.0	<40	<1.0	2800	360	64	140	63000	16	17000	1200	<2.0	130	250	360	<10	<2.0	230	6.9	170	<1.0	<2.0	1500	<10	130	180
TX-FCOSC-155	TerraX Northbelt	-	-	-	<0.01	2.2	5.9	92	<4.0	<40	<1.0	3000	300	61	130	58000	16	15000	1800	<2.0	120	230	340	<10	<2.0	130	18	130	<1.0	<2.0	1200	<10	110	170
TX-FCOSC-155 D	TerraX Northbelt	21.9	0.190	21.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX-FCOSC-157	TerraX Northbelt	-	-	-	0.059	12	60	83	<4.0	<20	<1.0	14000	<20	8	15	21000	14	6800	430	<2.0	11	790	510	<10	<2.0	<75	13	2400	<1.0	<2.0	320	<10	57	63
TX-FCSC-144	TerraX Northbelt	23.9	0.119	23.8	0.025	10	130	150	<4.0	<40	<1.0	8400	<20	5.5	20	16000	10	2600	160	<2.0	14	820	2200	<10	<2.0	120	35	960	<1.0	<2.0	310	<10	26	55
TX-FCSC-144	TerraX Northbelt	-	-	-	<0.05	<1.0	44	150	0.61	13	<0.60	3100	35	10	20	20000	8.5	5000	240	0.65	20	440	1400	<1.0	<0.25	210	26	180	<1.0	<2.0	820	<5.0	40	58
TX-FCSC-144 D	TerraX Northbelt	-	-	-	<0.05	<1.0	43	150	0.58	13	<0.60	3100	35	9.6	19	19000	7.7	4800	230	0.55	18	460	1400	<1.0	<0.25	320	24	180	<1.0	<2.0	800	<5.0	37	56
TX-FCSC-144 S	TerraX Northbelt	23.9	0.119	23.8	0.033	11	100	180	0.39	9.6	1	9100	17	6.2	23	12000	8.6	2900	190	0.81	14	800	2000	<1.0	<0.25	130	36	<250	<1.0	<2.0	380	<5.0	21	58
TX-FCSC-148	TerraX Northbelt	45.9	0.451	45.5	0.033	4.6	14	91	<4.0	<20	<1.0	19000	<20	<5.0	14	910	<10	760	170	<2.0	<5.0	810	550	<10	<2.0	<75	19	1700	<1.0	<2.0	12	<10	<10	57
TX-FCSC-154	TerraX Northbelt	38.5	0.088	38.4	<0.01	2	22	56	<4.0	<20	<1.0	6700	140	16	59	32000	<10	8800	580	<2.0	32	390	490	<10	<2.0	<75	8.3	620	<1.0	<2.0	530	<10	42	43
TX-OSC-145	TerraX Northbelt	-	-	-	0.02	1.3	43	69	<4.0	<20	<1.0	2900	53	13	26	21000	<10	7400	260	<2.0	30	370	1800	<10	<2.0	170	13	190	<1.0	<2.0	540	<10	43	52
TX-OSC-145	TerraX Northbelt	-	-	-	<0.05	4.3	320	340	0.42	10	2.7	8100	47	48	89	49000	17	14000	4400	<0.50	39	630	740	<1.0	0.57	210	28	350	1.4	<2.0	570	<5.0	130	700
TX-OSC-147	TerraX Northbelt	-	-	-	0.021	16	54	74	<4.0	<20	<1.0	7600	<20	<5.0	14	2000	<10	350	45	<2.0	6.5	1700	580	<10	<2.0	<75	9.6	3700	<1.0	<2.0	14	<10	<10	21
TX-OSC-151	TerraX Northbelt	2.12	0.036	2.09	0.011	7.3	72	78	<4.0	<40	<1.0	1700	44	12	19	33000	12	5000	290	<2.0	21	150	450	<10	<2.0	120	12	<500	<1.0	<2.0	970	<10	55	93
TX-OSC-153	TerraX Northbelt	45.0	0.510	44.5	0.042	12	44	150	<4.0	<20	<1.0	19000	<20	<5.0	11	2400	<10	1400	890	<2.0	5.4	650	930	<10	<2.0	80	23	990	<1.0	<2.0	63	<10	<10	140
TX-OSG-143	TerraX Northbelt	-	-	-	0.024	7.4	120	100	<4.0	<20	<1.0	17000	45	12	22	23000	15	7900	820	<2.0	25	470	420	<10	<2.0	110	28	670	<1.0	<2.0	450	<10	44	88
TX-OSG-146	TerraX Northbelt	-	-	-	<0.01	3.1	110	100	<4.0	<20	1.3	2800	150	19	54	34000	15	17000	490	<2.0	49	1700	620	<10	<2.0	<75	7.4	1400	<1.0	<2.0	200	<10	98	100
TX-OSG-149	TerraX Northbelt	-	-	-	0.028	4.4	70	340	<4.0	<20	<1.0	6500	56	21	19	27000	13	6200	2500	<2.0	29	500	370	<10	<2.0	140	14	660	<1.0	<2.0	750	<10	53	180
TX-OSG-149 D	TerraX Northbelt	-	-	-	<0.01	2.6	73	310	<4.0	<20	<1.0	5500	61	22	19	29000	12	6900	2200	<2.0	30	440	350	<10	<2.0	110	12	590	<1.0	<2.0	820	<10	54	160
TX-OSG-152	TerraX Northbelt	10.9	0.082	10.8	0.015	11	210	170	<4.0	<20	<1.0	3800	43	19	26	42000	18	5200	1600	<2.0	26	260	620	<10	<2.0	99	18	320	<1.0	<2.0	910	<10	54	320
TX-OSG-152 D	TerraX Northbelt	12.2	0.083	12.1	0.016	9.5	210	160	<4.0	<20	<1.0	3700	45	19	30	39000	18	5300	1500	<2.0	27	270	630	<10	<2.0	100	19	340	<1.0	<2.0	840	<10	56	310
TX-OSG-152 D	TerraX Northbelt	-	-	-	0.065	11	230	170	<4.0	<20	<1.0	3500	46	20	30	45000	19	5400	1500	<2.0	28	260	620	<10	<2.0	110	18	320	<1.0	<2.0	930	<10	60	330

Table B: Bulk Geochemistry and Total Carbon Results

Sample ID	Area	Carbon			Total Metals and Detection Limits (µg/g)																													
		Total Carbon% dry	Inorganic Carbon% dry	Organic Carbon% dry	Gold 0.025	Antimony 1	Arsenic 1	Barium 0.5	Beryllium 0.01	Boron 2.0	Cadmium 0.6	Calcium 100	Chromium 1	Cobalt 0.5	Copper 2	Iron 50	Lead 5	Magnesium 20	Manganese 0.5	Molybdenum 0.5	Nickel 1	Phosphorus 20	Potassium 20	Selenium 1	Silver 0.25	Sodium 75	Strontium 1	Sulphur 25	Thallium 1	Tin 2	Titanium 5	Uranium 5	Vanadium 1	Zinc 5
TX-OSG-152 S	TerraX Northbelt	10.9	0.082	10.8	0.021	15	230	170	0.67	15	<0.60	5100	45	21	32	39000	14	5600	1500	<0.50	28	340	700	1.2	<0.25	120	21	550	<1.0	<2.0	1100	<5.0	60	330
TX-OSG-156	TerraX Northbelt	36.2	0.131	36.1	0.059	26	150	200	<4.0	<20	2.4	8400	27	11	68	21000	37	3800	390	<2.0	37	3300	880	<10	<2.0	98	19	2100	<1.0	<2.0	240	<10	49	180
TX-OSG-156 NR	TerraX Northbelt	34.5	0.123	34.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VL-FCOSC-107	TerraX Northbelt	-	-	-	<0.01	1.1	15	210	<4.0	<20	<1.0	16000	<20	<5.0	35	500	<10	3100	3500	<2.0	<5.0	900	1100	<10	<2.0	<75	49	1400	2.8	<2.0	<10	<10	<10	260
VL-FCOSG-112	TerraX Northbelt	43.5	0.106	43.4	0.022	6	38	230	<4.0	<20	<1.0	5500	<20	<5.0	18	2800	<10	670	110	<2.0	6.5	1400	890	<10	<2.0	140	31	1500	<1.0	<2.0	38	<10	<10	55
VL-FCOSG-112	TerraX Northbelt	-	-	-	0.014	5.7	37	210	<4.0	<20	<1.0	5200	<20	<5.0	13	2600	<10	600	100	<2.0	5.1	1200	800	<10	<2.0	130	30	1800	<1.0	<2.0	30	<10	<10	57
VL-FCOSG-112 NR	TerraX Northbelt	46.0	0.085	45.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VL-FCOSG-113	TerraX Northbelt	45.7	0.104	45.6	0.028	9.5	100	240	<4.0	<20	<1.0	5400	<20	<5.0	11	4400	<10	710	75	<2.0	<5.0	930	480	<10	<2.0	84	31	1100	<1.0	<2.0	36	<10	<10	38
VL-FCOSG-114	TerraX Northbelt	48.2	0.172	48.0	0.014	5.3	51	180	<4.0	<20	<1.0	6800	<20	8.1	18	2000	<10	780	1000	<2.0	9	630	810	<10	<2.0	120	36	810	<1.0	<2.0	50	<10	<10	62
VL-FCOSG-114 D	TerraX Northbelt	48.2	0.174	48.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VL-FCSC-108	TerraX Northbelt	48.3	0.059	48.2	0.029	11	120	100	<4.0	<20	<1.0	5400	<20	6.7	12	2900	<10	1000	1300	<2.0	<5.0	970	1400	<10	<2.0	79	23	1000	<1.0	<2.0	34	<10	<10	54
VL-FCSC-111	TerraX Northbelt	46.4	0.072	46.4	0.015	5.1	34	75	<4.0	<20	<1.0	5200	<20	<5.0	16	2400	<10	860	42	<2.0	<5.0	860	680	<10	<2.0	110	22	1300	<1.0	<2.0	23	<10	<10	26
VL-FCSC-111	TerraX Northbelt	-	-	-	<0.05	<1.0	3.8	52	0.37	<10	<0.60	2000	34	8.5	13	18000	5.7	5400	180	<0.50	17	370	670	<1.0	<0.25	170	9.2	<50	<1.0	<2.0	820	<5.0	33	24
VL-OSC-110	TerraX Northbelt	49.7	0.0819	49.6	0.037	23	130	68	<4.0	<20	<1.0	4100	<20	<5.0	7.5	980	15	350	180	<2.0	<5.0	460	340	<10	<2.0	<75	13	1100	<1.0	<2.0	17	<10	<10	57
VL-OSC-110 D	TerraX Northbelt	-	-	-	0.049	28	170	120	<4.0	<20	<1.0	5400	<20	<5.0	8.2	1100	20	520	240	<2.0	<5.0	580	500	<10	<2.0	<75	22	1100	<1.0	<2.0	16	<10	<10	84
VL-OSC-110 S	TerraX Northbelt	49.7	0.082	49.6	0.056	31	190	100	0.067	<10	<0.60	6200	2.5	0.89	10	1200	15	480	250	<0.50	3.4	570	300	1	<0.25	<75	20	1300	<1.0	<2.0	24	<5.0	2.9	75
VL-OSG-109	TerraX Northbelt	-	-	-	0.032	13	110	63	<4.0	<20	<1.0	3300	<20	<5.0	5.3	3400	<10	910	160	<2.0	<5.0	470	520	<10	<2.0	<75	16	1200	<1.0	<2.0	90	<10	<10	53

Appendix C: Definitions for Abbreviations Found in Table A and B

Table C: Definitions for abbreviations found in Table A and B

Sample ID	Sample ID's provide some information as to where the sample was collected. The following are definitions for the acronyms used
BC20	Previous research site, small lake off Bypass Road
BERRY	Berry Hill
BPR	Bypass Road
CHAN	Chan Lake
DETR	Dettah Road
DUCK	Duck Lake
DUF	Duckfish Lake
EAST	far east of Giant Mine
HL	Handle Lake
HOML	Homer Lake
HW3	Highway 3
INGT	Ingraham Trail
LL	Landing Lake
MASL	Mason Lake
MIR	Mirage Islands
ML	Martin Lake
NDILO	Samples collected in Ndilǫ
NWC	NWC = Northwest close
NWFAR	Northwest Far
SW	Southwest
TX	TerraX Northbelt
VL	Vital Lake
YK67	Previous research site on Dettah Road
D	Duplicate of parent sample (split sample)
DC	Down core; samples taken at depth from the base of core tubes
PH	Public Health layer; samples taken at a depth of 0 to 5cm (surface samples)
NR	Not Refrigerated; sample was left at room temperature following sub-sampling and prior to submission for TOC analysis
S	Sieved; sample was sieved to <2mm prior to analysis
Area	Samples have been grouped based on their geographic location; see text for full description of each area
QAQC	**Quality Assurance Quality Control**
P	Parent sample = First sample collected at the specified location
LD	Laboratory duplicate = Duplicate analysis performed on the same sample
SS	Split sample = One sample split event into 2 samples; each sample was given a unique sample name prior to submission
S	Sieve sample = Samples were sieved to <2mm; the sieved fraction was submitted for analysis
Date	dd-mmm-yy (day - month - year)
Total Sample Depth	The depth of sample material

Table C: Definitions for abbreviations found in Table A and B

PH Layer Submitted for Analysis	The Public Health (PH) Layer is the top 5 centimeters of material. When soil samples are collected, compression occurs. Therefore, the amount of compression was calculated to determine the PH layer in the sample. The rate of compression was determined by measuring the length of the uncompressed sample divided by the length of compressed sample. The new PH layer was then determined by calculating 5 divided by the rate of compression.
Terrain	**Samples collection was focused on 4 different terrain types**
FCOSC	Forest Canopy Outcrop Soil Core
FCOSG	Forest Canopy Outcrop Soil Grab
FCSC	Forest Canopy Soil Core
FCSG	Forest Canopy Soil Grab
OSC	Outcrop Soil Core
OSG	Outcrop Soil Grab
PSC	Peat Soil Core
PSG	Peat Soil Grab
Elevation	Based on digital elevation model file of the Yellowknife area
Latitude	Decimal degrees; recorded with Garmin GPS
Longitude	Decimal degrees; recorded with Garmin GPS
Distance from Giant and Con Mine - distance was calculated based on the following equation: Distance = 6371 × acos(cos(radians(90-latitude(S))) × cos(radians(90-latitude(R)) + sin(radians(90-latitude(90-S) × sin(radians(90-latitude(R)) × cos(radians(longitude(S)-longitude(R)))) where S is the coordinate of the sample, R is the coordinate of the roaster, and 6371 is the radius of Earth	
Direction	Direction from Giant and Con Mine roasters - the value provide is the bearing (between 0 to 360°) from the location of the roaster. Direction was determined based on using the Near tool in ArcGIS with the GEODESIC option
Bedrock Geology	The subclass rock units were used for the purposes of this project. Geological units include granitoid, mafic, metamorphic, sedimentary, and volcanic (Yellowknife Greenstone Belt). Not shown as it does not appear on this map is the alkaline sub class. Source from Stubley, (2005).
Carbon	Carbon analysis was subcontracted through Analytical Services Unit (ASU) and performed at Guelph University.
Total Metals	Total metals were analyzed by Analytical Services Unit (ASU) at Queen's University by ICP-MS and ICP-OES.
Results	Data with "<" indicates the result was below the analytical detection limit Arsenic values bolded in blue text are above the Residential Guideline (GNWT, 2003). Arsenic values bolded in red text are above the Industrial Guideline (GNWT, 2003).
References	GNWT. 2003. Environmental Guideline for Contaminated Site Remediation. 39.Stubley, M.P. (2005). Bedrock Geology of the Slave Craton. Northwest Territories Geoscience Office.

Appendix D: Quality Assurance and Quality Control (QAQC) Tables

Table D-1: ASU Blanks and Standards Results

Sample	Report No.	Aluminum Al	Antimony Sb	Arsenic As	Barium Ba	Beryllium Be	Boron B	Cadmium Cd	Calcium Ca	Chromium Cr	Cobalt Co	Copper Cu	Iron Fe	Lead Pb	Magnesium Mg	Manganese Mn	Molybdenum Mo	Nickel Ni	Phosphorus P	Potassium K	Selenium Se	Silver Ag	Sodium Na	Strontium Sr	Sulphur S **	Thallium Tl	Tin Sn	Titanium Ti	Uranium U	Vanadium V	Zinc Zn
Blank	ASU15587-S1	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<25	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S1	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<25	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S1	15000	<1.0	17	300	<4.0	-	<1.0	14000	29	12	30	35000	22	13000	310	2.3	36	1100	3900	<10	<2.0	12000	59	1700	<1.0	<2.0	-	<10	68	140
MESS-3 Found	ASU15587-S1	15000	<1.0	16	300	<4.0	-	<1.0	13000	27	10	29	33000	20	12000	290	2.1	33	940	3600	<10	<2.0	10000	56	1700	<1.0	<2.0	-	<10	65	120
MESS-3 Expected	ASU15587-S1	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
Blank	ASU15587-S2	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<100	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S2	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<100	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S2	16000	<1.0	19	330	<4.0	-	<1.0	13000	30	13	31	34000	22	13000	300	2.3	39	1000	4400	<10	<2.0	12000	64	1500	<1.0	<2.0	-	<10	73	140
MESS-3 Found	ASU15587-S2	17000	<1.0	19	340	<4.0	-	<1.0	14000	33	13	32	34000	22	13000	310	2.2	40	1000	4400	<10	<2.0	12000	67	1800	<1.0	<2.0	-	<10	78	140
MESS-3 Expected	ASU15587-S2	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
Blank	ASU15587-S3	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<200	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S3	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<200	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S3	16000	<1.0	19	320	<4.0	-	<1.0	14000	29	13	31	36000	23	13000	320	2.7	37	1200	4100	<10	<2.0	12000	62	1800	<1.0	<2.0	-	<10	70	140
MESS-3 Found	ASU15587-S3	17000	<1.0	20	320	<4.0	-	<1.0	14000	32	13	33	37000	22	14000	330	2.8	38	1100	4200	<10	<2.0	12000	66	1800	<1.0	<2.0	-	<10	75	140
MESS-3 Expected	ASU15587-S3	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
															***																
Blank	ASU15587-S4	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<30	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<200	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S4	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<30	<1.0	<2.0	<5.0	<20	<20	<10	<2.0	<75	<5.0	<200	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S4	16000	<1.0	20	310	<4.0	-	<1.0	14000	30	12	29	35000	23	14000	320	2.6	36	1200	4500	<10	<2.0	12000	61	1700	<1.0	<2.0	-	<10	71	140
MESS-3 Found	ASU15587-S4	16000	<1.0	19	350	<4.0	-	<1.0	13000	35	12	29	33000	23	13000	300	<2.0	36	950	4500	<10	<2.0	11000	68	1500	<1.0	<2.0	-	<10	82	140
MESS-3 Expected	ASU15587-S4	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
		***					***		***						***					***											
Blank	ASU15587-S5	<200	<1.0	<1.0	<5.0	<4.0	<40	<1.0	<750	<20	<5.0	<5.0	<50	<10	<25	<1.0	<2.0	<5.0	<20	<50	<10	<2.0	<75	<5.0	<500	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S5	<200	<1.0	<1.0	<5.0	<4.0	<40	<1.0	<750	<20	<5.0	<5.0	<50	<10	<25	<1.0	<2.0	<5.0	<20	<50	<10	<2.0	<75	<5.0	<500	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S5	15000	<1.0	18	280	<4.0	-	<1.0	12000	27	11	29	32000	22	12000	280	2.1	33	910	3700	<10	<2.0	9600	55	1400	<1.0	<2.0	-	<10	65	130
MESS-3 Found	ASU15587-S5	16000	1.3	17	300	<4.0	-	<1.0	13000	29	11	30	36000	21	12000	290	2.1	33	940	3800	<10	<2.0	10000	57	1400	<1.0	<2.0	-	<10	69	120
MESS-3 Expected	ASU15587-S5	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
																				***											
Blank	ASU15587-S6	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<40	<10	<2.0	<75	<5.0	<500	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S6	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<40	<10	<2.0	<75	<5.0	<500	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S6	17000	1.1	18	300	<4.0	-	<1.0	13000	29	11	29	34000	20	12000	280	<2.0	33	910	4000	<10	<2.0	10000	57	1400	<1.0	<2.0	-	<10	70	120
MESS-3 Found	ASU15587-S6	16000	<1.0	18	310	<4.0	-	<1.0	13000	28	11	33	33000	21	12000	290	2	34	1000	3800	<10	<2.0	10000	58	1700	<1.0	<2.0	-	<10	71	120
MESS-3 Expected	ASU15587-S6	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
																***				***											
Blank	ASU15587-S7	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<10	<2.0	<5.0	<20	<40	<10	<2.0	<75	<5.0	<500	<1.0	<2.0	<10	<10	<10	<15
Blank	ASU15587-S7	<50	<1.0	<1.0	<5.0	<4.0	<20	<1.0	<100	<20	<5.0	<5.0	<50	<10	<20	<10	<2.0	<5.0	<20	<40	<10	<2.0	<75	<5.0	<500	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S7	16000	<1.0	17	290	<4.0	-	<1.0	15000	26	12	30	39000	22	12000	300	<2.0	35	930	3800	<10	<2.0	11000	57	1500	<1.0	<2.0	-	<10	65	130
MESS-3 Found	ASU15587-S7	16000	<1.0	17	300	<4.0	-	<1.0	13000	28	11	31	35000	20	11000	290	<2.0	33	850	3700	<10	<2.0	10000	56	1400	<1.0	<2.0	-	<10	68	120
MESS-3 Expected	ASU15587-S7	20000	1.1	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
									***											***											
Blank	ASU15587-S8	<50	<10	<1.0	<5.0	<4.0	<20	<1.0	<200	<20	<5.0	<5.0	<50	<10	<20	<1.0	<2.0	<5.0	<20	<30	<10	<2.0	<75	<5.0	<25	<1.0	<2.0	<10	<10	<10	<15
MESS-3 Found	ASU15587-S8	23000	<10	20	360	<4.0	-	<1.0	14000	37	13	34	38000	23	14000	320	2.2	39	1000	5300	<10	<2.0	11000	71	1800	<1.0	<2.0	-	<10	89	140
MESS-3 Expected	ASU15587-S8	20000	<10	18	350	<4.0	-	<1.0	14000	36	12	31	35000	19	13000	300	2.1	37	1000	4900	<10	<2.0	11000	64	1700	<1.0	<2.0	-	<10	84	130
							***																								
Blank	ASU15587-S9	<50	<1.0	<1.0	<0.5	<0.010	<10	<0.60	<100	<1.0	<0.50	<2.0	<50	<5.0	<20	<0.50	<0.50	<1.0	<20	<20	<1.0	<0.25	<75	<1.0	<25	<1.0	<2.0	<5.0	<5.0	<1.0	<5.0
MESS-4 Found	ASU15587-S9	19000	-	20	360	1.2	-	<0.60	15000	33	13	35	34000	21	13000	310	2.2	38	1000	4700	-	<0.25	10000	66	1700	-	<2.0	-	-	82	140
MESS-4 Expected	ASU15587-S9	18000	-	18	330	1.1	-	<0.60	12000	31	11	31	32000	22	11000	290	1.6	35	880	4700	-	<0.25	8100	62	1400	-	<2.0	-	-	77	130
																				***					***						
Blank	ASU15587-S10	<50	<1.0	<1.0	<0.5	<0.010	<2.0	<0.60	<100	<1.0	<0.50	<2.0	<50	<5.0	<20	<0.50	<0.50	<1.0	<20	<50	<1.0	<0.25	<75	<1.0	<250	<1.0	<2.0	<5.0	<5.0	<1.0	<5.0
Blank	ASU15587-S10	<50	<1.0	<1.0	<0.5	<0.010	<2.0	<0.60	<100	<1.0	<0.50	<2.0	<50	<5.0	<20	<0.50	<0.50	<1.0	<20	<50	<1.0	<0.25	<75	<1.0	<250	<1.0	<2.0	<5.0	<5.0	<1.0	<5.0
MESS-4 Found	ASU15587-S10	18000	-	18	350	0.99	-	<0.60	12000	30	12	36	32000	20	12000	280	2	35	880	3900	-	<0.25	8000	58	1500	-	<2.0	-	-	75	130
MESS-4 Found	ASU15587-S10	20000	-	18	370	1.1	-	<0.60	12000	33	12	35	32000	19	12000	270	2	34	860	4200	-	<0.25	7900	60	1400	-	<2.0	-	-	83	120
MESS-4 Expected	ASU15587-S10	18000	-	18	330	1.1	-	<0.60	12000	31	11	31	32000	22	11000	290	1.6	35	880	4700	-	<0.25	8100	62	1400	-	<2.0	-	-	77	130
							***																		***						
Blank	ASU16320-S1	<50	<5.0	<1.0	<0.5	<0.010	<10	<0.60	<100	<1.0	<0.50	<2.0	<50	<5.0	<20	<0.50	<0.50	<1.0	<20	<20	<1.0	<0.25	<75	<1.0	<50	<1.0	<2.0	<5.0	<5.0	<1.0	<5.0
Blank	ASU16320-S1	<50	<5.0	<1.0	<0.5	<0.010	<10	<0.60	<100	<1.0	<0.50	<2.0	<50	<5.0	<20	<0.50	<0.50	<1.0	<20	<20	<1.0	<0.25	<75	<1.0	<50	<1.0	<2.0	<5.0	<5.0	<1.0	<5.0
MESS-4 Found	ASU16320-S1	17000	-	16	320	0.99	-	-	11000	28	11	30	32000	18	11000	260	2	31	920	4000	-	-	7600	54	1400	-	-	-	-	73	120
MESS-4 Found	ASU16320-S1	20000	-	17	370	1.1	-	-	11000	32	12	35	32000	20	12000	280	2	34	1000	4300	-	-	7500	60	1500	-	-	-	-	82	130
MESS-4 Expected	ASU16320-S1	18000	-	18	330	1.1	-	-	12000	31	11	31	32000	22	11000	290	1.6	35	880	4700	-	-	8100	62	1400	-	-	-	-	77	130

Notes: MESS-3 and MESS-4 results were all within the relevant control limits. ** S results were blank subtracted (cysteine in gold). *** Detection limit raised due to interference.

Table D-2: Relative Percent Difference (RPD) results for measured As concentrations in ASU MESS-3 and MESS-4 standards.

Sample	Report No.	Arsenic Result (mg/kg)	Expected Result (mg/kg)	RPD
Certified Reference Material SS-1	ASU15587-S9	23	20.7	11%
Certified Reference Material SS-2-2	ASU15587-S9	3.3	3.36	2%
MESS-3 Found	ASU15587-S1	17	18	6%
MESS-3 Found	ASU15587-S1	16	18	12%
MESS-3 Found	ASU15587-S2	19	18	5%
MESS-3 Found	ASU15587-S2	19	18	5%
MESS-3 Found	ASU15587-S3	19	18	5%
MESS-3 Found	ASU15587-S3	20	18	11%
MESS-3 Found	ASU15587-S4	20	18	11%
MESS-3 Found	ASU15587-S4	19	18	5%
MESS-3 Found	ASU15587-S5	18	18	0%
MESS-3 Found	ASU15587-S5	17	18	6%
MESS-3 Found	ASU15587-S6	18	18	0%
MESS-3 Found	ASU15587-S6	18	18	0%
MESS-3 Found	ASU15587-S7	17	18	6%
MESS-3 Found	ASU15587-S7	17	18	6%
MESS-3 Found	ASU15587-S8	20	18	11%
MESS-4 Found	ASU15587-S9	20	18	11%
MESS-4 Found	ASU15587-S10	18	18	0%
MESS-4 Found	ASU15587-S10	18	18	0%
MESS-4 Found	ASU16320-S1	16	18	12%
MESS-4 Found	ASU16320-S1	17	18	6%
Notes: MESS-3 and MESS-4 results were all within the relevant control limits.				

Table D-3: EnviroMAT Certified Reference Material - Reference Values, Confidence Intervals and Tolerance Intervals

Element Name	Element Symbol	EnviroMAT Contaminated Soil (SS - 1)[1]			EnviroMAT Contaminated Soil (SS - 2 - 2)[2]		
		Reference Value (mg/kg)	Confidence Interval (mg/kg)	Tolerance Interval (mg/kg)	Reference Value (mg/kg)	Confidence Interval (mg/kg)	Tolerance Interval (mg/kg)
Silver	Ag	0.88	0.85 – 0.91	0.72 – 1.04	3.9	3.6 – 4.1	1.8 – 6.0
Aluminum	Al	12 163	11 753 – 12 572	9 579 – 14 746	9548	9254 – 9842	7060 – 12036
Arsenic	As	20.7	19.7 – 21.8	14.0 – 27.5	3.36	3.18 – 3.53	1.77 – 4.94
Boron	B	26.9	18.5 – 35.2	0.0 – 77.8	8.5	8.1 – 9.0	5.9 – 11.1
Barium	Ba	464	448 – 480	359 – 569	100	98 – 102	80 – 119
Beryllium	Be	0.48	0.43 – 0.53	0.22 – 0.74	0.34	0.33 – 0.36	0.25 – 0.44
Calcium	Ca	50 265	49 052 – 51 478	42 222 – 53 308	31082	30519 – 31645	26317 – 35847
Cadmium	Cd	3.2	3.0 – 3.5	1.8 – 4.7	0.91	0.88 – 0.94	0.65 – 1.17
Cesium	Ce	(40.1)	-	-	-	-	-
Cobalt	Co	12.9	12.5 – 13.4	10.2 – 15.7	6.9	6.6 – 7.2	4.0 – 9.8
Chromium	Cr	103	97.9 – 109	66.6 – 140	92.6	88.4 – 96.7	54.2 – 131
Copper	Cu	403	393 – 413	334 – 472	120	118 - 122	99 – 141
Iron	Fe	72 00	69 728 – 74 273	57 212 – 86 789	23083	22486 - 23680	17 888 – 28278
Mercury	Hg	0.41	0.39 – 0.43	0.29 – 0.53	0.059	0.055 – 0.063	0.034 – 0.084
Potassium	K	2232	2082 – 2382	1257 – 3208	1671	1584 – 1758	907 – 2435
Lithium	Li	14.3	12.9 – 15.8	6.4 – 22.3	9.5	8.8 – 10.1	5.9 – 13.1
Magnesium	Mg	9690	9459 – 9920	8141 – 11 239	5132	4975 – 5290	3798 – 6467
Manganes	Mn	737	718 – 756	605 – 869	252	245 – 258	191 – 313
Molybdenu	Mo	6.8	6.5 – 7.2	4.7 – 9.0	1.03	0.99 – 1.07	0.69 – 1.38
Sodium	Na	650	587 – 714	235 – 1066	797	760 – 833	486 – 1107
Nickel	Ni	59.2	57.9 – 60.5	50.4 – 68.0	25.1	24.5 – 25.6	19.6 – 30.6
Phosphoru	P	1552	1518 – 1586	1329 – 1775	752	735 – 770	614 – 891
Lead	Pb	764	749 – 779	665 – 863	244	239 – 250	192 – 297
Sulphur	S	1916	1776 – 2057	1045 – 2787	550	525 – 574	395 – 705
Antimony	Sb	5.5	4.4 – 6.6	0.0 – 12.0	3.5	3.1 – 3.8	0.5 – 6.4
Selenium	Se	0.78	0.64 – 0.92	0.02 – 1.54	0.49	0.39 – 0.58	0 – 1.04
Tin	Sn	340	324 – 357	245 – 436	10.6	10.1 – 11.0	7.1 – 14.1
Strontium	Sr	114	113 - 116	106 – 122	80	77 – 82	60 – 99
Titanium	Ti	530	473 – 587	195 – 865	-	-	-
Thallium	Tl	(0.19)	-	-	0.084	0.078 – 0.089	0.054 – 0.114
Uranium	U	0.78	0.74 – 0.81	0.61 – 0.94	0.52	0.50 – 0.54	0.40 – 0.64
Vanadium	V	27.2	25.9 – 28.6	18.8 – 35.7	30	29.2 – 30.7	23.7 – 36.3
Zinc	Zn	1114	1078 – 1151	860 – 1369	281	274 – 288	220 – 342

Note: Values in brackets are not certified. Listed only for information.

[1] SCP Science. 2016. *Analysis Report: Matrix Reference Material EnviroMAT Contaminated Soil (SS-1)* . Certificate of Analysis.

[2] SCP Science. 2016. *Analysis Report: Matrix Reference Material EnviroMAT Contaminated Soil (SS-2)* . Certificate of Analysis.

Table D-4: ASU Results for EnviroMAT Certified Reference Materials (SS-1 and SS-2-2)

Parameter	DL	Consensus Values	ASU Report: ASU15587-S9		Consensus Values	ASU Report: ASU15587-S9	
		Certified Reference Material SS-1 [1]	Certified Reference Material SS-1	Relative Percent Difference	Certified Reference Material SS-2-2 [2]	Certified Reference Material SS-2-2	Relative Percent Difference
Gold	<0.01	-	0.098	-	-	0.12	-
Aluminum	<1	12163	15000	21%	9548	11000	14%
Antimony	<75	5.5	9.5	53%	3.5	5.4	43%
Arsenic	<1	20.7	23	11%	3.36	3.3	2%
Barium	<0.01	464	500	7%	100	120	18%
Beryllium	<10	0.48	0.6	22%	0.34	0.43	23%
Boron	<0.5	26.9	33	20%	8.5	18	72%
Cadmium	<100	3.2	2.5	25%	0.91	0.9	1%
Calcium	<0.6	50265	56000	11%	31082	38000	20%
Chromium	<0.5	103	110	7%	92.6	120	26%
Cobalt	<1	12.9	17	27%	6.9	11	46%
Copper	<2	403	450	11%	120	140	15%
Iron	<50	72000	83000	14%	23083	26000	12%
Lead	<1	764	760	1%	244	270	10%
Magnesium	<20	9690	11000	13%	5132	6500	24%
Manganese	<0.5	737	870	17%	252	350	33%
Molybdenum	<0.5	6.8	6.9	1%	1.03	1.1	7%
Nickel	<20	59.2	64	8%	25.1	29	14%
Phosphorus	<20	1552	1600	3%	752	770	2%
Potassium	<5	2232	2900	26%	1671	1900	13%
Selenium	<1	0.78	<1.0	-	0.49	<1.0	-
Silver	<50	0.88	0.84	5%	3.9	6.4	49%
Sodium	<1	650	650	0%	797	800	0%
Strontium	<1	114	120	5%	80	94	16%
Sulphur	<0.25	1916	1900	1%	550	630	14%
Thallium	<5	0.19	<1.0	-	0.084	<1.0	-
Tin	<25	340	350	3%	10.6	10	6%
Titanium	<2	530	810	42%	-	1600	-
Uranium	<5	0.78	<15	-	0.52	<5.0	-
Vanadium	<1	27.2	35	25%	30	41	31%
Zinc	<5	1114	1100	1%	281	290	3%

[1] SCP Science. 2016. Analysis Report: Matrix Reference Material EnviroMAT Contaminated Soil (SS-1). Certificate of Analysis.

[2] SCP Science. 2016. Analysis Report: Matrix Reference Material EnviroMAT Contaminated Soil (SS-2-2). Certificate of Analysis.

Table D-5: Relative Percent Difference (RPD) results for measured As concentrations in Lab Duplicates**.**

Sample ID	QAQC	Sample Type	Depth Control	Detection Limit (µg/g)	Arsenic Parent Result (µg/g)	Arsenic QAQC Result (µg/g)	RPD
EAST2-FCSC-66	LD	Core	DC	1	4.6	4.5	2%
HW3-OSC-136	LD	Core	DC	1	3.7	2.9	**24%**
TX-FCOSC-150	LD	Core	DC	1	18	18	0%
TX-FCOSC-155	LD	Core	DC	1	7.1	5.9	18%
BPR-PSG-19.2	LD	Grab	DC	1	130	150	14%
BPR-OSG-11 D	LD	Grab	ND	1	510	480	6%
BPR-OSG-11	LD	Grab	ND	1	610	610	0%
BPR-PSG-19.1	LD	Grab	ND	1	730	680	7%
DETR-OSG-36 D	LD	Grab	ND	1	82	52	**45%**
INGT-OSG-47	LD	Grab	ND	1	98	99	1%
INGT-OSG-47 S	LD	Grab	ND	1	120	120	0%
NWC3-OSG-84	LD	Grab	ND	1	150	59	**87%**
VL-FCOSG-112	LD	Grab	ND	1	38	37	3%
TX-OSG-152 D	LD	Grab	ND	1	210	230	9%
BPR-FCSC-14	LD	Core	PH	1	500	420	17%
BPR-FENC-18	LD	Core	PH	1	120	110	9%
INGT-OSC-39	LD	Core	PH	1	21	21	0%
INGT-FCSC-50	LD	Core	PH	1	27	26	4%
INGT-OSC-52	LD	Core	PH	1	47	37	**24%**
DUF-PSC-53	LD	Core	PH	1	65	44	**39%**
HOML-FCSC-56 D	LD	Core	PH	1	25	27	8%
EAST2-PSC-68	LD	Core	PH	1	20	15	**29%**
MASL-OSC-65	LD	Core	PH	1	87	96	10%
NWC1-FCSC-82	LD	Core	PH	1	250	270	8%
HW3-FCSC-124	LD	Core	PH	1	12	10	18%
HW3-FCSC-125	LD	Core	PH	1	3.2	3.5	9%
HW3-FCSC-131	LD	Core	PH	1	6.6	8.4	**24%**
TX-FCOSC-150	LD	Core	PH	1	53	54	2%
BC20-PSC-164.1	LD	Core	PH	1	480	470	2%
MIR-FCG-02 D	LD	Grab	PH	1	2.8	2.6	7%
BERRY-OSG-63S	LD	Grab	PH	1	93	110	17%

Table D-6: Relative Percent Difference (RPD) results for measured As concentrations in Split Samples

Sample ID	QAQC	Sample Type	Depth Control	Detection Limit (ug/g)	Arsenic Parent Result (µg/g)	Arsenic QAQC Result (µg/g)	RPD
BPR-FCSC-02 D	SS	Core	DC	1	29	30	3%
DETR-FCSC-38 D	SS	Core	DC	1	5.4	6.2	14%
ML-OSC-98 D	SS	Core	DC	1	29	35	19%
TX-FCSC-144 D	SS	Core	DC	1	44	43	2%
BPR-PSC-161B D	SS	Core	DC	1	240	220	9%
BPR-PSC-161C D	SS	Core	DC	1	1200	1100	9%
BPR-PSG-08 D	SS	Grab	DC	1	31	32	3%
LL-PSG-117.2 D	SS	Grab	DC	1	19	21	10%
BPR-OSG-11 D	SS	Grab	ND	1	610	510	18%
BPR-OSG-15 D	SS	Grab	ND	1	130	110	17%
DETR-OSG-36 D	SS	Grab	ND	1	150	82	**59%**
INGT-FCOSG-46 D	SS	Grab	ND	1	240	270	12%
INGT-FENG-43 D	SS	Grab	ND	1	200	200	0%
EAST2-OSG-67 D	SS	Grab	ND	1	22	26	17%
NWC2-OSG-79 D	SS	Grab	ND	1	84	93	10%
TX-OSG-149 D	SS	Grab	ND	1	70	73	4%
TX-OSG-152 D	SS	Grab	ND	1	210	210	0%
BPR-OSC-01 D	SS	Core	PH	1	1800	1500	18%
NDILO-OSC-23 D	SS	Core	PH	1	220	230	4%
INGT-FCSC-40 D	SS	Core	PH	1	3.6	3.7	3%
INGT-FENC-51 D	SS	Core	PH	1	84	160	**62%**
HOML-FCSC-56 D	SS	Core	PH	1	26	25	4%
HOML-PSC-58 D	SS	Core	PH	1	19	23	19%
BPR-OSC-92 D	SS	Core	PH	1	600	630	5%
BPR-OSC-93 D	SS	Core	PH	1	2300	2200	4%
VL-OSC-110 D	SS	Core	PH	1	130	170	**27%**
LL-OSC-118 D	SS	Core	PH	1	120	88	**31%**
LL-OSC-119 D	SS	Core	PH	1	95	110	15%
INGT-FCSC-122 D	SS	Core	PH	1	15	16	6%
INGT-OSC-142 D	SS	Core	PH	1	16	16	0%
BPR-PSC-161 D	SS	Core	PH	1	3400	4900	**36%**
BC20-FCSC-163 D	SS	Core	PH	1	110	81	**30%**
MIR-FCG-02 D	SS	Grab	PH	1	3.8	2.8	**30%**
MIR-PSG-03 D	SS	Grab	PH	1	2.9	2.8	4%

Table D-7: Aluminum core fragment results.

Parameter	Units	Aluminum Sample 1	Aluminum Sample 2	Aluminum Sample 3	Average
Ag	ug/g	<0.25	<0.25	<0.25	NA
Al	ug/g	850000	810000	850000	836667
As	ug/g	<1.0	<1.0	<1.0	NA
B	ug/g	16	13	14	14
Ba	ug/g	1.1	0.78	0.86	1
Be	ug/g	0.044	0.037	0.039	0
Ca	ug/g	<100	<100	<100	NA
Cd	ug/g	<10	<10	<10	NA
Co	ug/g	1.1	0.96	1.0	1
Cr	ug/g	680	650	680	670
Cu	ug/g	2100	1600	2100	1933
Fe	ug/g	2300	2100	2200	2200
K	ug/g	<20	<20	<20	NA
Mg	ug/g	9400	8900	9400	9233
Mn	ug/g	260	220	230	237
Mo	ug/g	2.8	2.7	2.9	3
Na	ug/g	<75	<75	<75	NA
Ni	ug/g	49	41	49	46
P	ug/g	<150	<150	<150	NA
Pb	ug/g	<10	<10	<10	NA
S	ug/g	36	25	30	30
Sb	ug/g	<15	<15	<15	NA
Se	ug/g	<10	<10	<10	NA
Sn	ug/g	<5.0	<5.0	3.6	4
Sr	ug/g	<1.0	<1.0	<1.0	NA
Ti	ug/g	120	110	120	117
Tl	ug/g	<1.0	<1.0	<1.0	NA
U	ug/g	<5.0	<5.0	<5.0	NA
V	ug/g	110	110	110	110
Zn	ug/g	89	75	80	81

Appendix E: SEM Reference Material – Settings used for SEM scans, and Mineral Reference Library Data

Table E-1: Settings used during SEM scans

SEM Run	Samples	Settings				
					Kilocounts Per Second	Down Time (%)
1	TX-152 A	Brightness	84.2	Left Detector	262	31
	TX-152 B	Contrast	19.9	Right Detector	NA	NA
	BERRY-63	Working Distance	12.51			
	BERRY-62 PH	Grey Level	244			
		Acquisition Time	NA			
2	TX-155 DC	Brightness	83.9	Left Detector	187	24
	HW3-133 PH	Contrast	27.7	Right Detector	184	23
	ML-103 PH A	Working Distance	12.42			
	HOML-57	Grey Level	246			
	TX-144 PH A	Acquisition Time	NA			
	TX-144 PH B					
	ML-103 PH B					
	TX-152 C					
3	DETR-34 PH	Brightness	83.9	Left Detector	123	16
	NDILO-23 PH A	Contrast	31.4	Right Detector	122	16
	BPR-14 DC	Working Distance	11.88			
	BPR-14 PH	Grey Level	247			
	DETR-38 PH	Acquisition Time	30			
	BPR-01 PH					
	NDILO-25 PH					
	BPR-22 PH					
	LL-106 PH					
	ML-97 PH					
	LL-120 PH					
	NDILO-23 PH B					
	TX-155 PH					
	TX-151 PH					
4	INGT-28 DC	Brightness	83.8	Left Detector	169	22
	YK67-06 DC	Contrast	28.7	Right Detector	165	21
	YK67-06 PH	Working Distance	12.15			
	HW3-135 DC	Grey Level	248			
	EAST2-66 DC	Acquisition Time	10			
	INGT-39 PH					
	INGT-28 PH					
	ML-103 PH C					
	SW3-89 PH					
	MASL-65 PH					
	ML-98 PH					
	BPR-161 DC					
	VL-110 PH					
	BPR-161 PH					
5	LL-120 DC	Brightness	83.9	Left Detector	152	19
	ML-98 DC	Contrast	31.1	Right Detector	151	18
	INGT-51 PH	Working Distance	13.7			
	ML-97 PH D	Grey Level	250			
	NWC3-86 PH	Acquisition Time	10			
	DETR-37 PH					
	EAST2-66 PH					
	HW3-135 PH					
	BPR-93 PH					
	INGT-46 G					
	INGT-51 PH B					
	DUF-54 PH					
	LL-117 PH					
	BPR-160 PH *					
6	BPR-160 PH *	Brightness	83.8	Left Detector	151	19
	VL-108 PH	Contrast	29.9	Right Detector	149	18
	BPR-18 PH	Working Distance	12.4			
	TX-145 PH	Grey Level	246			
	NWC1-82 PH	Acquisition Time	NA			
	BPR-14 DC D					
	NDILO-25 PH D					
	MIR-01 PH					
	HOML-58 PH					
	TX-145 DC					

* Sample was half-scanned in SEM run 5, and finished scanning in SEM run 6

Table E-2: Mineral Reference Library - Mineral phases, densities, z-values, formulas, compositions, and spectra included for each phase. Notes and assumptions pertain to the source of information for each mineral and any assumptions used in defining the relative percentage of elements contained in each mineral phase.

Mineral/Bin	Density	Z	Formula	Composition	Spectra Included	Notes/Assumptions:
Carbon	2.16	6	C	C (100%)	2 (Carbon with other mixed elements)	Used values for graphite (primary form of carbon in sample)
Aluminum	2.7	13	Al	Al (100%)	Collected Al contamination	Values from FEI reference library
Gold	19.32	79	Au	Au (100%)	Native Gold (collected)	Density from online source, other values from FEI reference library
Silver	10.5	47	Ag	Ag (100%)	Native Silver (collected)	Values from FEI reference library
Ankerite	3.05	13.42	Ca(Fe,Mg,Mn)(CO3)2	C (11.71%), O (46.80%), Mg (3.95%), Ca (19.54%), Mn (8.93%), Fe (9.08%)	Ankerite (2)	Composition / values from Ankerite (reference library)
Calcite	2.71	12.57	CaCO3	Ca(40.05%), C (12%), O (47.96%)	Calcite, Calcite Mix	From past libraries (Golder Library), and FEI reference
Dolomite	2.85	10.87	CaMg(CO3)2	C (13.03%), O (52.06%), Mg (13.18%), Ca (21.73%)	Dolomite	From FEI reference library
Plagioclase	2.69	11.38	Na0.5Ca0.5Si3AlO8	O (47.28%), Na (4.24%), Al (9.96%), Si (31.12%), Ca (7.40%)	Plagioclase (2)	From past libraries (Golder Library)
Albite	2.62	10.77	NaAlSi3O8	O (48.66%), Na (8.30%), Al (10.77%), Si (31.50%), Ca (0.76%)	Albite (2)	From past libraries (Golder Library)
Orthoclase	2.56	11.85	KAlSi3O8	O (45.99%), Al (9.69%), Si (30.28%), K (14.04%)	Orthoclase (2)	From past libraries (Golder Library)
Muscovite	2.83	11.33	KAl3Si3O10(OH)1.9F0.1	K (9.81%), Al (20.31%), Si (21.14%), O (47.78%), H (0.48%), F (0.48%)	Muscovite (2), Ti-Muscovite (1)	Values for Muscovite (FEI reference library) used
Illite	2.75	10.87	K0.6(H3O)0.4Al1.3Mg0.3Fe2+0.1Si3.5O10(OH)2 ·(H2O)	K (6.03%), H (1.35%), O (55.06%), Al (9.01%), Mg (1.87%), Fe (1.43%), Si (25.25%)	Illite (2)	One from CM library, other collected from BPR-22 Unknown
Phlogopite	2.8	11.28	KMg3AlSi3O10(OH)F	K (9.33%), Mg (17.39%), Al (6.44%), Si (20.10%), O (41.98%), H (0.24%), F (4.53%)	Phlogopite (2)	From CM library
Biotite	3.1	12.17	KMg2.5Fe2+0.5AlSi3O10(OH)1.75F0.25	K (9.02%), Mg (14.02%), Fe (6.44%), Al (6.22%), Si (19.43%), O (43.36%), H (0.41%), F (1.10%)	Biotite	FEI reference library
Chlorite	2.95	13.97	(Mg,Fe)3(Si,Al)4O10(OH)2·(Mg,Fe)3(OH)6	H (1.25%), O (44.53%), Al (8.34%), Si (8.69%), Mg (11.28%), Fe (25.91%)	Chlorite, Mn-Chlorite	From past libraries (Golder)
Amphiboles	2.9	12.88	Ca2(Mg,Fe,Al)5(Al,Si)8O22(OH)2	Ca (9.27%), Mg (4.68%), Fe (10.76%), Al (17.68%), Si (12.99%), O (44.39%), H (0.23%)	Hornblende/Augite (3), 1 spectra from AB library	Values for Hornblende (FEI ref lib.) used
Quartz	2.63	10.8	(SiO2)	O (53.26%), Si (46.74%)	Quartz/Quartz Mix (6), Silica, Collected Rhombic Hollow Circles (2)	Values from FEI reference library
Epidote	3.45	12.91	Ca2Al2(Fe3+,Al)(SiO4)(Si2O7)O(OH)	Ca (17.10%), Al (14.39%), Fe (5.96%), Si (17.97%), O (44.37%), H (0.22%)	Epidote	Values from FEI reference library, Spectra from past libraries (Golder Library)
Andalusite	3.15	10.71	Al2SiO5	O (49.36%), Al (33.30%), Si (17.33%)	Andalusite	Values from FEI reference library, Spectra from past libraries (Golder Library)
Olivine	3.32	12.74	Mg1.6Fe2+0.4(SiO4)	O (41.75%), Mg (25.37%), Si (18.31%), Fe (14.57%)	Olivine	Values from FEI reference library
Enstatite	3.2	10.65	Mg2Si2O6	O (47.81%), Mg (24.21%), Si (27.97%)	Enstatite	Values from FEI reference library, Spectra from past libraries (Golder Library)
Ferrosilite	3.95	14.2	Fe2+MgSi2O6	O (41.33%), Mg (10.46%), Si (24.17%), Fe (24.03%)	Ferrosilite	Values from FEI reference library
Zircon	4.65	24.84	ZrSiO4	O (34.91%), Si (15.32%), Zr (49.76%)	Zirconium, 1 collected spectra	Values from FEI reference library
Anhydrite	2.97	13.42	Ca(SO4)	O (47.01%), S (23.55%), Ca (29.44%)	Anhydrite	Values from FEI reference library

Gypsum	2.3	12.12	Ca(SO4)·2(H2O)	H (2.34%), O (55.76%), S (18.62%), Ca (23.27%)	Gypsum (Clare's library)	Values from FEI reference library
Barite	4.48	37.34	Ba(SO4)	O (27.42%), S (13.73%), Ba (58.85%)	Barite, 3 collected spectra (bright white spots in organic material)	Values from FEI reference library
Phosphates	3.19	14.22	Ca5(PO4)(F,Cl,OH)	H (0.06%), O (38.76%), F (1.24%), P (18.25%), Cl (2.32%), Ca (39.37%)	Apatite, Monazite	Values for Apatite (FEI ref lib.) used, Spectra from past libraries (Golder Library)
Pyrrhotite	4.62	22.23	Fe2+0.95S	S (37.67%), Fe (62.33%)	Pyrrhotite	Values & Spectra from FEI reference library
Pyrite	5.01	20.65	Fe2+S2	S (53.46%), Fe (46.54%)	Pyrite	Values & Spectra from FEI reference library
Chalopyrite	4.2	23.54	CuFeS2	S (34.94%), Fe (30.43%), Cu (34.62%)	Chalcopyrite	Values & Spectra from FEI reference library
Covellite	4.68	24.64	CuS	S (33.53%), Cu (66.47%)	Covellite	Values & Spectra from FEI reference library
Diopside	3.4	12.23	CaMg(Si2O6)	O (44.33%), Mg (11.22%), Si (25.94%), Ca (18.51%)	Diopside	Values & Spectra from FEI reference library
Cuprite	6.1	26.65	Cu2O	O (11.18%), Cu (88.82%)	Cuprite	Values & Spectra from FEI reference library
Sphalerite	4.05	25.26	(Zn, Fe)S	S (33.07%), Fe (2.87%), Zn(64.06%)	Sphalerite, Sphalerite with L, M & H Fe (3)	Values from Sphalerite with loFe, Spectra from FEI reference library
Galena	7.4	73.16	PbS	S (13.40%), Pb (86.60%)	Galena	Values & Spectra from FEI reference library
Pentlandite	4.8	23.36	Fe4.5Ni4.5S8	S (33.23%), Fe (32.55%), Ni(34.22%)	Pentlandite	Values & Spectra from FEI reference library
Stibnite	4.63	41.09	Sb2S3	S (28.32%), sb (71.68%)	Stibnite	Values & Spectra from FEI reference library
Ti - bearing Minerals	4.72	16.71	SiO2Fe2+TiO3	Fe (26.36%), Ti (22.61%), O(37.76%), Si (13.26%)	Ilmenite, Ilmenorutile, Rutile, Ti-Bearing Collected Spectra (2 - Jon's samples)	Values and Spectra from combination of FEI reference library and past Golder Library - mixed formula SiO + Titanite
Zinc Oxide	5.56	25.67	ZnO	Zn (80.34%), O (19.66%)	Spectrum collected from DETR34PH sample	Average density for Zincite ([Zn,Mn]O), calculated Z from formula in MLA
Vanadium Bearing	2.83	17.99	VS4	V (28.43%), S (71.57%)	Collected by Jon	Values for Patronite used (VS4), calculated composition and Z from patronite formula and density
Pb Contamination	11.37	82	Pb	Pb (100%)	1 Collected	Spectrum collected on using SEM
NiCr Contamination	8.8	26.08	CrFeNi	Ni (35.25%), Cr (31.22%), Fe(33.53%)	1 Collected	Formula for NiCr alloy - common use = steel
Salts	2.17	14.64	NaCl	Na (39.33%), Cl (60.67%)	NaCl (1), CaCl (1)	Denisty and Z values for Halite (from FEI ref lib.) used
Garnet / Mixed Spectra	4.2	15.62	Fe2+3Al2(SiO4)3	O (38.58%), Al (10.84%), Si(16.92%), Fe (33.66%)	Almandine	From FEI reference library - used for garnet and mixed spectra - difficult to distinguish between the two and lots of mixed spectras happening
Organic Phases (no As)	0.5	17.14	CaCO3+FeS	Ca (21.32%), C (6.39%), O (25.53%), Fe (29.71%), S (17.06%)	7 Collected spectra (Woody organics, and sinewy leaf like structures from various samples)	Mixed spectra collected from organics in samples - pieces of bark, roots and leaves, mixed with other elements
CaOx Mix, no As	3.35	15.41	CaO+Al	Ca (48.25%), O ()19.26%), Al(32.48%)	CaO mixed spectra (1)	Density for CaO from online soucrce, calculated Z value based on formula created in MinRef Library editor

MnOx	4.73	18.74	Mn4+O2	Mn (63.19%), O (36.81%)	One collected spectra	Used values for pyrolusite (common MnOx mineral) from FEI reference library
Organics + FeOx, no As	3	14.59	C5FeO(OH)	C (35.09%), Fe (40.80%), O(23.37%), H (0.74%)	One mixed spectra used from golder library	Used formula from golder library for C + goethite
FeOx - no As	4.9	20.59	Fe3+2O3	O (30.05%), Fe (69.95%)	6 spectra from Agatha's collected working library spectrum	Used values for Maghemite from FEI reference library
Enargite	4.45	25.53	Cu3AsS4	S (32.57%), Cu (48.41%), As(19.02%)	Enargite	Values & Spectra from FEI reference library
Arsenopyrite	6.07	27.25	Fe3+AsS	S (19.69%), Fe (34.29%), As(46.01%)	Arsenopyrite	Values & Spectra from FEI reference library
Realgar	3.56	27.91	As4S4	As (70.03%), S (29.97%)	Realgar - from past library	Values from FEI reference library
Arsenolite	3.7	26.93	As2O3	As (75.74%), O (24.26%)	From past library (Golder)	Values from FEI reference library
As-bearing Pyrite	5.01	20.81	Fe2+As0.011S2	S (53.09%), Fe (46.23%), As(0.68%)	From past library (Golder)	Density value for Pyrite, Z calculated from formula, Chryssoulis avg for As in pyrite grains = 0.68%
MnOx + MnOx Mix, no	4	13.76	AlO(OH)Mn3+0.5O(OH)Ca0.15Fe0.1	O (48.46%), Mn (20.80%), Al(20.43%), H (1.53%), Ca (4.55%),Fe (4.23%)	Collected spectra from rims of woody organics (2), Mix spectra from past golder library (1)	Used formula from past golder mixed spectra for best estimate
MnOx Mix, with As	4	22.11	AlMnFe0.25As0.04	Al (27.29%), Mn (55.56%), Fe(14.12%), As (3.03%)	Collected spectra (2), Spectra from past library (1)	Assumed 3 wt.% arsenic in MnOx mixes
FeOx - with As	4.9	20.97	Fe3+2O3(As0.068)	O (29.13%), Fe (67.78%), As(3.09%)	3 spectra from past golder library, 1 from coblat library	Used formula for maghemite and added arsenic (from FEI reference library)
FeOx Mix, with As	4	21.72	Fe2O2(OH)As0.115Ca1.35Mn1.1	Fe (39.35%), As (3.04%), Ca(19.06%), Mn (21.29%), O(16.91%), H (0.36%)	4 spectra from past libraries, various mixes: Mg-MnCa-FeOx + As, Mg-Al-Ca-FeOx + As, FeMnOx+ As (2)	Mixed spectra, used existing formula from past library and edited to assume approx. 3 wt.% arsenic within phases as per past studies (Walker Chris Bailey)
Organics + FeOx, with A	3	14.64	C5FeO(OH)As0.065Ca0.1	C (38.06%), Fe (35.40%), O(20.28%), H (0.64%), As (3.09%),Ca (2.54%)	3 from past libraries (1 from CM library)	Used formula for C+Geothite+As(constructed for golder report, edited to contain 3 wt.% As as per assumptions)
Fe-Ca Arsenate	3.92	18.16	Ca2Fe3+3(AsO4)3O2-3H20	Ca (13.43%), Fe (28.06%), As(14.93%), O (40.20%), H (3.38%)	Fe-Ca Arsenate (1)	From cobalt library
Scorodite	3.27	20.35	FeAsO4·2H2O	Fe (24.20%), As (32.46%), O(41.59%), H (1.75%)	From Jon's library (collected after microprobe use)	Density from online source (Mindat), Z calculated from composition
Unknown	-	-	-	-	-	-
No_Xray	-	-	-	-	-	-
Low_Counts	-	-	-	-	-	-
TOTAL PHASES	64					

Appendix F: Table Used to Complete Weight Percent Calculations for As-bearing Phases Identified by SEM / AM in PHL Samples

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

	Mineral Phase	Enargite	Arsenolite	Scorodite	MnOx Mix, with As	FeOx/FeOx Mix, with As	Organics + FeOx, with As	Fe-Ca Arsenate	Arsenopyrite	Realgar	As-Bearing Pyrite	Total Mass of As in Each Sample	Total As Results (ASU) (mg/kg)
	Density (g/cm^3)	**4.45**	**3.70**	**3.27**	**4.00**	**4.50**	**3.00**	**3.92**	**6.07**	**3.56**	**5.01**		
	Density (g/m^3)	**4450000**	**3700000**	**3270000**	**4000000**	**4500000**	**3000000**	**3920000**	**6070000**	**3560000**	**5010000**		
	wt % As in each Phase	**0.19**	**0.76**	**0.32**	**0.03**	**0.03**	**0.03**	**0.15**	**0.46**	**0.70**	**0.0068**		
BPR-OSC-01PH	Area (micron)	0.00	2229.51	0.00	0.00	223.53	487.84	0.00	0.00	125.24	0.00		
	Area (m)	0.00E+00	2.23E-03	0.00E+00	0.00E+00	2.24E-04	4.88E-04	0.00E+00	0.00E+00	1.25E-04	0.00E+00		
	Volume (m^3)	0.00E+00	2.23E-09	0.00E+00	0.00E+00	2.24E-10	4.88E-10	0.00E+00	0.00E+00	1.25E-10	0.00E+00		
	Mass of each phase	0.00E+00	8.25E-03	0.00E+00	0.00E+00	1.01E-03	1.46E-03	0.00E+00	0.00E+00	4.46E-04	0.00E+00		
	Mass As in each phase	0.00E+00	6.27E-03	0.00E+00	0.00E+00	3.02E-05	4.39E-05	0.00E+00	0.00E+00	3.12E-04	0.00E+00	**6.66E-03**	
	Total As in each phase (wt. %)	0.00	0.94	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.00		
	Total As in each phase (mg/kg)	**0.00**	**1695.56**	**0.00**	**0.00**	**8.16**	**11.87**	**0.00**	**0.00**	**84.41**	**0.00**		**1800**
BPR-FCSC-14PH	Area (micron)	0.00	10557.02	0.00	4424.06	12346.02	5149.27	0.00	0.00	319.65	1568.37		
	Area (m)	0.00E+00	1.06E-02	0.00E+00	4.42E-03	1.23E-02	5.15E-03	0.00E+00	0.00E+00	3.20E-04	1.57E-03		
	Volume (m^3)	0.00E+00	1.06E-08	0.00E+00	4.42E-09	1.23E-08	5.15E-09	0.00E+00	0.00E+00	3.20E-10	1.57E-09		
	Mass of each phase	0.00E+00	3.91E-02	0.00E+00	1.77E-02	5.56E-02	1.54E-02	0.00E+00	0.00E+00	1.14E-03	7.86E-03		
	Mass As in each phase	0.00E+00	2.97E-02	0.00E+00	5.31E-04	1.67E-03	4.63E-04	0.00E+00	0.00E+00	7.97E-04	5.34E-05	**3.32E-02**	
	Total As in each phase (wt. %)	0.00	0.89	0.00	0.02	0.05	0.01	0.00	0.00	0.02	0.00		
	Total As in each phase (mg/kg)	**0.00**	**447.12**	**0.00**	**8.00**	**25.10**	**6.98**	**0.00**	**0.00**	**12.00**	**0.80**		**500**
BPR-FENC-18PH	Area (micron)	0.00	0.00	0.00	0.00	1389.25	362.60	0.00	0.00	53.15	321.10		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-03	3.63E-04	0.00E+00	0.00E+00	5.32E-05	3.21E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-09	3.63E-10	0.00E+00	0.00E+00	5.32E-11	3.21E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.25E-03	1.09E-03	0.00E+00	0.00E+00	1.89E-04	1.61E-03		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-04	3.26E-05	0.00E+00	0.00E+00	1.32E-04	1.09E-05	**3.64E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.52	0.09	0.00	0.00	0.36	0.03		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**61.90**	**10.77**	**0.00**	**0.00**	**43.72**	**3.61**		**120**
BPR-OSC-22PH	Area (micron)	0.00	219.16	0.00	495.12	712.83	111.40	0.00	0.00	13.83	27.67		
	Area (m)	0.00E+00	2.19E-04	0.00E+00	4.95E-04	7.13E-04	1.11E-04	0.00E+00	0.00E+00	1.38E-05	2.77E-05		
	Volume (m^3)	0.00E+00	2.19E-10	0.00E+00	4.95E-10	7.13E-10	1.11E-10	0.00E+00	0.00E+00	1.38E-11	2.77E-11		
	Mass of each phase	0.00E+00	8.11E-04	0.00E+00	1.98E-03	3.21E-03	3.34E-04	0.00E+00	0.00E+00	4.93E-05	1.39E-04		
	Mass As in each phase	0.00E+00	6.16E-04	0.00E+00	5.94E-05	9.62E-05	1.00E-05	0.00E+00	0.00E+00	3.45E-05	9.43E-07	**8.17E-04**	
	Total As in each phase (wt. %)	0.00	0.75	0.00	0.07	0.12	0.01	0.00	0.00	0.04	0.00		
	Total As in each phase (mg/kg)	**0.00**	**354.37**	**0.00**	**34.16**	**55.33**	**5.77**	**0.00**	**0.00**	**19.82**	**0.54**		**470**
BPR-OSC-93 PH	Area (micron)	0.00	6649.20	0.00	71.36	1384.89	2050.39	0.00	0.00	155.82	41.50		
	Area (m)	0.00E+00	6.65E-03	0.00E+00	7.14E-05	1.38E-03	2.05E-03	0.00E+00	0.00E+00	1.56E-04	4.15E-05		
	Volume (m^3)	0.00E+00	6.65E-09	0.00E+00	7.14E-11	1.38E-09	2.05E-09	0.00E+00	0.00E+00	1.56E-10	4.15E-11		
	Mass of each phase	0.00E+00	2.46E-02	0.00E+00	2.85E-04	6.23E-03	6.15E-03	0.00E+00	0.00E+00	5.55E-04	2.08E-04		
	Mass As in each phase	0.00E+00	1.87E-02	0.00E+00	8.56E-06	1.87E-04	1.85E-04	0.00E+00	0.00E+00	3.88E-04	1.41E-06	**1.95E-02**	
	Total As in each phase (wt. %)	0.00	0.96	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00		
	Total As in each phase (mg/kg)	**0.00**	**2209.05**	**0.00**	**1.01**	**22.09**	**21.80**	**0.00**	**0.00**	**45.88**	**0.17**		**2300**
BPR-PSC-161PH	Area (micron)	0.00	158.73	0.00	0.00	940.00	42.23	0.00	9.47	0.00	8.01		
	Area (m)	0.00E+00	1.59E-04	0.00E+00	0.00E+00	9.40E-04	4.22E-05	0.00E+00	9.47E-06	0.00E+00	8.01E-06		
	Volume (m^3)	0.00E+00	1.59E-10	0.00E+00	0.00E+00	9.40E-10	4.22E-11	0.00E+00	9.47E-12	0.00E+00	8.01E-12		
	Mass of each phase	0.00E+00	5.87E-04	0.00E+00	0.00E+00	4.23E-03	1.27E-04	0.00E+00	5.75E-05	0.00E+00	4.01E-05		
	Mass As in each phase	0.00E+00	4.46E-04	0.00E+00	0.00E+00	1.27E-04	3.80E-06	0.00E+00	2.64E-05	0.00E+00	2.73E-07	**6.04E-04**	
	Total As in each phase (wt. %)	0.00	0.74	0.00	0.00	0.21	0.01	0.00	0.04	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**2513.59**	**0.00**	**0.00**	**714.63**	**21.40**	**0.00**	**148.84**	**0.00**	**1.54**		**3400**

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

BPR-PSC-160PH													
	Area (micron)	0.00	45.14	0.00	0.00	763.07	46.60	0.00	0.00	0.00	218.44		
	Area (m)	0.00E+00	4.51E-05	0.00E+00	0.00E+00	7.63E-04	4.66E-05	0.00E+00	0.00E+00	0.00E+00	2.18E-04		
	Volume (m^3)	0.00E+00	4.51E-11	0.00E+00	0.00E+00	7.63E-10	4.66E-11	0.00E+00	0.00E+00	0.00E+00	2.18E-10		
	Mass of each phase	0.00E+00	1.67E-04	0.00E+00	0.00E+00	3.43E-03	1.40E-04	0.00E+00	0.00E+00	0.00E+00	1.09E-03		
	Mass As in each phase	0.00E+00	1.27E-04	0.00E+00	0.00E+00	1.03E-04	4.19E-06	0.00E+00	0.00E+00	0.00E+00	7.44E-06	**2.42E-04**	
	Total As in each phase (wt. %)	0.00	0.53	0.00	0.00	0.43	0.02	0.00	0.00	0.00	0.03		
	Total As in each phase (mg/kg)	**0.00**	**525.44**	**0.00**	**0.00**	**426.40**	**17.36**	**0.00**	**0.00**	**0.00**	**30.80**		**1000**
DETR-FCSC-34PH													
	Area (micron)	0.00	1046.31	0.00	0.00	943.64	835.15	0.00	219.89	0.00	875.20		
	Area (m)	0.00E+00	1.05E-03	0.00E+00	0.00E+00	9.44E-04	8.35E-04	0.00E+00	2.20E-04	0.00E+00	8.75E-04		
	Volume (m^3)	0.00E+00	1.05E-09	0.00E+00	0.00E+00	9.44E-10	8.35E-10	0.00E+00	2.20E-10	0.00E+00	8.75E-10		
	Mass of each phase	0.00E+00	3.87E-03	0.00E+00	0.00E+00	4.25E-03	2.51E-03	0.00E+00	1.33E-03	0.00E+00	4.38E-03		
	Mass As in each phase	0.00E+00	2.94E-03	0.00E+00	0.00E+00	1.27E-04	7.52E-05	0.00E+00	6.14E-04	0.00E+00	2.98E-05	**3.79E-03**	
	Total As in each phase (wt. %)	0.00	0.78	0.00	0.00	0.03	0.02	0.00	0.16	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**209.68**	**0.00**	**0.00**	**9.08**	**5.36**	**0.00**	**43.76**	**0.00**	**2.12**		**270**
DETR-OSC-37PH													
	Area (micron)	8.01	270.86	0.00	21.12	1100.92	255.57	0.00	3.64	0.00	333.48		
	Area (m)	8.01E-06	2.71E-04	0.00E+00	2.11E-05	1.10E-03	2.56E-04	0.00E+00	3.64E-06	0.00E+00	3.33E-04		
	Volume (m^3)	8.01E-12	2.71E-10	0.00E+00	2.11E-11	1.10E-09	2.56E-10	0.00E+00	3.64E-12	0.00E+00	3.33E-10		
	Mass of each phase	3.56E-05	1.00E-03	0.00E+00	8.45E-05	4.95E-03	7.67E-04	0.00E+00	2.21E-05	0.00E+00	1.67E-03		
	Mass As in each phase	6.77E-06	7.62E-04	0.00E+00	2.53E-06	1.49E-04	2.30E-05	0.00E+00	1.02E-05	0.00E+00	1.14E-05	**9.64E-04**	
	Total As in each phase (wt. %)	0.01	0.79	0.00	0.00	0.15	0.02	0.00	0.01	0.00	0.01		
	Total As in each phase (mg/kg)	**1.55**	**173.80**	**0.00**	**0.58**	**33.91**	**5.25**	**0.00**	**2.32**	**0.00**	**2.59**		**220**
DETR-FCSC-38PH													
	Area (micron)	0.00	93.93	0.00	918.89	253.39	56.07	0.00	6.55	0.00	0.00		
	Area (m)	0.00E+00	9.39E-05	0.00E+00	9.19E-04	2.53E-04	5.61E-05	0.00E+00	6.55E-06	0.00E+00	0.00E+00		
	Volume (m^3)	0.00E+00	9.39E-11	0.00E+00	9.19E-10	2.53E-10	5.61E-11	0.00E+00	6.55E-12	0.00E+00	0.00E+00		
	Mass of each phase	0.00E+00	3.48E-04	0.00E+00	3.68E-03	1.14E-03	1.68E-04	0.00E+00	3.98E-05	0.00E+00	0.00E+00		
	Mass As in each phase	0.00E+00	2.64E-04	0.00E+00	1.10E-04	3.42E-05	5.05E-06	0.00E+00	1.83E-05	0.00E+00	0.00E+00	**4.32E-04**	
	Total As in each phase (wt. %)	0.00	0.61	0.00	0.26	0.08	0.01	0.00	0.04	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**28.13**	**0.00**	**11.74**	**3.64**	**0.54**	**0.00**	**1.95**	**0.00**	**0.00**		**46**
YK67-OSC-06PH													
	Area (micron)	0.00	382.99	0.00	0.00	1255.28	138.34	0.00	0.00	0.00	214.07		
	Area (m)	0.00E+00	3.83E-04	0.00E+00	0.00E+00	1.26E-03	1.38E-04	0.00E+00	0.00E+00	0.00E+00	2.14E-04		
	Volume (m^3)	0.00E+00	3.83E-10	0.00E+00	0.00E+00	1.26E-09	1.38E-10	0.00E+00	0.00E+00	0.00E+00	2.14E-10		
	Mass of each phase	0.00E+00	1.42E-03	0.00E+00	0.00E+00	5.65E-03	4.15E-04	0.00E+00	0.00E+00	0.00E+00	1.07E-03		
	Mass As in each phase	0.00E+00	1.08E-03	0.00E+00	0.00E+00	1.69E-04	1.25E-05	0.00E+00	0.00E+00	0.00E+00	7.29E-06	**1.27E-03**	
	Total As in each phase (wt. %)	0.00	0.85	0.00	0.00	0.13	0.01	0.00	0.00	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**52.74**	**0.00**	**0.00**	**8.30**	**0.61**	**0.00**	**0.00**	**0.00**	**0.36**		**62**
NDILO-OSC-23PH													
	Area (micron)	0.00	2055.49	0.00	1342.65	1751.86	1659.39	0.00	0.00	0.00	41.50		
	Area (m)	0.00E+00	2.06E-03	0.00E+00	1.34E-03	1.75E-03	1.66E-03	0.00E+00	0.00E+00	0.00E+00	4.15E-05		
	Volume (m^3)	0.00E+00	2.06E-09	0.00E+00	1.34E-09	1.75E-09	1.66E-09	0.00E+00	0.00E+00	0.00E+00	4.15E-11		
	Mass of each phase	0.00E+00	7.61E-03	0.00E+00	5.37E-03	7.88E-03	4.98E-03	0.00E+00	0.00E+00	0.00E+00	2.08E-04		
	Mass As in each phase	0.00E+00	5.78E-03	0.00E+00	1.61E-04	2.37E-04	1.49E-04	0.00E+00	0.00E+00	0.00E+00	1.41E-06	**6.33E-03**	
	Total As in each phase (wt. %)	0.00	0.91	0.00	0.03	0.04	0.02	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**200.94**	**0.00**	**5.60**	**8.22**	**5.19**	**0.00**	**0.00**	**0.00**	**0.05**		**220**

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

	Area (micron)	0.00	514.05	46.60	390.27	1947.72	1668.12	0.00	0.00	0.00	573.76		
	Area (m)	0.00E+00	5.14E-04	4.66E-05	3.90E-04	1.95E-03	1.67E-03	0.00E+00	0.00E+00	0.00E+00	5.74E-04		
NDILO-OSC-23PH D	Volume (m^3)	0.00E+00	5.14E-10	4.66E-11	3.90E-10	1.95E-09	1.67E-09	0.00E+00	0.00E+00	0.00E+00	5.74E-10		
	Mass of each phase	0.00E+00	1.90E-03	1.52E-04	1.56E-03	8.76E-03	5.00E-03	0.00E+00	0.00E+00	0.00E+00	2.87E-03		
	Mass As in each phase	0.00E+00	1.45E-03	4.88E-05	4.68E-05	2.63E-04	1.50E-04	0.00E+00	0.00E+00	0.00E+00	1.95E-05	**1.97E-03**	
	Total As in each phase (wt. %)	0.00	0.73	0.02	0.02	0.13	0.08	0.00	0.00	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**161.12**	**5.44**	**5.22**	**29.31**	**16.73**	**0.00**	**0.00**	**0.00**	**2.18**		**220**
	Area (micron)	0.00	899.23	0.00	1635.36	5099.76	2457.41	7.28	0.00	0.00	10.19		
	Area (m)	0.00E+00	8.99E-04	0.00E+00	1.64E-03	5.10E-03	2.46E-03	7.28E-06	0.00E+00	0.00E+00	1.02E-05		
NDILO-FCSC-25PH	Volume (m^3)	0.00E+00	8.99E-10	0.00E+00	1.64E-09	5.10E-09	2.46E-09	7.28E-12	0.00E+00	0.00E+00	1.02E-11		
	Mass of each phase	0.00E+00	3.33E-03	0.00E+00	6.54E-03	2.29E-02	7.37E-03	2.85E-05	0.00E+00	0.00E+00	5.11E-05		
	Mass As in each phase	0.00E+00	2.53E-03	0.00E+00	1.96E-04	6.88E-04	2.21E-04	4.28E-06	0.00E+00	0.00E+00	3.47E-07	**3.64E-03**	
	Total As in each phase (wt. %)	0.00	0.69	0.00	0.05	0.19	0.06	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**194.56**	**0.00**	**15.10**	**52.97**	**17.02**	**0.33**	**0.00**	**0.00**	**0.03**		**280**
	Area (micron)	0.00	2122.47	0.00	1479.54	9400.77	2740.65	27.67	192.22	53.15	32.04		
	Area (m)	0.00E+00	2.12E-03	0.00E+00	1.48E-03	9.40E-03	2.74E-03	2.77E-05	1.92E-04	5.32E-05	3.20E-05		
NDILO-FCSC-25PH D	Volume (m^3)	0.00E+00	2.12E-09	0.00E+00	1.48E-09	9.40E-09	2.74E-09	2.77E-11	1.92E-10	5.32E-11	3.20E-11		
	Mass of each phase	0.00E+00	7.85E-03	0.00E+00	5.92E-03	4.23E-02	8.22E-03	1.08E-04	1.17E-03	1.89E-04	1.61E-04		
	Mass As in each phase	0.00E+00	5.97E-03	0.00E+00	1.78E-04	1.27E-03	2.47E-04	1.63E-05	5.37E-04	1.32E-04	1.09E-06	**8.35E-03**	
	Total As in each phase (wt. %)	0.00	0.71	0.00	0.02	0.15	0.03	0.00	0.06	0.02	0.00		
	Total As in each phase (mg/kg)	**0.00**	**200.18**	**0.00**	**5.95**	**42.57**	**8.27**	**0.55**	**18.00**	**4.44**	**0.04**		**280**
	Area (micron)	0.00	190.77	0.00	14.56	3752.74	3713.42	0.00	0.00	0.00	50.97		
	Area (m)	0.00E+00	1.91E-04	0.00E+00	1.46E-05	3.75E-03	3.71E-03	0.00E+00	0.00E+00	0.00E+00	5.10E-05		
LL-OSC-106PH	Volume (m^3)	0.00E+00	1.91E-10	0.00E+00	1.46E-11	3.75E-09	3.71E-09	0.00E+00	0.00E+00	0.00E+00	5.10E-11		
	Mass of each phase	0.00E+00	7.06E-04	0.00E+00	5.82E-05	1.69E-02	1.11E-02	0.00E+00	0.00E+00	0.00E+00	2.55E-04		
	Mass As in each phase	0.00E+00	5.36E-04	0.00E+00	1.75E-06	5.07E-04	3.34E-04	0.00E+00	0.00E+00	0.00E+00	1.74E-06	**1.38E-03**	
	Total As in each phase (wt. %)	0.00	0.39	0.00	0.00	0.37	0.24	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**77.70**	**0.00**	**0.25**	**73.38**	**48.41**	**0.00**	**0.00**	**0.00**	**0.25**		**200**
	Area (micron)	0.00	0.00	0.00	822.78	1474.44	465.27	0.00	0.00	0.00	33.49		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	8.23E-04	1.47E-03	4.65E-04	0.00E+00	0.00E+00	0.00E+00	3.35E-05		
LL-PSC-117PH	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	8.23E-10	1.47E-09	4.65E-10	0.00E+00	0.00E+00	0.00E+00	3.35E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	3.29E-03	6.64E-03	1.40E-03	0.00E+00	0.00E+00	0.00E+00	1.68E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	9.87E-05	1.99E-04	4.19E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-06	**3.41E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.29	0.58	0.12	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**6.95**	**14.02**	**2.95**	**0.00**	**0.00**	**0.00**	**0.08**		**24**
	Area (micron)	0.00	61.16	0.00	0.00	199.51	16.75	0.00	0.00	0.00	15.29		
	Area (m)	0.00E+00	6.12E-05	0.00E+00	0.00E+00	2.00E-04	1.67E-05	0.00E+00	0.00E+00	0.00E+00	1.53E-05		
LL-OSC-120PH	Volume (m^3)	0.00E+00	6.12E-11	0.00E+00	0.00E+00	2.00E-10	1.67E-11	0.00E+00	0.00E+00	0.00E+00	1.53E-11		
	Mass of each phase	0.00E+00	2.26E-04	0.00E+00	0.00E+00	8.98E-04	5.02E-05	0.00E+00	0.00E+00	0.00E+00	7.66E-05		
	Mass As in each phase	0.00E+00	1.72E-04	0.00E+00	0.00E+00	2.69E-05	1.51E-06	0.00E+00	0.00E+00	0.00E+00	5.21E-07	**2.01E-04**	
	Total As in each phase (wt. %)	0.00	0.86	0.00	0.00	0.13	0.01	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**50.50**	**0.00**	**0.00**	**7.91**	**0.44**	**0.00**	**0.00**	**0.00**	**0.15**		**59**
	Area (micron)	0.00	39.32	0.00	142.71	512.60	109.95	0.00	0.00	0.00	29.12		
	Area (m)	0.00E+00	3.93E-05	0.00E+00	1.43E-04	5.13E-04	1.10E-04	0.00E+00	0.00E+00	0.00E+00	2.91E-05		
VL-FCSC-108PH	Volume (m^3)	0.00E+00	3.93E-11	0.00E+00	1.43E-10	5.13E-10	1.10E-10	0.00E+00	0.00E+00	0.00E+00	2.91E-11		
	Mass of each phase	0.00E+00	1.45E-04	0.00E+00	5.71E-04	2.31E-03	3.30E-04	0.00E+00	0.00E+00	0.00E+00	1.46E-04		
	Mass As in each phase	0.00E+00	1.11E-04	0.00E+00	1.71E-05	6.92E-05	9.90E-06	0.00E+00	0.00E+00	0.00E+00	9.92E-07	**2.08E-04**	
	Total As in each phase (wt. %)	0.00	0.53	0.00	0.08	0.33	0.05	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**63.86**	**0.00**	**9.89**	**39.97**	**5.71**	**0.00**	**0.00**	**0.00**	**0.57**		**120**

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

VL-OSC-110PH	Area (micron)	0.00	409.93	0.00	0.00	310.91	369.89	0.00	0.00	0.00	29.12		
	Area (m)	0.00E+00	4.10E-04	0.00E+00	0.00E+00	3.11E-04	3.70E-04	0.00E+00	0.00E+00	0.00E+00	2.91E-05		
	Volume (m^3)	0.00E+00	4.10E-10	0.00E+00	0.00E+00	3.11E-10	3.70E-10	0.00E+00	0.00E+00	0.00E+00	2.91E-11		
	Mass of each phase	0.00E+00	1.52E-03	0.00E+00	0.00E+00	1.40E-03	1.11E-03	0.00E+00	0.00E+00	0.00E+00	1.46E-04		
	Mass As in each phase	0.00E+00	1.15E-03	0.00E+00	0.00E+00	4.20E-05	3.33E-05	0.00E+00	0.00E+00	0.00E+00	9.92E-07	**1.23E-03**	
	Total As in each phase (wt. %)	0.00	0.94	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**121.93**	**0.00**	**0.00**	**4.44**	**3.52**	**0.00**	**0.00**	**0.00**	**0.10**		**130**
BERRY-FCOSC-62PH	Area (micron)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.19		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.12E-05		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.12E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.06E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-06	**1.40E-06**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6.10**		**6.1**
BERRY-OSG-63	Area (micron)	0.00	98.43	0.00	1046.35	44665.31	15499.52	0.00	49.22	0.00	680.99		
	Area (m)	0.00E+00	9.84E-05	0.00E+00	1.05E-03	4.47E-02	1.55E-02	0.00E+00	4.92E-05	0.00E+00	6.81E-04		
	Volume (m^3)	0.00E+00	9.84E-11	0.00E+00	1.05E-09	4.47E-08	1.55E-08	0.00E+00	4.92E-11	0.00E+00	6.81E-10		
	Mass of each phase	0.00E+00	3.64E-04	0.00E+00	4.19E-03	2.01E-01	4.65E-02	0.00E+00	2.99E-04	0.00E+00	3.41E-03		
	Mass As in each phase	0.00E+00	2.77E-04	0.00E+00	1.26E-04	6.03E-03	1.39E-03	0.00E+00	1.37E-04	0.00E+00	2.32E-05	**7.99E-03**	
	Total As in each phase (wt. %)	0.00	0.03	0.00	0.02	0.75	0.17	0.00	0.02	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**2.91**	**0.00**	**1.32**	**63.41**	**14.67**	**0.00**	**1.45**	**0.00**	**0.24**		**84**
TX-FCSC-144PH	Area (micron)	0.00	451.43	0.00	979.32	6823.95	3774.58	0.00	0.00	0.00	104.12		
	Area (m)	0.00E+00	4.51E-04	0.00E+00	9.79E-04	6.82E-03	3.77E-03	0.00E+00	0.00E+00	0.00E+00	1.04E-04		
	Volume (m^3)	0.00E+00	4.51E-10	0.00E+00	9.79E-10	6.82E-09	3.77E-09	0.00E+00	0.00E+00	0.00E+00	1.04E-10		
	Mass of each phase	0.00E+00	1.67E-03	0.00E+00	3.92E-03	3.07E-02	1.13E-02	0.00E+00	0.00E+00	0.00E+00	5.22E-04		
	Mass As in each phase	0.00E+00	1.27E-03	0.00E+00	1.18E-04	9.21E-04	3.40E-04	0.00E+00	0.00E+00	0.00E+00	3.55E-06	**2.65E-03**	
	Total As in each phase (wt. %)	0.00	0.48	0.00	0.04	0.35	0.13	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**62.24**	**0.00**	**5.76**	**45.17**	**16.66**	**0.00**	**0.00**	**0.00**	**0.17**		**130**
TX-FCSC-144PH D	Area (micron)	0.00	60.43	0.00	1087.08	1409.64	857.73	0.00	0.00	0.00	45.14		
	Area (m)	0.00E+00	6.04E-05	0.00E+00	1.09E-03	1.41E-03	8.58E-04	0.00E+00	0.00E+00	0.00E+00	4.51E-05		
	Volume (m^3)	0.00E+00	6.04E-11	0.00E+00	1.09E-09	1.41E-09	8.58E-10	0.00E+00	0.00E+00	0.00E+00	4.51E-11		
	Mass of each phase	0.00E+00	2.24E-04	0.00E+00	4.35E-03	6.34E-03	2.57E-03	0.00E+00	0.00E+00	0.00E+00	2.26E-04		
	Mass As in each phase	0.00E+00	1.70E-04	0.00E+00	1.30E-04	1.90E-04	7.72E-05	0.00E+00	0.00E+00	0.00E+00	1.54E-06	**5.69E-04**	
	Total As in each phase (wt. %)	0.00	0.30	0.00	0.23	0.33	0.14	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**38.80**	**0.00**	**29.78**	**43.45**	**17.62**	**0.00**	**0.00**	**0.00**	**0.35**		**130**
TX-OSC-145PH	Area (micron)	0.00	7.28	0.00	2271.74	36783.94	11001.91	4.37	267.22	0.00	16489.75		
	Area (m)	0.00E+00	7.28E-06	0.00E+00	2.27E-03	3.68E-02	1.10E-02	4.37E-06	2.67E-04	0.00E+00	1.65E-02		
	Volume (m^3)	0.00E+00	7.28E-12	0.00E+00	2.27E-09	3.68E-08	1.10E-08	4.37E-12	2.67E-10	0.00E+00	1.65E-08		
	Mass of each phase	0.00E+00	2.69E-05	0.00E+00	9.09E-03	1.66E-01	3.30E-02	1.71E-05	1.62E-03	0.00E+00	8.26E-02		
	Mass As in each phase	0.00E+00	2.05E-05	0.00E+00	2.73E-04	4.97E-03	9.90E-04	2.57E-06	7.46E-04	0.00E+00	5.62E-04	**7.56E-03**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.04	0.66	0.13	0.00	0.10	0.00	0.07		
	Total As in each phase (mg/kg)	**0.00**	**0.12**	**0.00**	**1.55**	**28.25**	**5.63**	**0.01**	**4.24**	**0.00**	**3.20**		**43**
TX-OSC-151PH	Area (micron)	0.00	0.00	0.00	11.65	5763.80	9052.73	0.00	0.00	0.00	42.23		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	1.16E-05	5.76E-03	9.05E-03	0.00E+00	0.00E+00	0.00E+00	4.22E-05		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	1.16E-11	5.76E-09	9.05E-09	0.00E+00	0.00E+00	0.00E+00	4.22E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	4.66E-05	2.59E-02	2.72E-02	0.00E+00	0.00E+00	0.00E+00	2.12E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	1.40E-06	7.78E-04	8.15E-04	0.00E+00	0.00E+00	0.00E+00	1.44E-06	**1.60E-03**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.49	0.51	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.06**	**35.11**	**36.76**	**0.00**	**0.00**	**0.00**	**0.06**		**72**

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

	Area (micron)	0.00	164.56	0.00	89634.59	122005.39	46770.12	0.00	0.00	0.00	50.24		
	Area (m)	0.00E+00	1.65E-04	0.00E+00	8.96E-02	1.22E-01	4.68E-02	0.00E+00	0.00E+00	0.00E+00	5.02E-05		
TX-OSG-152	Volume (m^3)	0.00E+00	1.65E-10	0.00E+00	8.96E-08	1.22E-07	4.68E-08	0.00E+00	0.00E+00	0.00E+00	5.02E-11		
	Mass of each phase	0.00E+00	6.09E-04	0.00E+00	3.59E-01	5.49E-01	1.40E-01	0.00E+00	0.00E+00	0.00E+00	2.52E-04		
	Mass As in each phase	0.00E+00	4.63E-04	0.00E+00	1.08E-02	1.65E-02	4.21E-03	0.00E+00	0.00E+00	0.00E+00	1.71E-06	**3.19E-02**	
	Total As in each phase (wt. %)	0.00	0.01	0.00	0.34	0.52	0.13	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**3.05**	**0.00**	**70.81**	**108.43**	**27.71**	**0.00**	**0.00**	**0.00**	**0.01**		**210**
	Area (micron)	0.00	218.26	0.00	557.41	39287.50	7273.66	0.00	0.00	0.00	419.40		
	Area (m)	0.00E+00	2.18E-04	0.00E+00	5.57E-04	3.93E-02	7.27E-03	0.00E+00	0.00E+00	0.00E+00	4.19E-04		
TX-OSG-152 D	Volume (m^3)	0.00E+00	2.18E-10	0.00E+00	5.57E-10	3.93E-08	7.27E-09	0.00E+00	0.00E+00	0.00E+00	4.19E-10		
	Mass of each phase	0.00E+00	8.08E-04	0.00E+00	2.23E-03	1.77E-01	2.18E-02	0.00E+00	0.00E+00	0.00E+00	2.10E-03		
	Mass As in each phase	0.00E+00	6.14E-04	0.00E+00	6.69E-05	5.30E-03	6.55E-04	0.00E+00	0.00E+00	0.00E+00	1.43E-05	**6.65E-03**	
	Total As in each phase (wt. %)	0.00	0.09	0.00	0.01	0.80	0.10	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**19.37**	**0.00**	**2.11**	**167.40**	**20.66**	**0.00**	**0.00**	**0.00**	**0.45**		**210**
	Area (micron)	0.00	108.49	0.00	6577.12	2277.56	645.12	0.00	5.82	0.00	0.00		
	Area (m)	0.00E+00	1.08E-04	0.00E+00	6.58E-03	2.28E-03	6.45E-04	0.00E+00	5.82E-06	0.00E+00	0.00E+00		
TX-FCOSC-155PH	Volume (m^3)	0.00E+00	1.08E-10	0.00E+00	6.58E-09	2.28E-09	6.45E-10	0.00E+00	5.82E-12	0.00E+00	0.00E+00		
	Mass of each phase	0.00E+00	4.01E-04	0.00E+00	2.63E-02	1.02E-02	1.94E-03	0.00E+00	3.54E-05	0.00E+00	0.00E+00		
	Mass As in each phase	0.00E+00	3.05E-04	0.00E+00	7.89E-04	3.07E-04	5.81E-05	0.00E+00	1.63E-05	0.00E+00	0.00E+00	**1.48E-03**	
	Total As in each phase (wt. %)	0.00	0.21	0.00	0.53	0.21	0.04	0.00	0.01	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**16.12**	**0.00**	**41.71**	**16.25**	**3.07**	**0.00**	**0.86**	**0.00**	**0.00**		**78**
	Area (micron)	0.00	1268.39	0.00	0.00	402.65	855.54	0.00	0.00	0.00	0.00		
	Area (m)	0.00E+00	1.27E-03	0.00E+00	0.00E+00	4.03E-04	8.56E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
ML-FCOSC-97PH	Volume (m^3)	0.00E+00	1.27E-09	0.00E+00	0.00E+00	4.03E-10	8.56E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Mass of each phase	0.00E+00	4.69E-03	0.00E+00	0.00E+00	1.81E-03	2.57E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Mass As in each phase	0.00E+00	3.57E-03	0.00E+00	0.00E+00	5.44E-05	7.70E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**3.70E-03**	
	Total As in each phase (wt. %)	0.00	0.96	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**385.79**	**0.00**	**0.00**	**5.88**	**8.33**	**0.00**	**0.00**	**0.00**	**0.00**		**400**
	Area (micron)	0.00	1202.86	0.00	15.29	1301.15	752.15	0.00	0.00	0.00	7.28		
	Area (m)	0.00E+00	1.20E-03	0.00E+00	1.53E-05	1.30E-03	7.52E-04	0.00E+00	0.00E+00	0.00E+00	7.28E-06		
ML-FCOSC-97PH D	Volume (m^3)	0.00E+00	1.20E-09	0.00E+00	1.53E-11	1.30E-09	7.52E-10	0.00E+00	0.00E+00	0.00E+00	7.28E-12		
	Mass of each phase	0.00E+00	4.45E-03	0.00E+00	6.12E-05	5.86E-03	2.26E-03	0.00E+00	0.00E+00	0.00E+00	3.65E-05		
	Mass As in each phase	0.00E+00	3.38E-03	0.00E+00	1.83E-06	1.76E-04	6.77E-05	0.00E+00	0.00E+00	0.00E+00	2.48E-07	**3.63E-03**	
	Total As in each phase (wt. %)	0.00	0.93	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**372.94**	**0.00**	**0.20**	**19.37**	**7.46**	**0.00**	**0.00**	**0.00**	**0.03**		**400**
	Area (micron)	0.00	2913.21	0.00	0.00	1328.82	595.60	0.00	0.00	0.00	166.74		
	Area (m)	0.00E+00	2.91E-03	0.00E+00	0.00E+00	1.33E-03	5.96E-04	0.00E+00	0.00E+00	0.00E+00	1.67E-04		
ML-OSC-98PH	Volume (m^3)	0.00E+00	2.91E-09	0.00E+00	0.00E+00	1.33E-09	5.96E-10	0.00E+00	0.00E+00	0.00E+00	1.67E-10		
	Mass of each phase	0.00E+00	1.08E-02	0.00E+00	0.00E+00	5.98E-03	1.79E-03	0.00E+00	0.00E+00	0.00E+00	8.35E-04		
	Mass As in each phase	0.00E+00	8.19E-03	0.00E+00	0.00E+00	1.79E-04	5.36E-05	0.00E+00	0.00E+00	0.00E+00	5.68E-06	**8.43E-03**	
	Total As in each phase (wt. %)	0.00	0.97	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**204.05**	**0.00**	**0.00**	**4.47**	**1.34**	**0.00**	**0.00**	**0.00**	**0.14**		**210**
	Area (micron)	0.00	7815.65	0.00	8.01	20481.31	6892.39	0.00	0.00	238.82	693.90		
	Area (m)	0.00E+00	7.82E-03	0.00E+00	8.01E-06	2.05E-02	6.89E-03	0.00E+00	0.00E+00	2.39E-04	6.94E-04		
ML-OSC-103PH	Volume (m^3)	0.00E+00	7.82E-09	0.00E+00	8.01E-12	2.05E-08	6.89E-09	0.00E+00	0.00E+00	2.39E-10	6.94E-10		
	Mass of each phase	0.00E+00	2.89E-02	0.00E+00	3.20E-05	9.22E-02	2.07E-02	0.00E+00	0.00E+00	8.50E-04	3.48E-03		
	Mass As in each phase	0.00E+00	2.20E-02	0.00E+00	9.61E-07	2.76E-03	6.20E-04	0.00E+00	0.00E+00	5.95E-04	2.36E-05	**2.60E-02**	
	Total As in each phase (wt. %)	0.00	0.85	0.00	0.00	0.11	0.02	0.00	0.00	0.02	0.00		
	Total As in each phase (mg/kg)	**0.00**	**693.60**	**0.00**	**0.03**	**87.26**	**19.58**	**0.00**	**0.00**	**18.78**	**0.75**		**820**

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

ML-OSC-103PH D	Area (micron)	4.37	7027.82	0.00	0.00	8972.63	5164.56	0.00	0.00	98.30	63.35		
	Area (m)	4.37E-06	7.03E-03	0.00E+00	0.00E+00	8.97E-03	5.16E-03	0.00E+00	0.00E+00	9.83E-05	6.33E-05		
	Volume (m^3)	4.37E-12	7.03E-09	0.00E+00	0.00E+00	8.97E-09	5.16E-09	0.00E+00	0.00E+00	9.83E-11	6.33E-11		
	Mass of each phase	1.94E-05	2.60E-02	0.00E+00	0.00E+00	4.04E-02	1.55E-02	0.00E+00	0.00E+00	3.50E-04	3.17E-04		
	Mass As in each phase	3.69E-06	1.98E-02	0.00E+00	0.00E+00	1.21E-03	4.65E-04	0.00E+00	0.00E+00	2.45E-04	2.16E-06	**2.17E-02**	
	Total As in each phase (wt. %)	0.00	0.91	0.00	0.00	0.06	0.02	0.00	0.00	0.01	0.00		
	Total As in each phase (mg/kg)	**0.14**	**747.15**	**0.00**	**0.00**	**45.80**	**17.57**	**0.00**	**0.00**	**9.26**	**0.08**		**820**
NWC3-OSG-86													
	Area (micron)	0.00	393.19	0.00	289.79	3307.85	3067.57	0.00	0.00	0.00	80.09		
	Area (m)	0.00E+00	3.93E-04	0.00E+00	2.90E-04	3.31E-03	3.07E-03	0.00E+00	0.00E+00	0.00E+00	8.01E-05		
	Volume (m3)	0.00E+00	3.93E-10	0.00E+00	2.90E-10	3.31E-09	3.07E-09	0.00E+00	0.00E+00	0.00E+00	8.01E-11		
	Mass of each phase	0.00E+00	1.45E-03	0.00E+00	1.16E-03	1.49E-02	9.20E-03	0.00E+00	0.00E+00	0.00E+00	4.01E-04		
	Mass As in each phase	0.00E+00	1.11E-03	0.00E+00	3.48E-05	4.47E-04	2.76E-04	0.00E+00	0.00E+00	0.00E+00	2.73E-06	**1.87E-03**	
	Total As in each phase (wt. %)	0.00	0.59	0.00	0.02	0.24	0.15	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**367.40**	**0.00**	**11.56**	**148.39**	**91.74**	**0.00**	**0.00**	**0.00**	**0.91**		**620**
NWC1-FCSC-82PH													
	Area (micron)	0.00	1109.66	0.00	0.00	2197.47	1080.53	0.00	55.34	6.55	142.71		
	Area (m)	0.00E+00	1.11E-03	0.00E+00	0.00E+00	2.20E-03	1.08E-03	0.00E+00	5.53E-05	6.55E-06	1.43E-04		
	Volume (m3)	0.00E+00	1.11E-09	0.00E+00	0.00E+00	2.20E-09	1.08E-09	0.00E+00	5.53E-11	6.55E-12	1.43E-10		
	Mass of each phase	0.00E+00	4.11E-03	0.00E+00	0.00E+00	9.89E-03	3.24E-03	0.00E+00	3.36E-04	2.33E-05	7.15E-04		
	Mass As in each phase	0.00E+00	3.12E-03	0.00E+00	0.00E+00	2.97E-04	9.72E-05	0.00E+00	1.55E-04	1.63E-05	4.86E-06	**3.69E-03**	
	Total As in each phase (wt. %)	0.00	0.85	0.00	0.00	0.08	0.03	0.00	0.04	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**211.41**	**0.00**	**0.00**	**20.10**	**6.59**	**0.00**	**10.47**	**1.11**	**0.33**		**250**
INGT-FCSC-28PH													
	Area (micron)	0.00	492.94	0.00	0.00	1610.60	682.98	0.00	0.00	0.00	32.04		
	Area (m)	0.00E+00	4.93E-04	0.00E+00	0.00E+00	1.61E-03	6.83E-04	0.00E+00	0.00E+00	0.00E+00	3.20E-05		
	Volume (m3)	0.00E+00	4.93E-10	0.00E+00	0.00E+00	1.61E-09	6.83E-10	0.00E+00	0.00E+00	0.00E+00	3.20E-11		
	Mass of each phase	0.00E+00	1.82E-03	0.00E+00	0.00E+00	7.25E-03	2.05E-03	0.00E+00	0.00E+00	0.00E+00	1.61E-04		
	Mass As in each phase	0.00E+00	1.39E-03	0.00E+00	0.00E+00	2.17E-04	6.15E-05	0.00E+00	0.00E+00	0.00E+00	1.09E-06	**1.67E-03**	
	Total As in each phase (wt. %)	0.00	0.83	0.00	0.00	0.13	0.04	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**183.03**	**0.00**	**0.00**	**28.71**	**8.12**	**0.00**	**0.00**	**0.00**	**0.14**		**220**
INGT-OSC-39PH													
	Area (micron)	0.00	4.37	0.00	0.00	419.40	164.56	0.00	0.00	0.00	34.95		
	Area (m)	0.00E+00	4.37E-06	0.00E+00	0.00E+00	4.19E-04	1.65E-04	0.00E+00	0.00E+00	0.00E+00	3.49E-05		
	Volume (m3)	0.00E+00	4.37E-12	0.00E+00	0.00E+00	4.19E-10	1.65E-10	0.00E+00	0.00E+00	0.00E+00	3.49E-11		
	Mass of each phase	0.00E+00	1.62E-05	0.00E+00	0.00E+00	1.89E-03	4.94E-04	0.00E+00	0.00E+00	0.00E+00	1.75E-04		
	Mass As in each phase	0.00E+00	1.23E-05	0.00E+00	0.00E+00	5.66E-05	1.48E-05	0.00E+00	0.00E+00	0.00E+00	1.19E-06	**8.49E-05**	
	Total As in each phase (wt. %)	0.00	0.14	0.00	0.00	0.67	0.17	0.00	0.00	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**3.04**	**0.00**	**0.00**	**14.00**	**3.66**	**0.00**	**0.00**	**0.00**	**0.29**		**21**
INGT-FCOSG-46													
	Area (micron)	0.00	221.35	0.00	764519.65	6138.79	5200.97	0.00	50.97	0.00	1093.64		
	Area (m)	0.00E+00	2.21E-04	0.00E+00	7.65E-01	6.14E-03	5.20E-03	0.00E+00	5.10E-05	0.00E+00	1.09E-03		
	Volume (m3)	0.00E+00	2.21E-10	0.00E+00	7.65E-07	6.14E-09	5.20E-09	0.00E+00	5.10E-11	0.00E+00	1.09E-09		
	Mass of each phase	0.00E+00	8.19E-04	0.00E+00	3.06E+00	2.76E-02	1.56E-02	0.00E+00	3.09E-04	0.00E+00	5.48E-03		
	Mass As in each phase	0.00E+00	6.22E-04	0.00E+00	9.17E-02	8.29E-04	4.68E-04	0.00E+00	1.42E-04	0.00E+00	3.73E-05	**9.38E-02**	
	Total As in each phase (wt. %)	0.00	0.01	0.00	0.98	0.01	0.00	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**1.59**	**0.00**	**234.63**	**2.12**	**1.20**	**0.00**	**0.36**	**0.00**	**0.10**		**240**

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

INGT-FENC-51PH													
	Area (micron)	0.00	0.00	0.00	1141.69	22595.78	9286.45	0.00	0.00	40.77	4.37		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	1.14E-03	2.26E-02	9.29E-03	0.00E+00	0.00E+00	4.08E-05	4.37E-06		
	Volume (m3)	0.00E+00	0.00E+00	0.00E+00	1.14E-09	2.26E-08	9.29E-09	0.00E+00	0.00E+00	4.08E-11	4.37E-12		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	4.57E-03	1.02E-01	2.79E-02	0.00E+00	0.00E+00	1.45E-04	2.19E-05		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	1.37E-04	3.05E-03	8.36E-04	0.00E+00	0.00E+00	1.02E-04	1.49E-07	**4.12E-03**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.03	0.74	0.20	0.00	0.00	0.02	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**2.79**	**62.12**	**17.02**	**0.00**	**0.00**	**2.07**	**0.00**		**84**
INGT-FENC-51PH D													
	Area (micron)	0.00	0.00	0.00	2128.30	21070.36	17726.83	0.00	0.00	3.64	50.97		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	2.13E-03	2.11E-02	1.77E-02	0.00E+00	0.00E+00	3.64E-06	5.10E-05		
	Volume (m3)	0.00E+00	0.00E+00	0.00E+00	2.13E-09	2.11E-08	1.77E-08	0.00E+00	0.00E+00	3.64E-12	5.10E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	8.51E-03	9.48E-02	5.32E-02	0.00E+00	0.00E+00	1.30E-05	2.55E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	2.55E-04	2.84E-03	1.60E-03	0.00E+00	0.00E+00	9.07E-06	1.74E-06	**4.71E-03**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.05	0.60	0.34	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**4.56**	**50.77**	**28.48**	**0.00**	**0.00**	**0.16**	**0.03**		**84**
HW3-OSC-133PH													
	Area (micron)	0.00	10.92	0.00	0.00	2919.76	669.87	0.00	0.00	0.00	84.46		
	Area (m)	0.00E+00	1.09E-05	0.00E+00	0.00E+00	2.92E-03	6.70E-04	0.00E+00	0.00E+00	0.00E+00	8.45E-05		
	Volume (m^3)	0.00E+00	1.09E-11	0.00E+00	0.00E+00	2.92E-09	6.70E-10	0.00E+00	0.00E+00	0.00E+00	8.45E-11		
	Mass of each phase	0.00E+00	4.04E-05	0.00E+00	0.00E+00	1.31E-02	2.01E-03	0.00E+00	0.00E+00	0.00E+00	4.23E-04		
	Mass As in each phase	0.00E+00	3.07E-05	0.00E+00	0.00E+00	3.94E-04	6.03E-05	0.00E+00	0.00E+00	0.00E+00	2.88E-06	**4.88E-04**	
	Total As in each phase (wt. %)	0.00	0.06	0.00	0.00	0.81	0.12	0.00	0.00	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**3.15**	**0.00**	**0.00**	**40.38**	**6.18**	**0.00**	**0.00**	**0.00**	**0.29**		**50**
HW3-FCSC-135PH													
	Area (micron)	0.00	5.82	0.00	1762.05	5014.57	764.53	0.00	0.00	0.00	1191.93		
	Area (m)	0.00E+00	5.82E-06	0.00E+00	1.76E-03	5.01E-03	7.65E-04	0.00E+00	0.00E+00	0.00E+00	1.19E-03		
	Volume (m^3)	0.00E+00	5.82E-12	0.00E+00	1.76E-09	5.01E-09	7.65E-10	0.00E+00	0.00E+00	0.00E+00	1.19E-09		
	Mass of each phase	0.00E+00	2.16E-05	0.00E+00	7.05E-03	2.26E-02	2.29E-03	0.00E+00	0.00E+00	0.00E+00	5.97E-03		
	Mass As in each phase	0.00E+00	1.64E-05	0.00E+00	2.11E-04	6.77E-04	6.88E-05	0.00E+00	0.00E+00	0.00E+00	4.06E-05	**1.01E-03**	
	Total As in each phase (wt. %)	0.00	0.02	0.00	0.21	0.67	0.07	0.00	0.00	0.00	0.04		
	Total As in each phase (mg/kg)	**0.00**	**0.73**	**0.00**	**9.38**	**30.04**	**3.05**	**0.00**	**0.00**	**0.00**	**1.80**		**45**
MIR-OSG-01PH													
	Area (micron)	0.00	9.47	0.00	200.96	308.72	240.28	0.00	0.00	0.00	104.12		
	Area (m)	0.00E+00	9.47E-06	0.00E+00	2.01E-04	3.09E-04	2.40E-04	0.00E+00	0.00E+00	0.00E+00	1.04E-04		
	Volume (m^3)	0.00E+00	9.47E-12	0.00E+00	2.01E-10	3.09E-10	2.40E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-10		
	Mass of each phase	0.00E+00	3.50E-05	0.00E+00	8.04E-04	1.39E-03	7.21E-04	0.00E+00	0.00E+00	0.00E+00	5.22E-04		
	Mass As in each phase	0.00E+00	2.66E-05	0.00E+00	2.41E-05	4.17E-05	2.16E-05	0.00E+00	0.00E+00	0.00E+00	3.55E-06	**1.18E-04**	
	Total As in each phase (wt. %)	0.00	0.23	0.00	0.21	0.35	0.18	0.00	0.00	0.00	0.03		
	Total As in each phase (mg/kg)	**0.00**	**1.83**	**0.00**	**1.66**	**2.87**	**1.49**	**0.00**	**0.00**	**0.00**	**0.24**		**8.1**
MASL-OSC-65PH													
	Area (micron)	0.00	349.50	0.00	0.00	877.39	200.96	0.00	0.00	0.00	141.98		
	Area (m)	0.00E+00	3.49E-04	0.00E+00	0.00E+00	8.77E-04	2.01E-04	0.00E+00	0.00E+00	0.00E+00	1.42E-04		
	Volume (m^3)	0.00E+00	3.49E-10	0.00E+00	0.00E+00	8.77E-10	2.01E-10	0.00E+00	0.00E+00	0.00E+00	1.42E-10		
	Mass of each phase	0.00E+00	1.29E-03	0.00E+00	0.00E+00	3.95E-03	6.03E-04	0.00E+00	0.00E+00	0.00E+00	7.11E-04		
	Mass As in each phase	0.00E+00	9.83E-04	0.00E+00	0.00E+00	1.18E-04	1.81E-05	0.00E+00	0.00E+00	0.00E+00	4.84E-06	**1.12E-03**	
	Total As in each phase (wt. %)	0.00	0.87	0.00	0.00	0.11	0.02	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**76.06**	**0.00**	**0.00**	**9.17**	**1.40**	**0.00**	**0.00**	**0.00**	**0.37**		**87**
SW3-PSC-89PH													
	Area (micron)	0.00	0.00	0.00	0.00	473.28	8.01	0.00	0.00	0.00	123.78		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.73E-04	8.01E-06	0.00E+00	0.00E+00	0.00E+00	1.24E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.73E-10	8.01E-12	0.00E+00	0.00E+00	0.00E+00	1.24E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E-03	2.40E-05	0.00E+00	0.00E+00	0.00E+00	6.20E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E-05	7.21E-07	0.00E+00	0.00E+00	0.00E+00	4.22E-06	**6.88E-05**	

Table F: Weight percent calculator for As-bearing phases identified via SEM / AM in PHL samples.

	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.93	0.01	0.00	0.00	0.00	0.06		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**27.85**	**0.31**	**0.00**	**0.00**	**0.00**	**1.84**		**30**
HOML-OSG-57													
	Area (micron)	0.00	0.00	0.00	63551.85	2111512.72	746476.82	0.00	1076.89	0.00	2314.70		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	6.36E-02	2.11E+00	7.46E-01	0.00E+00	1.08E-03	0.00E+00	2.31E-03		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	6.36E-08	2.11E-06	7.46E-07	0.00E+00	1.08E-09	0.00E+00	2.31E-09		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	2.54E-01	9.50E+00	2.24E+00	0.00E+00	6.54E-03	0.00E+00	1.16E-02		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	7.63E-03	2.85E-01	6.72E-02	0.00E+00	3.01E-03	0.00E+00	7.89E-05	**3.63E-01**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.02	0.79	0.19	0.00	0.01	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**9.46**	**353.42**	**83.30**	**0.00**	**3.73**	**0.00**	**0.10**		**450**
HOML-PSC-58PH													
	Area (micron)	0.00	0.00	0.00	0.00	1253.82	108.49	0.00	0.00	0.00	168.92		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-03	1.08E-04	0.00E+00	0.00E+00	0.00E+00	1.69E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-09	1.08E-10	0.00E+00	0.00E+00	0.00E+00	1.69E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.64E-03	3.25E-04	0.00E+00	0.00E+00	0.00E+00	8.46E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E-04	9.76E-06	0.00E+00	0.00E+00	0.00E+00	5.75E-06	**1.85E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.92	0.05	0.00	0.00	0.00	0.03		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**17.40**	**1.00**	**0.00**	**0.00**	**0.00**	**0.59**		**19**
EAST2-FCSC-66PH													
	Area (micron)	0.00	16.75	0.00	70.63	350.95	340.03	0.00	21.84	0.00	190.77		
	Area (m)	0.00E+00	1.67E-05	0.00E+00	7.06E-05	3.51E-04	3.40E-04	0.00E+00	2.18E-05	0.00E+00	1.91E-04		
	Volume (m^3)	0.00E+00	1.67E-11	0.00E+00	7.06E-11	3.51E-10	3.40E-10	0.00E+00	2.18E-11	0.00E+00	1.91E-10		
	Mass of each phase	0.00E+00	6.20E-05	0.00E+00	2.83E-04	1.58E-03	1.02E-03	0.00E+00	1.33E-04	0.00E+00	9.56E-04		
	Mass As in each phase	0.00E+00	4.71E-05	0.00E+00	8.48E-06	4.74E-05	3.06E-05	0.00E+00	6.10E-05	0.00E+00	6.50E-06	**2.01E-04**	
	Total As in each phase (wt. %)	0.00	0.23	0.00	0.04	0.24	0.15	0.00	0.30	0.00	0.03		
	Total As in each phase (mg/kg)	**0.00**	**12.18**	**0.00**	**2.19**	**12.25**	**7.92**	**0.00**	**15.78**	**0.00**	**1.68**		**52**
DUF-OSC-54PH													
	Area (micron)	0.00	28.40	0.00	0.00	413.57	34.95	0.00	0.00	0.00	0.00		
	Area (m)	0.00E+00	2.84E-05	0.00E+00	0.00E+00	4.14E-04	3.49E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Volume (m^3)	0.00E+00	2.84E-11	0.00E+00	0.00E+00	4.14E-10	3.49E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Mass of each phase	0.00E+00	1.05E-04	0.00E+00	0.00E+00	1.86E-03	1.05E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Mass As in each phase	0.00E+00	7.99E-05	0.00E+00	0.00E+00	5.58E-05	3.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**1.39E-04**	
	Total As in each phase (wt. %)	0.00	0.58	0.00	0.00	0.40	0.02	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**29.91**	**0.00**	**0.00**	**20.91**	**1.18**	**0.00**	**0.00**	**0.00**	**0.00**		**52**

Appendix G: Table Used to Complete Weight Percent Calculations for As-bearing Phases Identified by SEM / AM in DC Samples

Table G – Weight percent calculations for As-bearing phases in DC samples

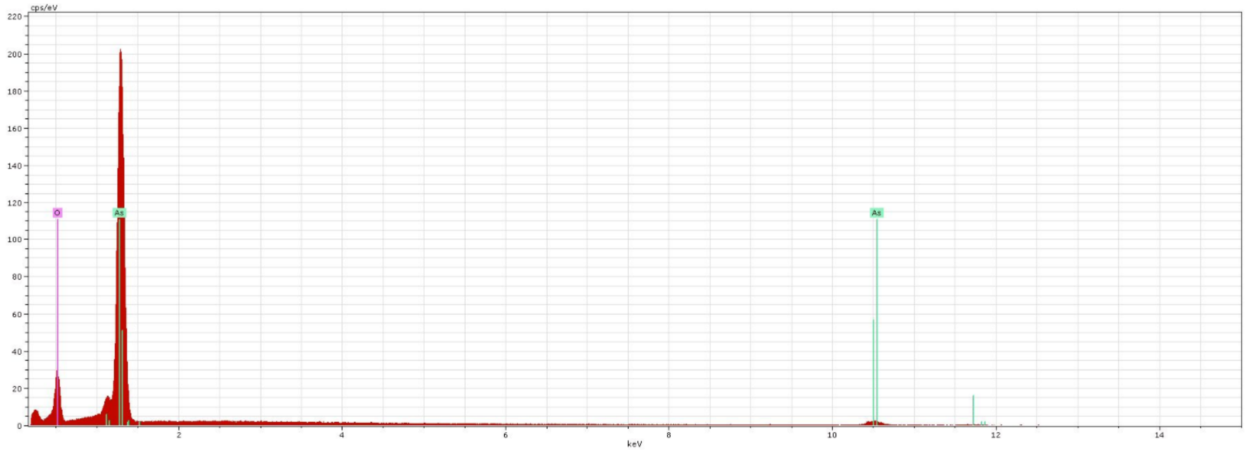
	Mineral Phase	Enargite	Arsenolite	Scorodite	MnOx Mix + As	FeOx/FeOx Mix + As	Organics + FeOx + As	Fe-Ca Arsenate	Arsenopyrite	Realgar	-bearing Pyrite	tal Mass of As in Each Sample	otal As Results (ASU) (mg/kg)
	Density (g/cm³)	**4.45**	**3.70**	**3.27**	**4.00**	**4.50**	**3.00**	**3.92**	**6.07**	**3.56**	**5.01**		
	Density (g/m³)	**4450000**	**3700000**	**3270000**	**4000000**	**4500000**	**3000000**	**3920000**	**6070000**	**3560000**	**5010000**		
	wt % As in each Phase	**0.19**	**0.76**	**0.32**	**0.03**	**0.03**	**0.03**	**0.15**	**0.46**	**0.70**	**0.0068**		
BPR-FCSC-14DC	Area (micron)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E+03	1.95E+03	0.00E+00	0.00E+00	0.00E+00	1.60E+01		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-03	1.95E-03	0.00E+00	0.00E+00	0.00E+00	1.60E-05		
	Volume (m³)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-09	1.95E-09	0.00E+00	0.00E+00	0.00E+00	1.60E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.78E-03	5.84E-03	0.00E+00	0.00E+00	0.00E+00	8.03E-05		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.44E-04	1.75E-04	0.00E+00	0.00E+00	0.00E+00	5.46E-07	**3.19E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.45	0.55	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**28.32**	**34.58**	**0.00**	**0.00**	**0.00**	**0.11**		**63**
BPR-FCSC-14DC D													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	2.53E+02	1.14E+03	8.26E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	2.53E-04	1.14E-03	8.26E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Volume (m³)	0.00E+00	0.00E+00	0.00E+00	2.53E-10	1.14E-09	8.26E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	1.01E-03	5.13E-03	2.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	3.04E-05	1.54E-04	7.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**2.59E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.12	0.60	0.29	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**7.40**	**37.50**	**18.09**	**0.00**	**0.00**	**0.00**	**0.00**		**63**
BPR-PSC-161DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.66E+02	5.17E+01	0.00E+00	0.00E+00	0.00E+00	1.60E+01		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.66E-04	5.17E-05	0.00E+00	0.00E+00	0.00E+00	1.60E-05		
	Volume (m³)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.66E-10	5.17E-11	0.00E+00	0.00E+00	0.00E+00	1.60E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-03	1.55E-04	0.00E+00	0.00E+00	0.00E+00	8.03E-05		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.94E-05	4.65E-06	0.00E+00	0.00E+00	0.00E+00	5.46E-07	**5.46E-05**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.90	0.09	0.00	0.00	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**1085.84**	**102.18**	**0.00**	**0.00**	**0.00**	**11.98**		**1200**
LL-OSC-120DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.52E+02	4.28E+02	0.00E+00	4.22E+01	0.00E+00	1.15E+02		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.52E-04	4.28E-04	0.00E+00	4.22E-05	0.00E+00	1.15E-04		
	Volume (m³)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.52E-10	4.28E-10	0.00E+00	4.22E-11	0.00E+00	1.15E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.83E-03	1.28E-03	0.00E+00	2.56E-04	0.00E+00	5.76E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-04	3.85E-05	0.00E+00	1.18E-04	0.00E+00	3.92E-06	**2.75E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.42	0.14	0.00	0.43	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**1.04**	**0.35**	**0.00**	**1.07**	**0.00**	**0.04**		**2.5**
TX-OSC-145DC													
	Area (micron)	0.00E+00	1.53E+01	0.00E+00	4.26E+05	9.95E+04	2.14E+05	0.00E+00	0.00E+00	0.00E+00	1.88E+03		
	Area (m)	0.00E+00	1.53E-05	0.00E+00	4.26E-01	9.95E-02	2.14E-01	0.00E+00	0.00E+00	0.00E+00	1.88E-03		
	Volume (m³)	0.00E+00	1.53E-11	0.00E+00	4.26E-07	9.95E-08	2.14E-07	0.00E+00	0.00E+00	0.00E+00	1.88E-09		
	Mass of each phase	0.00E+00	5.66E-05	0.00E+00	1.70E+00	4.48E-01	6.43E-01	0.00E+00	0.00E+00	0.00E+00	9.44E-03		
	Mass As in each phase	0.00E+00	4.30E-05	0.00E+00	5.11E-02	1.34E-02	1.93E-02	0.00E+00	0.00E+00	0.00E+00	6.42E-05	**8.39E-02**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.61	0.16	0.23	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.16**	**0.00**	**194.83**	**51.21**	**73.55**	**0.00**	**0.00**	**0.00**	**0.24**		**320**
TX-FCOSC-155DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	1.69E+04	2.73E+04	9.94E+04	0.00E+00	1.19E+02	0.00E+00	4.81E+01		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	1.69E-02	2.73E-02	9.94E-02	0.00E+00	1.19E-04	0.00E+00	4.81E-05		
	Volume (m³)	0.00E+00	0.00E+00	0.00E+00	1.69E-08	2.73E-08	9.94E-08	0.00E+00	1.19E-10	0.00E+00	4.81E-11		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	6.76E-02	1.23E-01	2.98E-01	0.00E+00	7.25E-04	0.00E+00	2.41E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	2.03E-03	3.68E-03	8.94E-03	0.00E+00	3.33E-04	0.00E+00	1.64E-06	**1.50E-02**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.14	0.25	0.60	0.00	0.02	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.96**	**1.74**	**4.24**	**0.00**	**0.16**	**0.00**	**0.00**		**7.1**

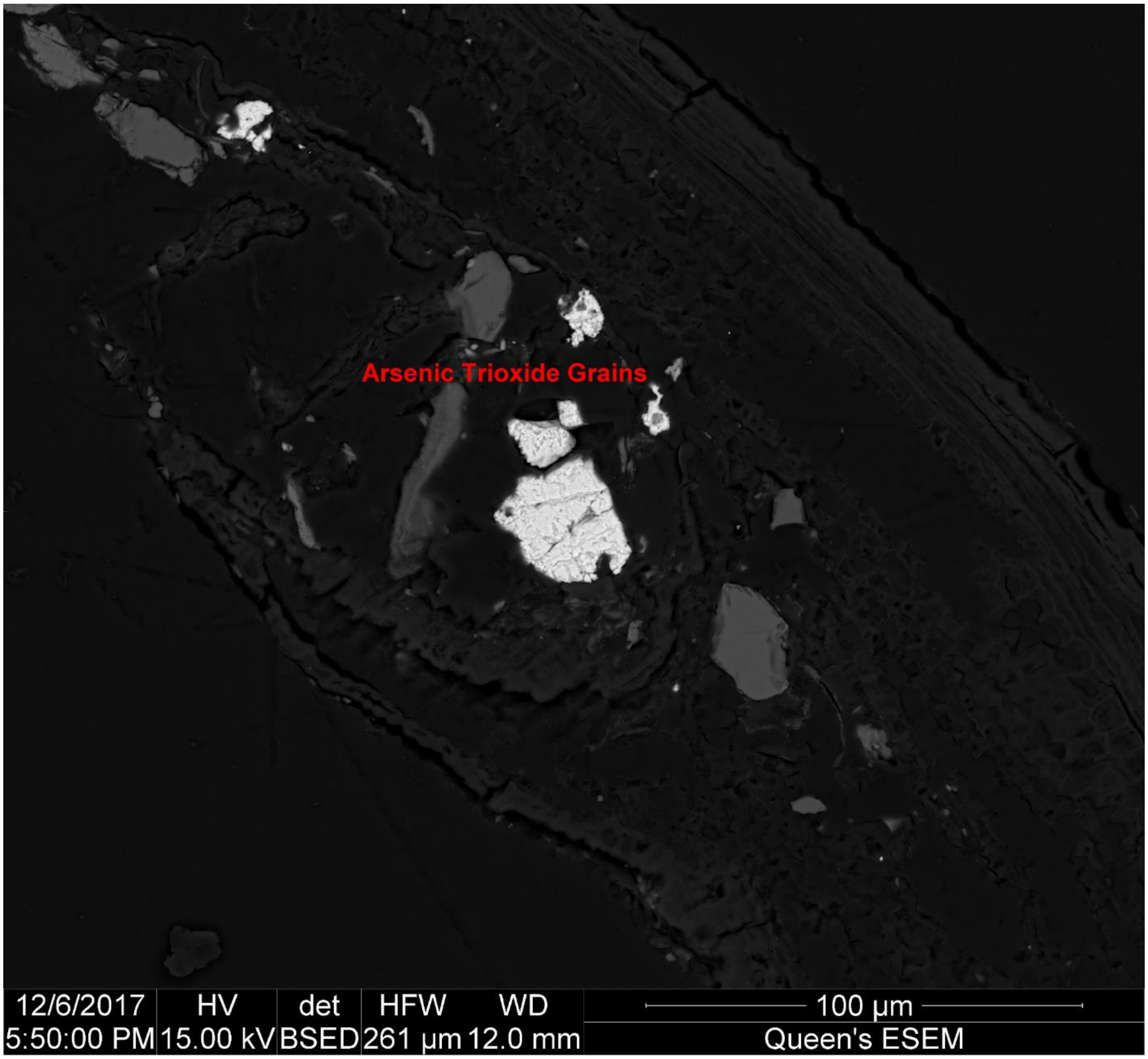
Table G – Weight percent calculations for As-bearing phases in DC samples

ML-OSC-98DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	5.10E+00	1.28E+05	1.29E+05	0.00E+00	0.00E+00	0.00E+00	7.86E+02		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	5.10E-06	1.28E-01	1.29E-01	0.00E+00	0.00E+00	0.00E+00	7.86E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	5.10E-12	1.28E-07	1.29E-07	0.00E+00	0.00E+00	0.00E+00	7.86E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	2.04E-05	5.76E-01	3.87E-01	0.00E+00	0.00E+00	0.00E+00	3.94E-03		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	6.12E-07	1.73E-02	1.16E-02	0.00E+00	0.00E+00	0.00E+00	2.68E-05	**2.89E-02**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.60	0.40	0.00	0.00	0.00	0.00		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**17.33**	**11.64**	**0.00**	**0.00**	**0.00**	**0.03**		**29**
INGT-FCSC-28 DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E+04	3.37E+03	0.00E+00	0.00E+00	0.00E+00	3.34E+02		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-02	3.37E-03	0.00E+00	0.00E+00	0.00E+00	3.34E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-08	3.37E-09	0.00E+00	0.00E+00	0.00E+00	3.34E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.22E-02	1.01E-02	0.00E+00	0.00E+00	0.00E+00	1.67E-03		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-03	3.03E-04	0.00E+00	0.00E+00	0.00E+00	1.14E-05	**1.88E-03**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.83	0.16	0.00	0.00	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**31.64**	**6.13**	**0.00**	**0.00**	**0.00**	**0.23**		**38**
HW3-FCSC-135 DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E+03	5.72E+02	0.00E+00	0.00E+00	0.00E+00	1.57E+02		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-03	5.72E-04	0.00E+00	0.00E+00	0.00E+00	1.57E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-09	5.72E-10	0.00E+00	0.00E+00	0.00E+00	1.57E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-03	1.71E-03	0.00E+00	0.00E+00	0.00E+00	7.88E-04		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-04	5.14E-05	0.00E+00	0.00E+00	0.00E+00	5.36E-06	**2.81E-04**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.00	0.80	0.18	0.00	0.00	0.00	0.02		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.00**	**7.98**	**1.83**	**0.00**	**0.00**	**0.00**	**0.19**		**10**
EAST2-FCSC-66DC													
	Area (micron)	0.00E+00	0.00E+00	0.00E+00	3.20E+03	1.27E+04	1.36E+03	0.00E+00	5.82E+00	0.00E+00	4.59E+02		
	Area (m)	0.00E+00	0.00E+00	0.00E+00	3.20E-03	1.27E-02	1.36E-03	0.00E+00	5.82E-06	0.00E+00	4.59E-04		
	Volume (m^3)	0.00E+00	0.00E+00	0.00E+00	3.20E-09	1.27E-08	1.36E-09	0.00E+00	5.82E-12	0.00E+00	4.59E-10		
	Mass of each phase	0.00E+00	0.00E+00	0.00E+00	1.28E-02	5.72E-02	4.09E-03	0.00E+00	3.54E-05	0.00E+00	2.30E-03		
	Mass As in each phase	0.00E+00	0.00E+00	0.00E+00	3.84E-04	1.72E-03	1.23E-04	0.00E+00	1.63E-05	0.00E+00	1.56E-05	**2.26E-03**	
	Total As in each phase (wt. %)	0.00	0.00	0.00	0.17	0.76	0.05	0.00	0.01	0.00	0.01		
	Total As in each phase (mg/kg)	**0.00**	**0.00**	**0.00**	**0.78**	**3.50**	**0.25**	**0.00**	**0.03**	**0.00**	**0.03**		**4.6**

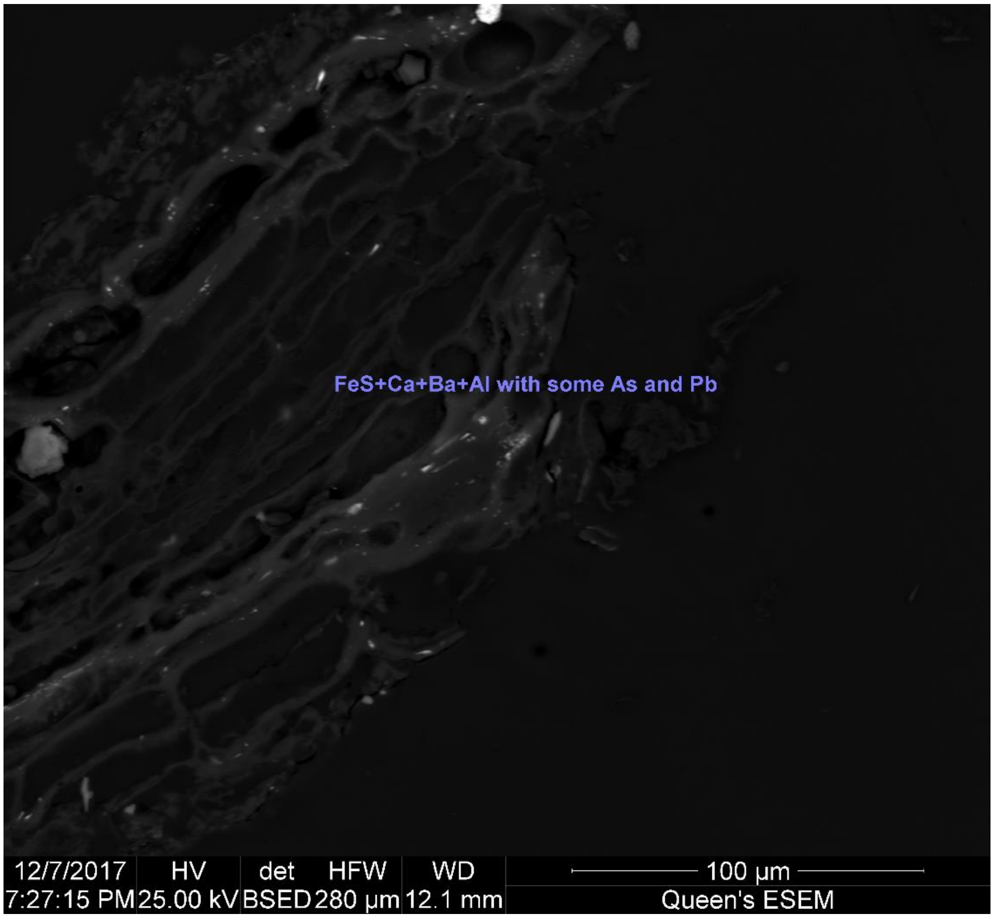
Appendix H: SEM / AM Images and Associated Spectra

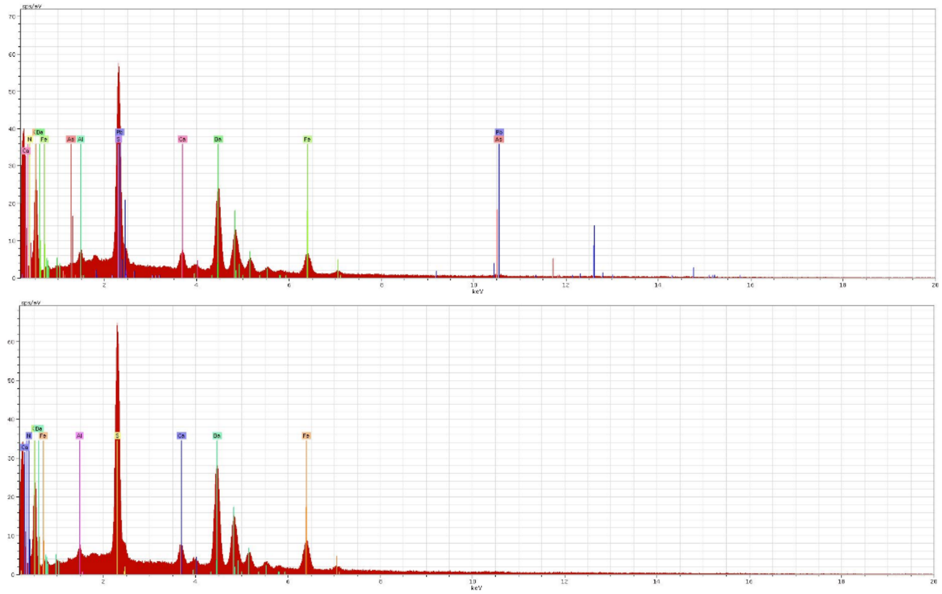
BPR – OSC – 93 PH: SEM Image and Associated Spectrum



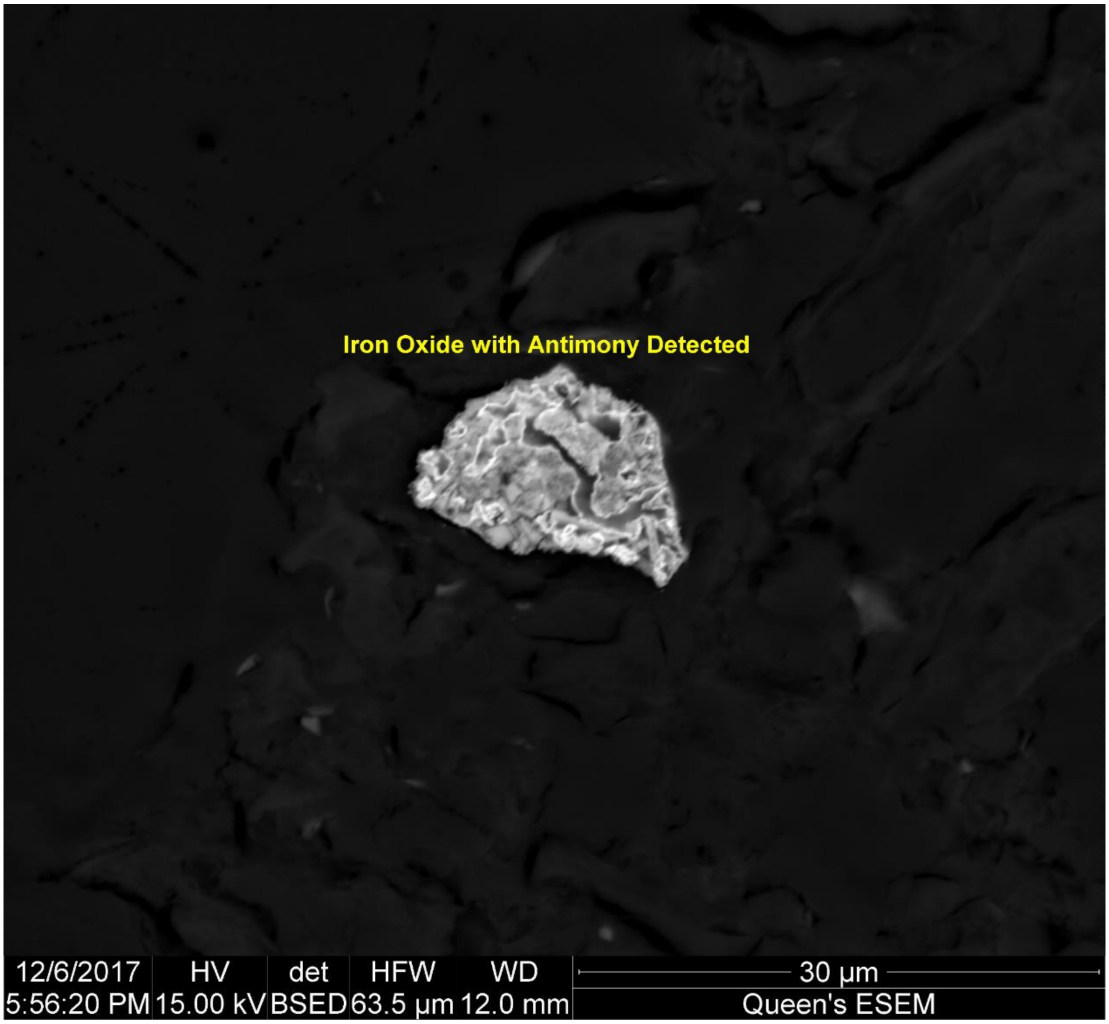


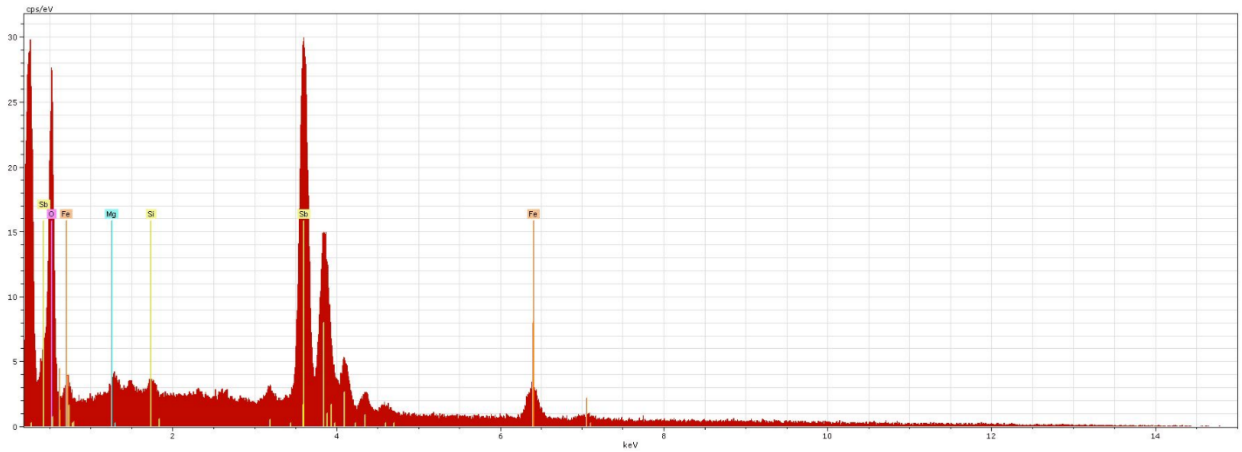
BPR – OSC – 93 PH: SEM Image and Associated Spectra



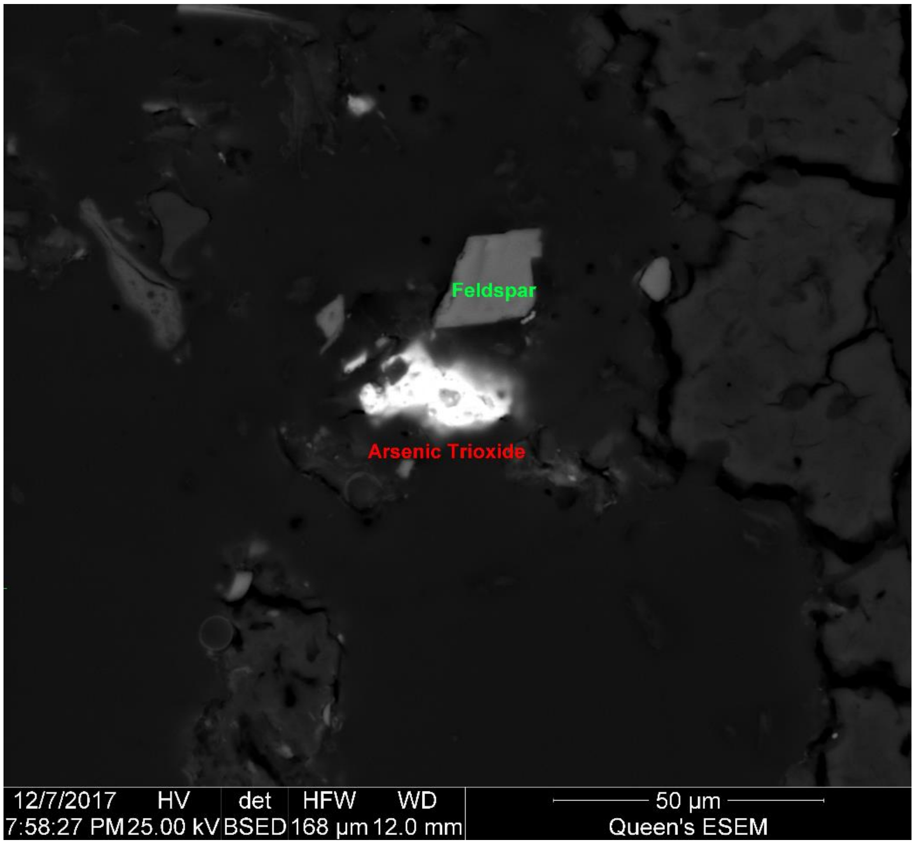


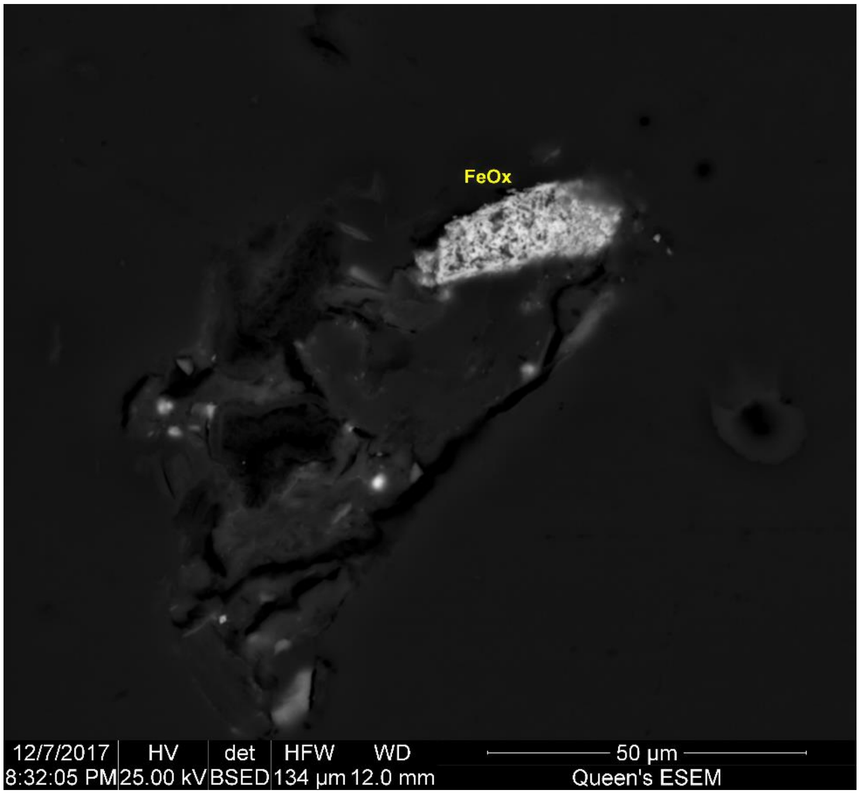
BPR – OSC – 93 PH: SEM Image and Associated Spectrum



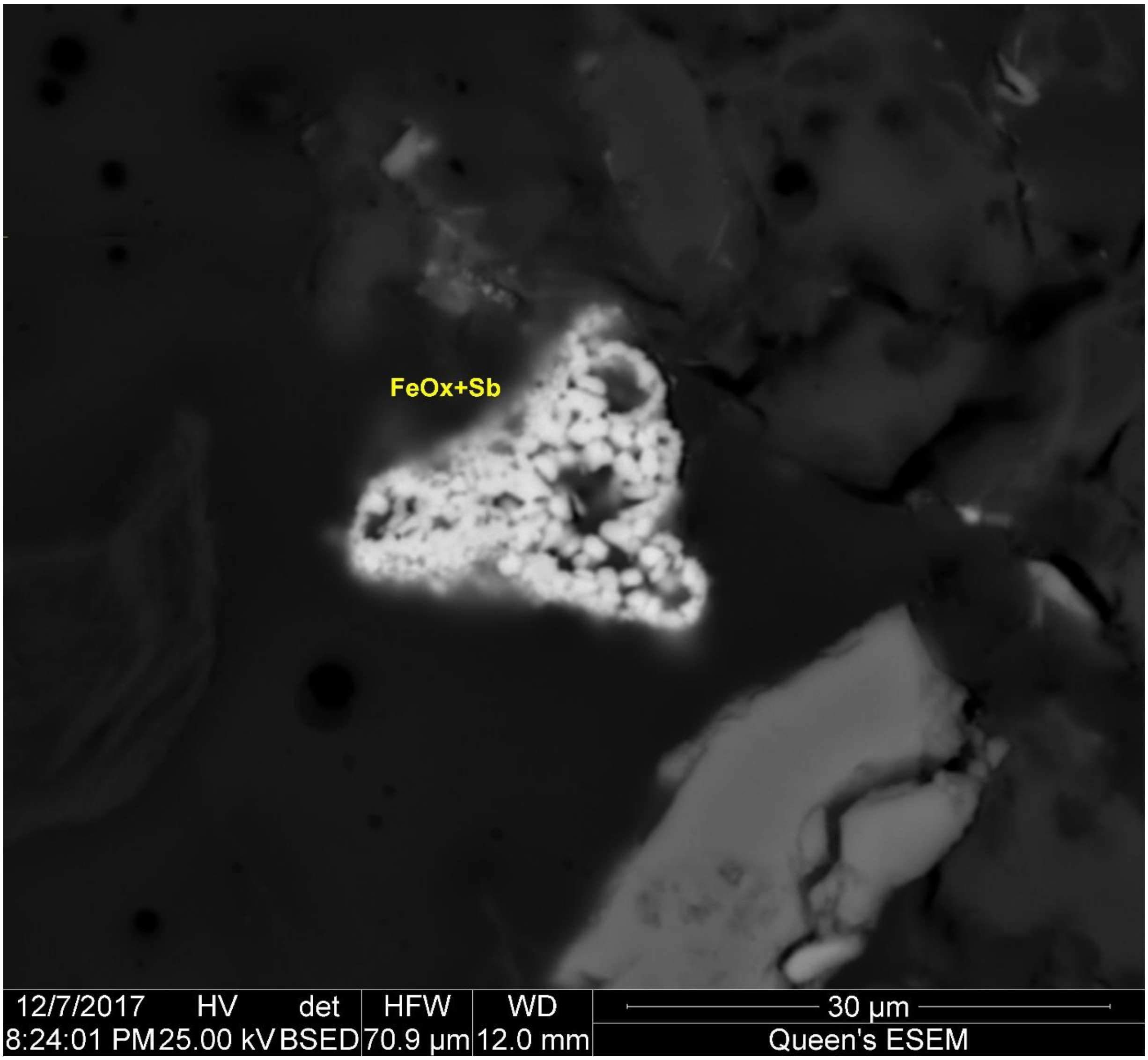


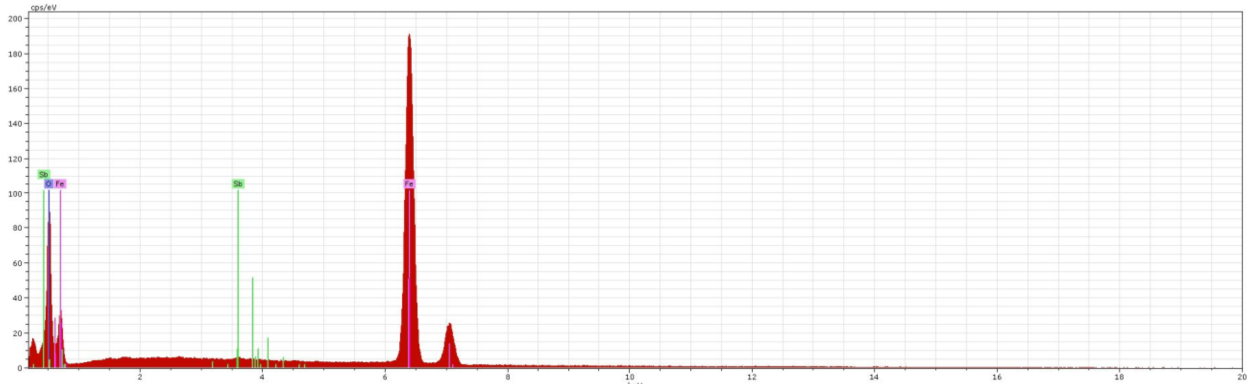
BPR – FCSC– 14 PH: SEM Images



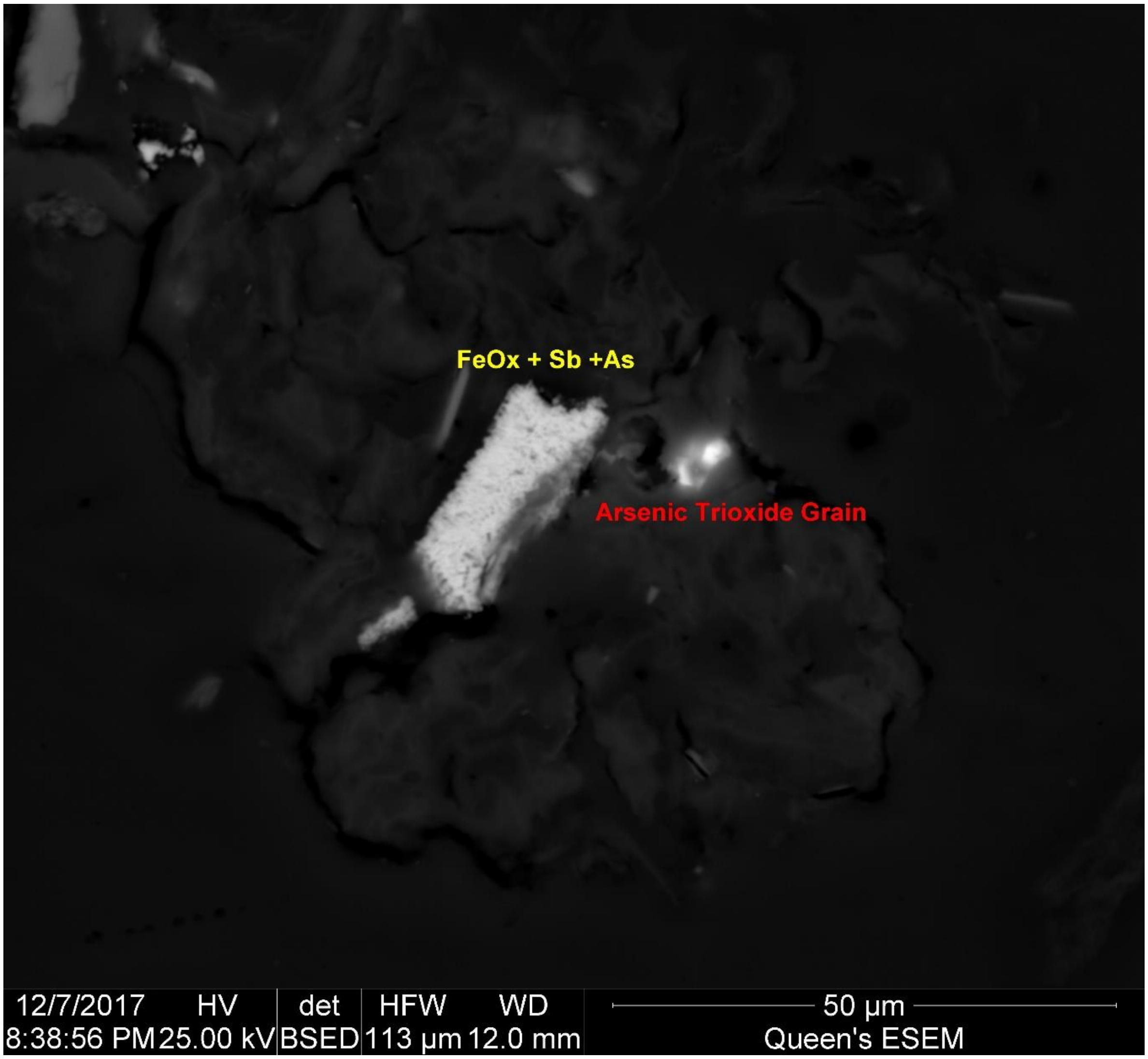


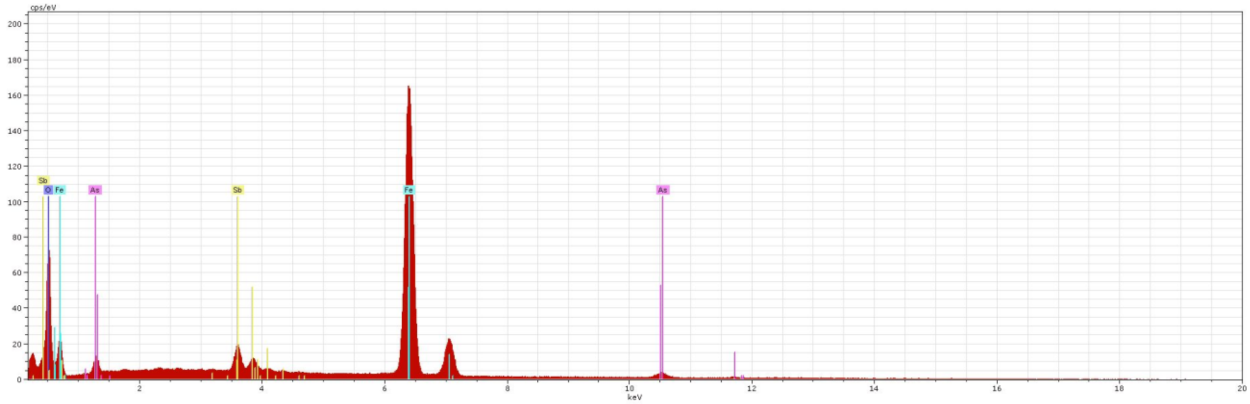
BPR – FCSC– 14 PH: SEM Image and Associated Spectrum



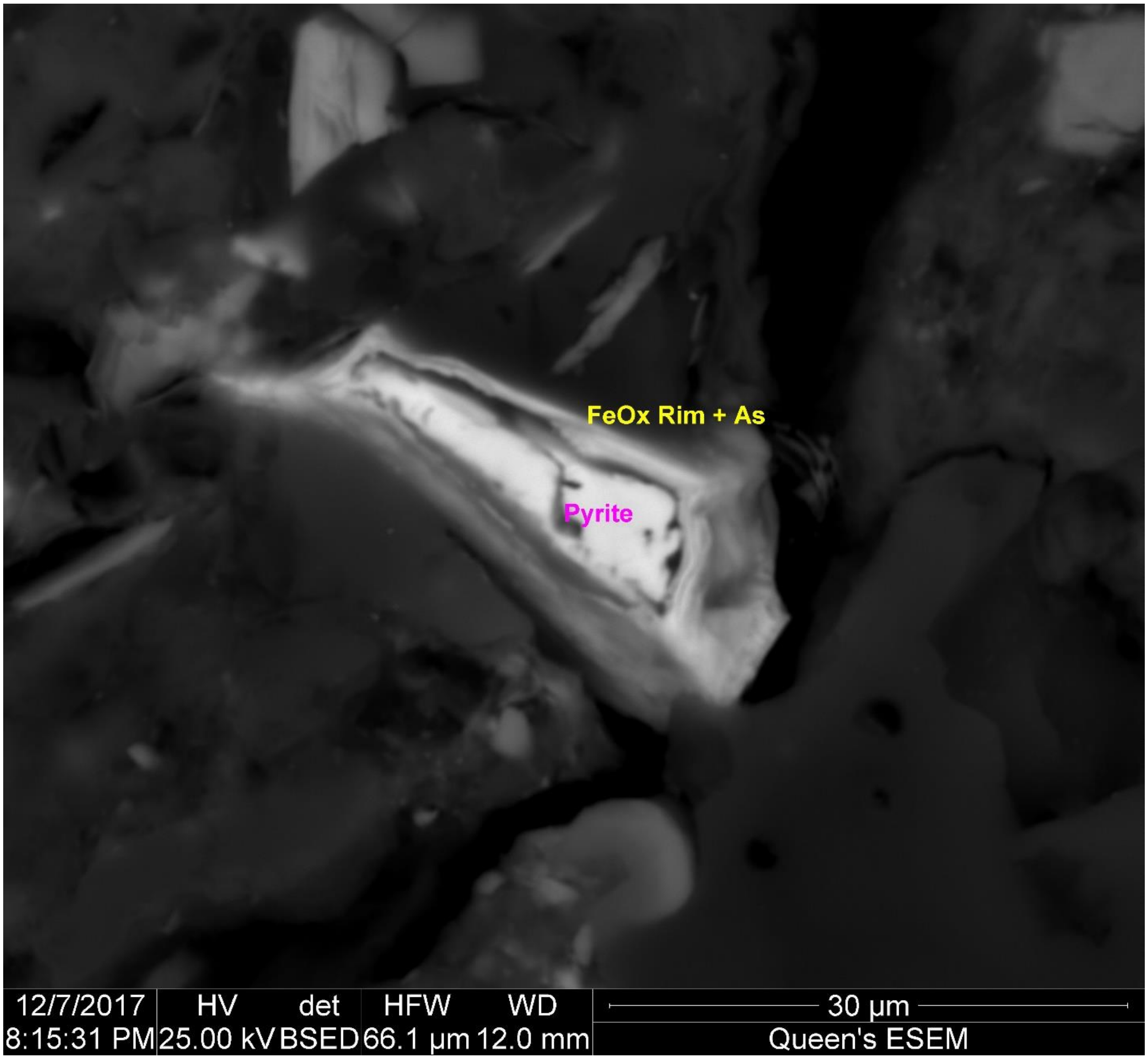


BPR – FCSC– 14 PH: SEM Image and Associated Spectrum

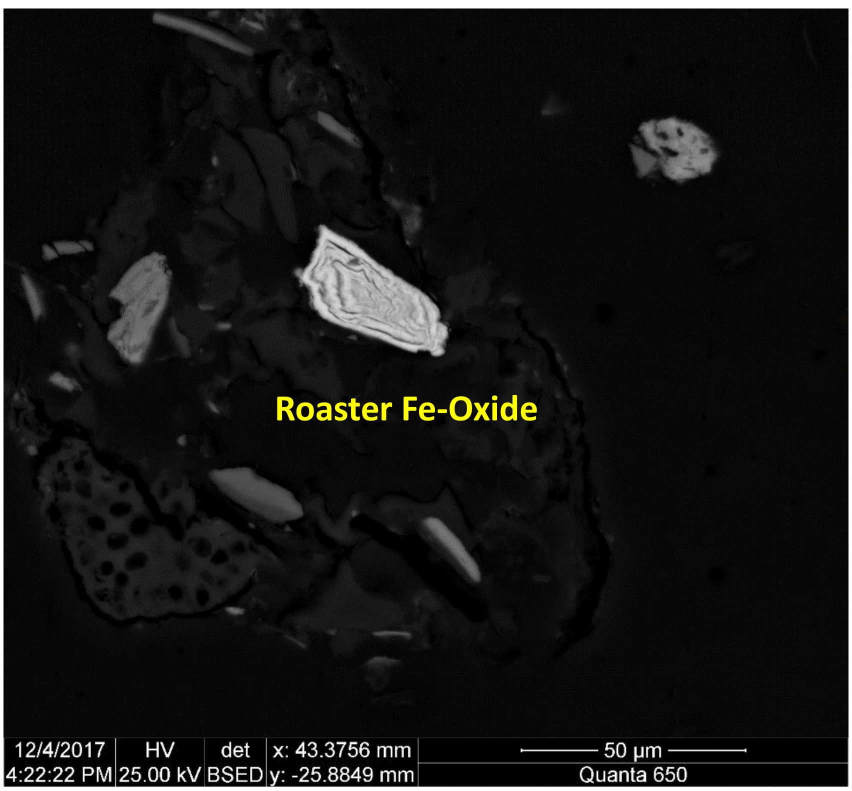




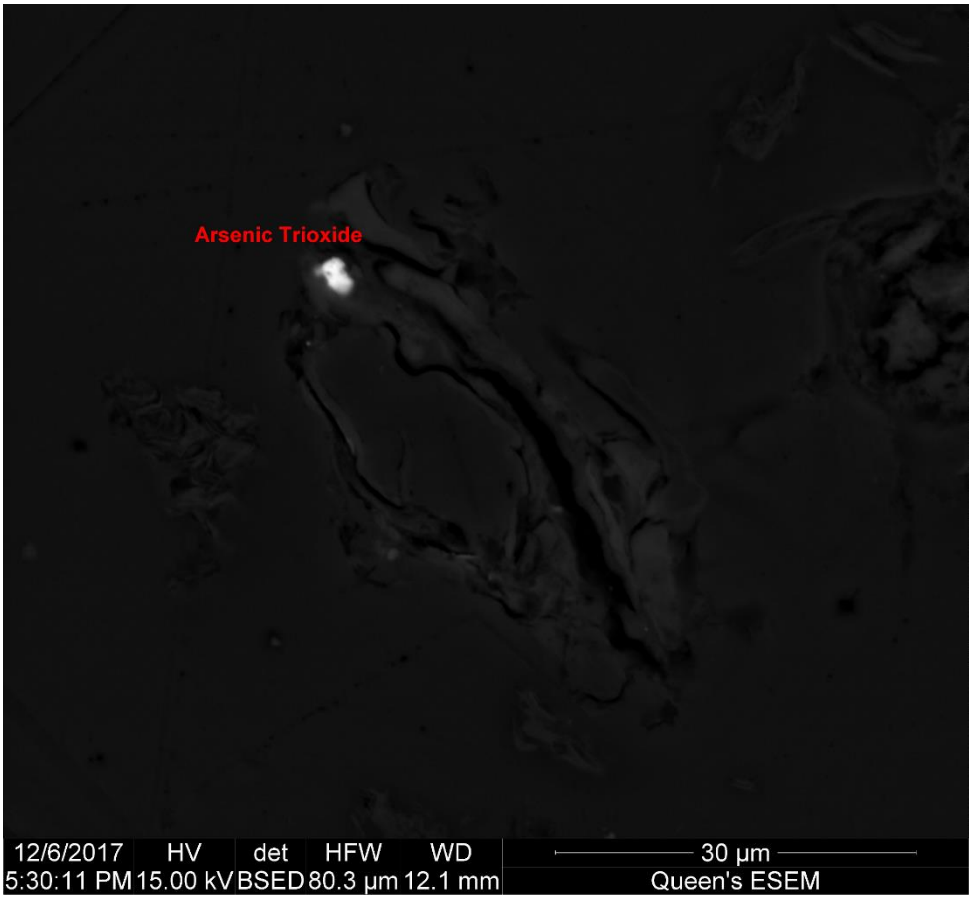
BPR – FCSC– 14 PH: SEM Image

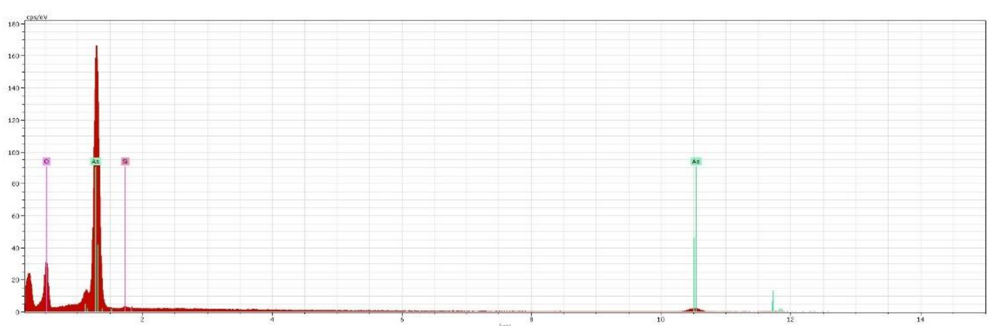


INGT – OSG – 46: SEM Images

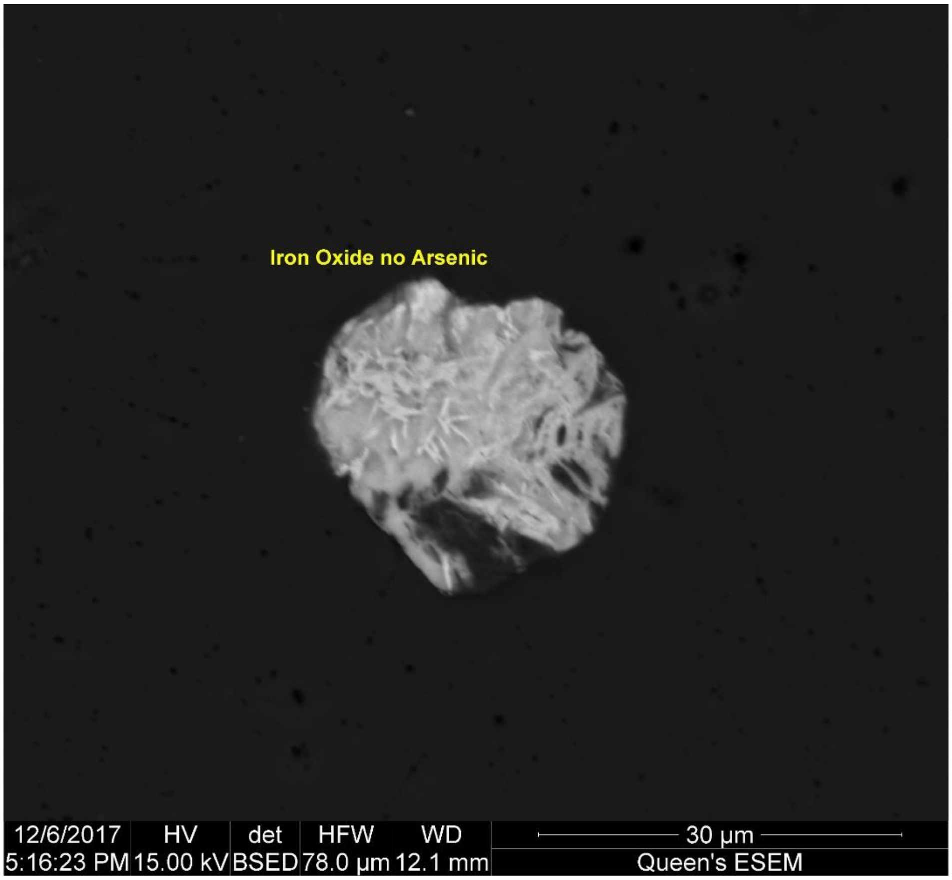


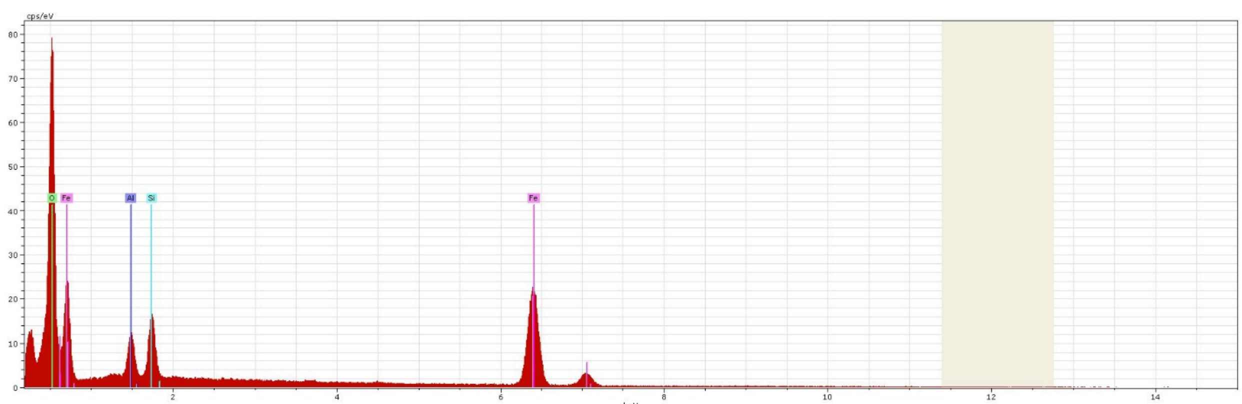
DUF – OSC – 54 PH: SEM Image and Associated Spectrum



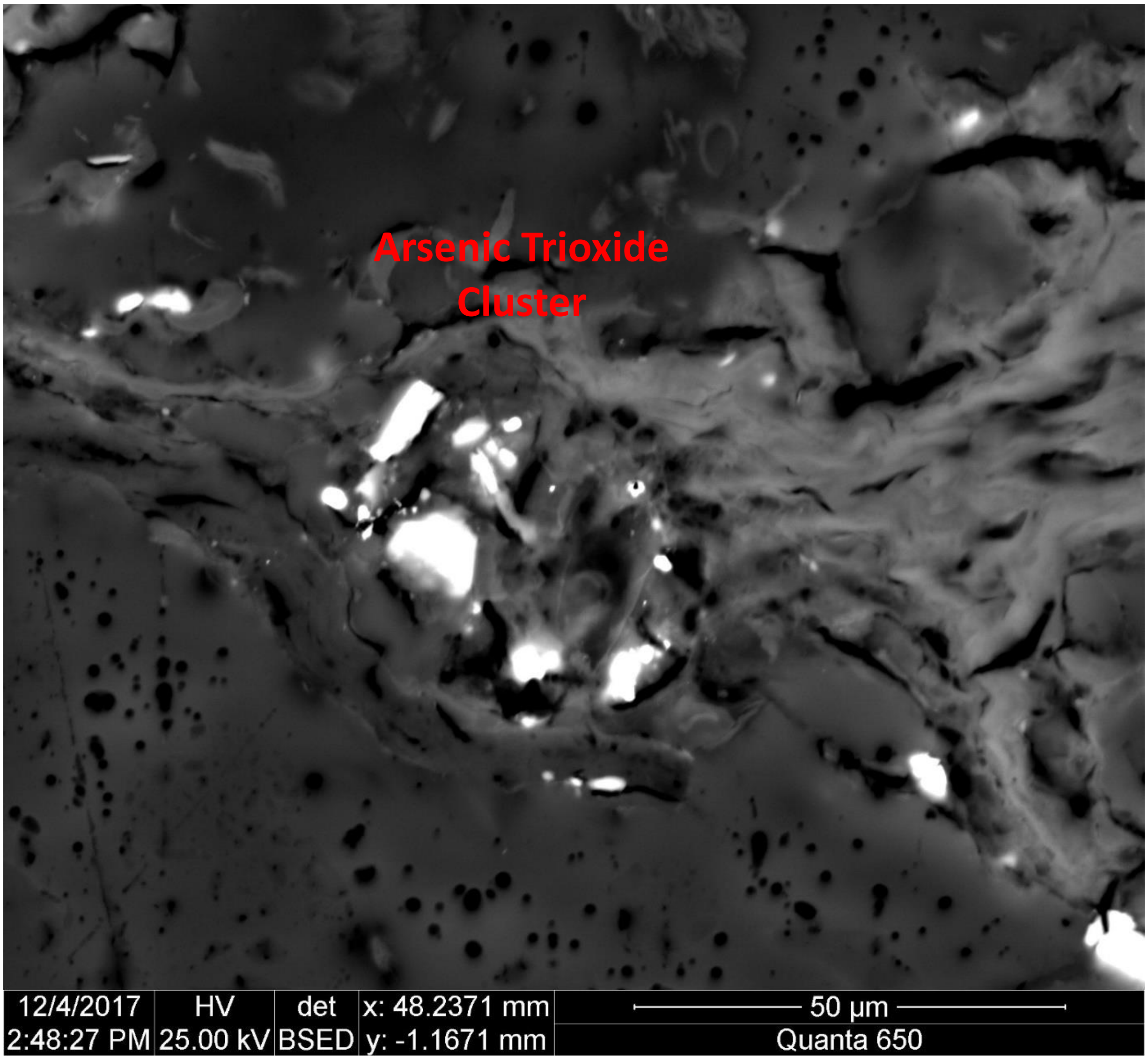


DUF – OSC – 54 PH: SEM Image and Associated Spectrum

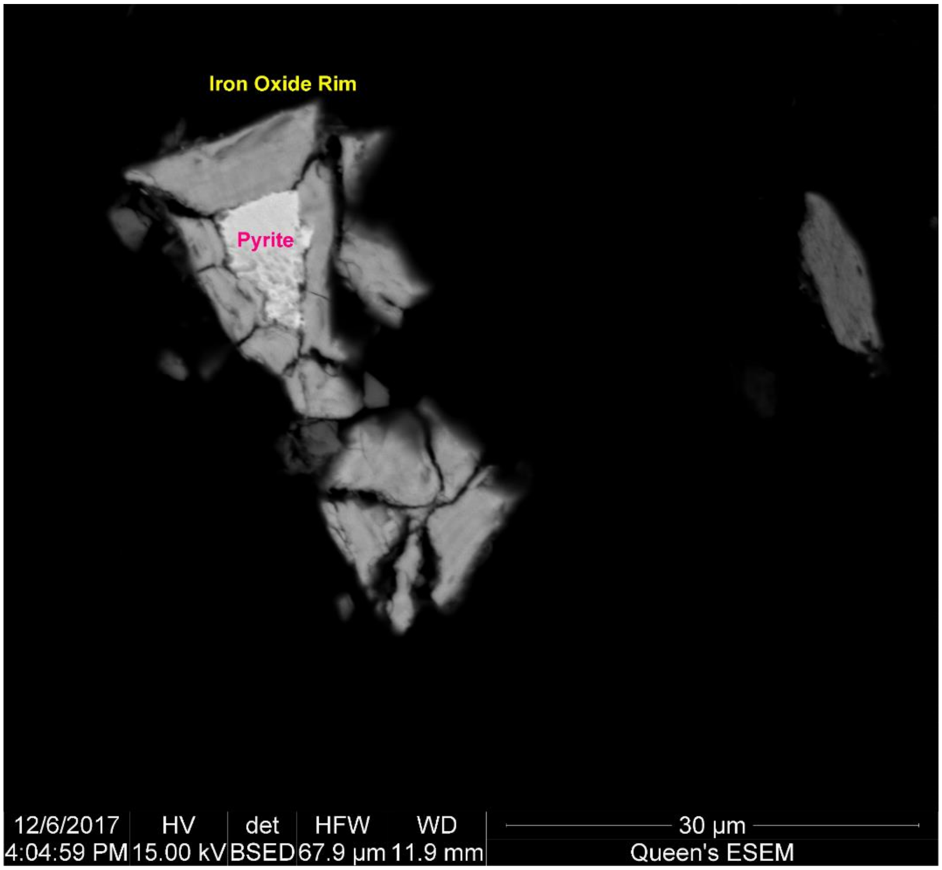


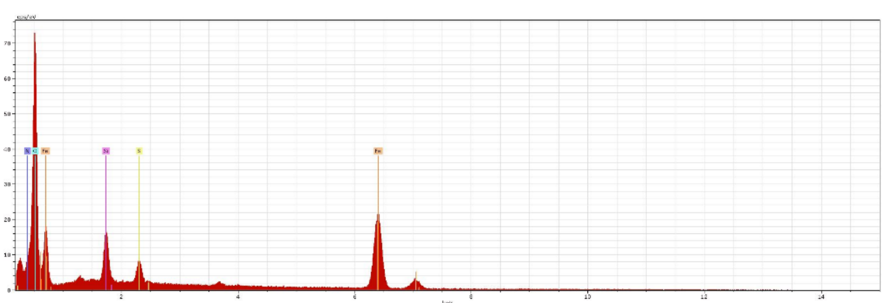


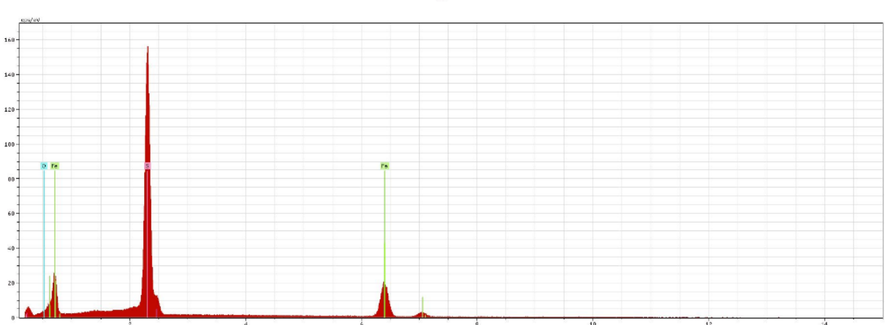
DETR – FCSC – 34 PH: SEM Image



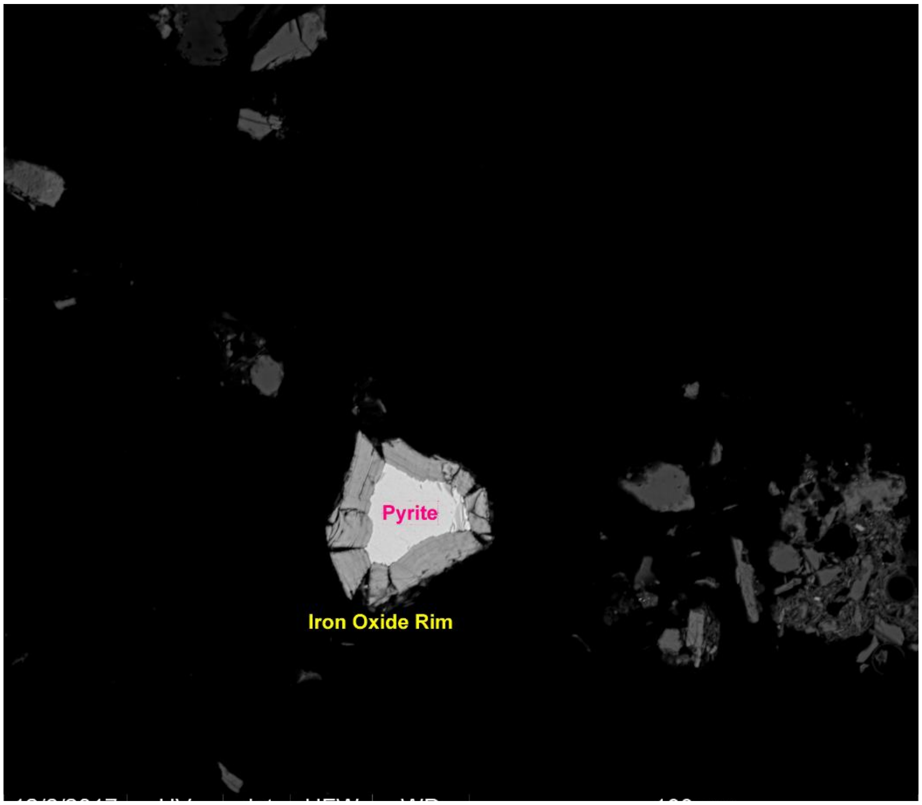
HW3 – FCSC – 135 PH: SEM Image and Associated Spectra

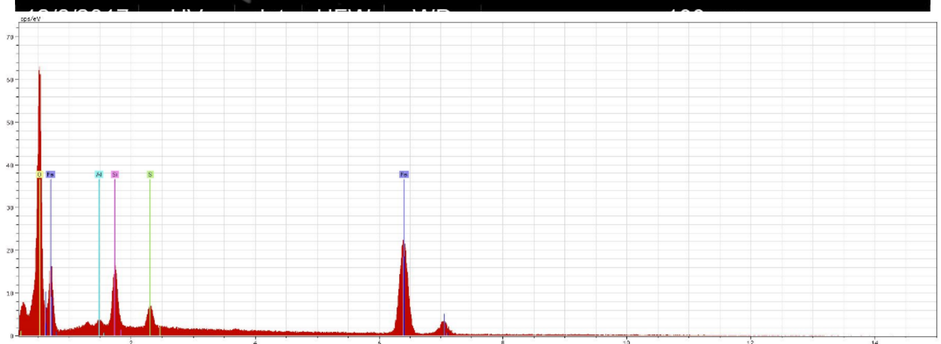


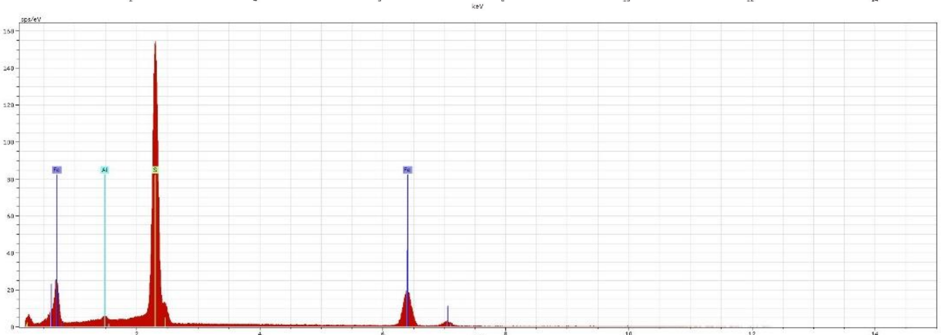




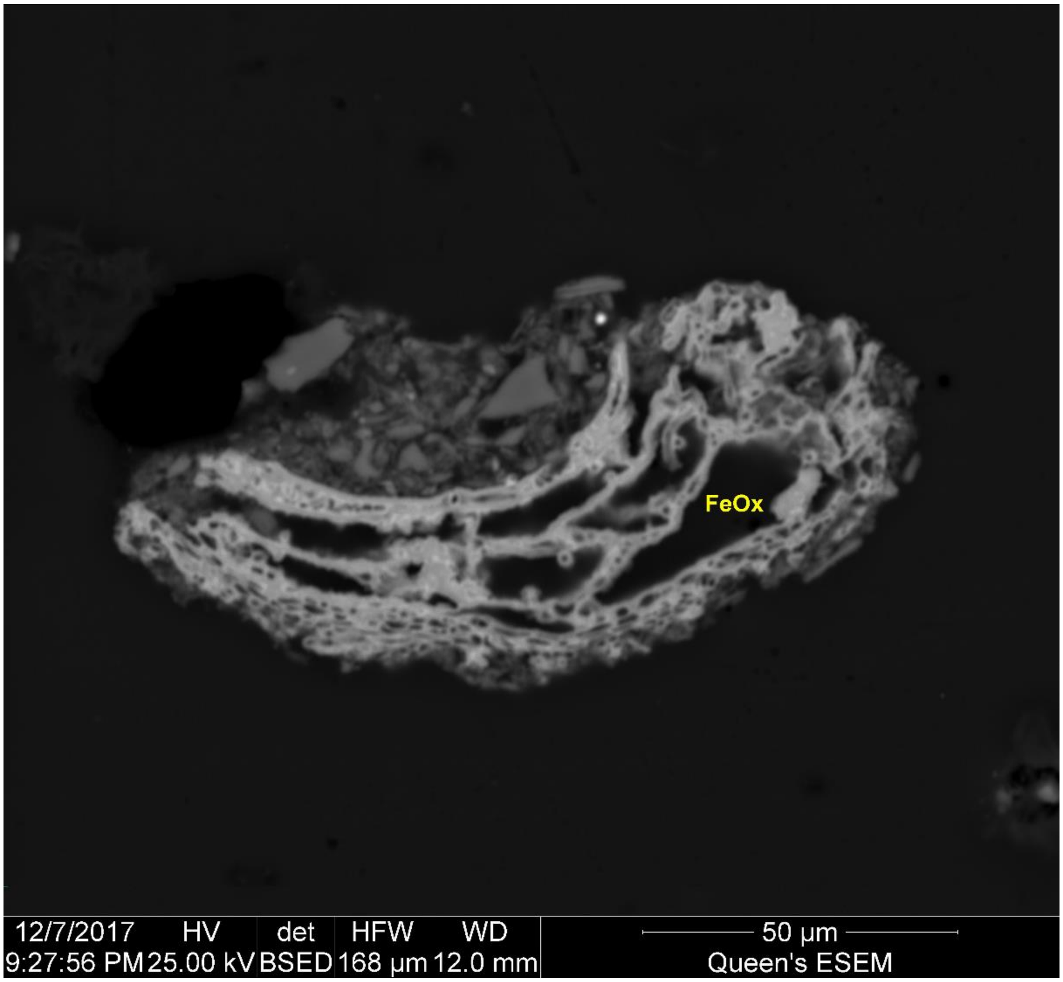
HW3 – FCSC – 135 PH: SEM Image and Associated Spectra

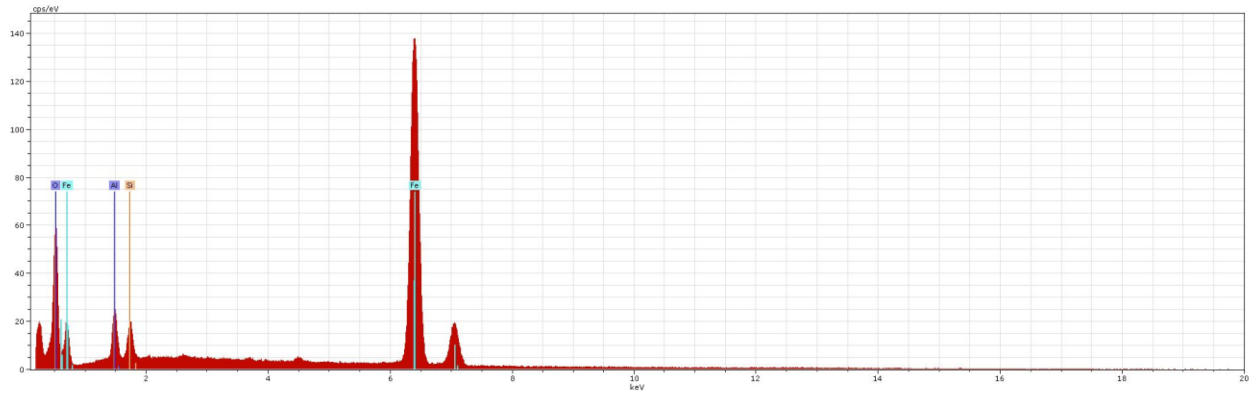




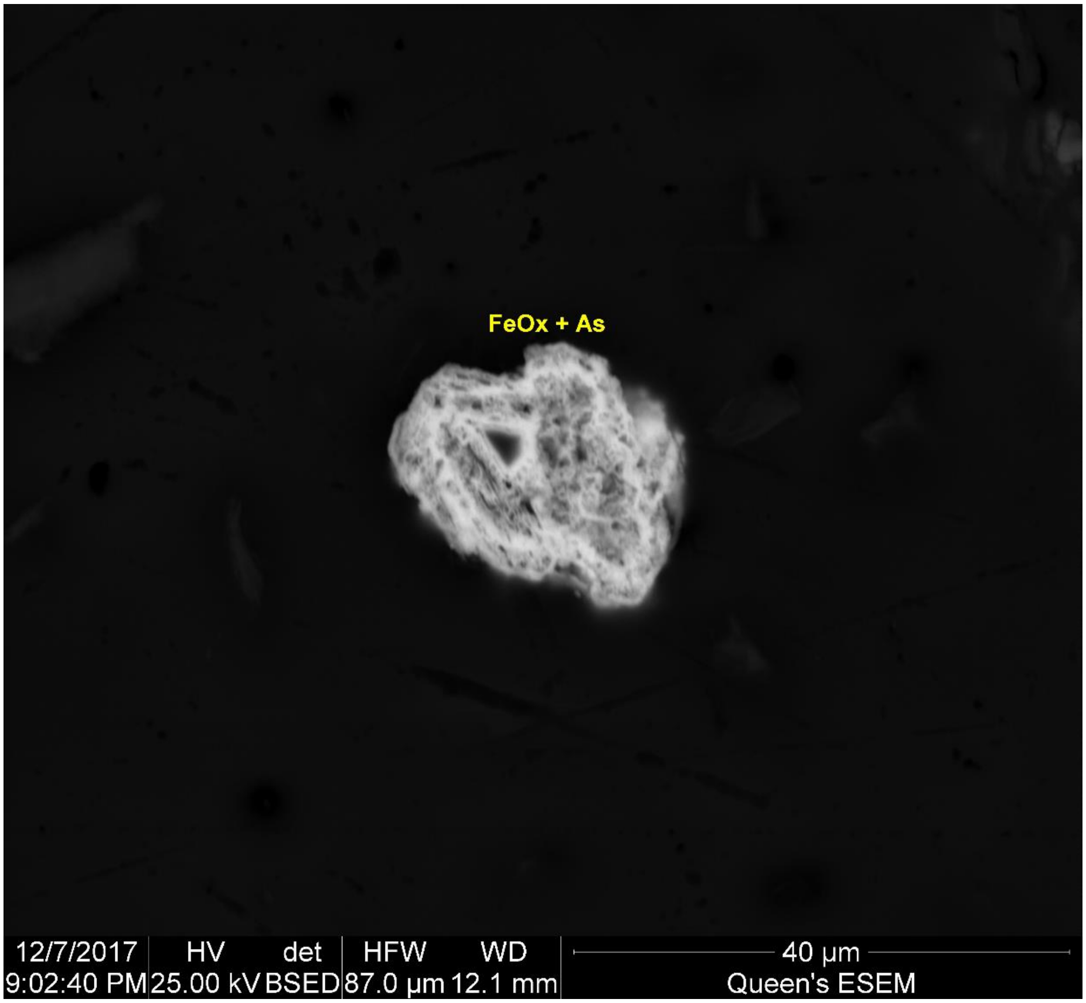


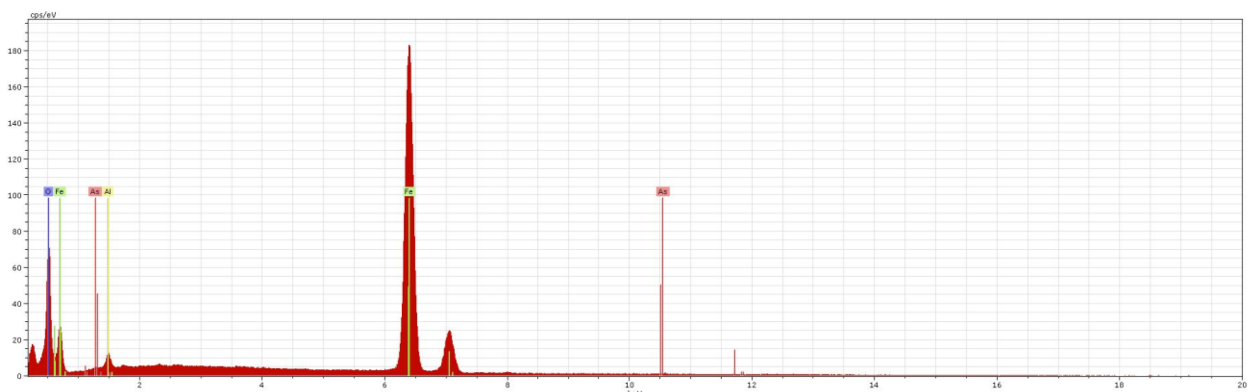
TX – OSC – 151 PH: SEM Image and Associated Spectrum



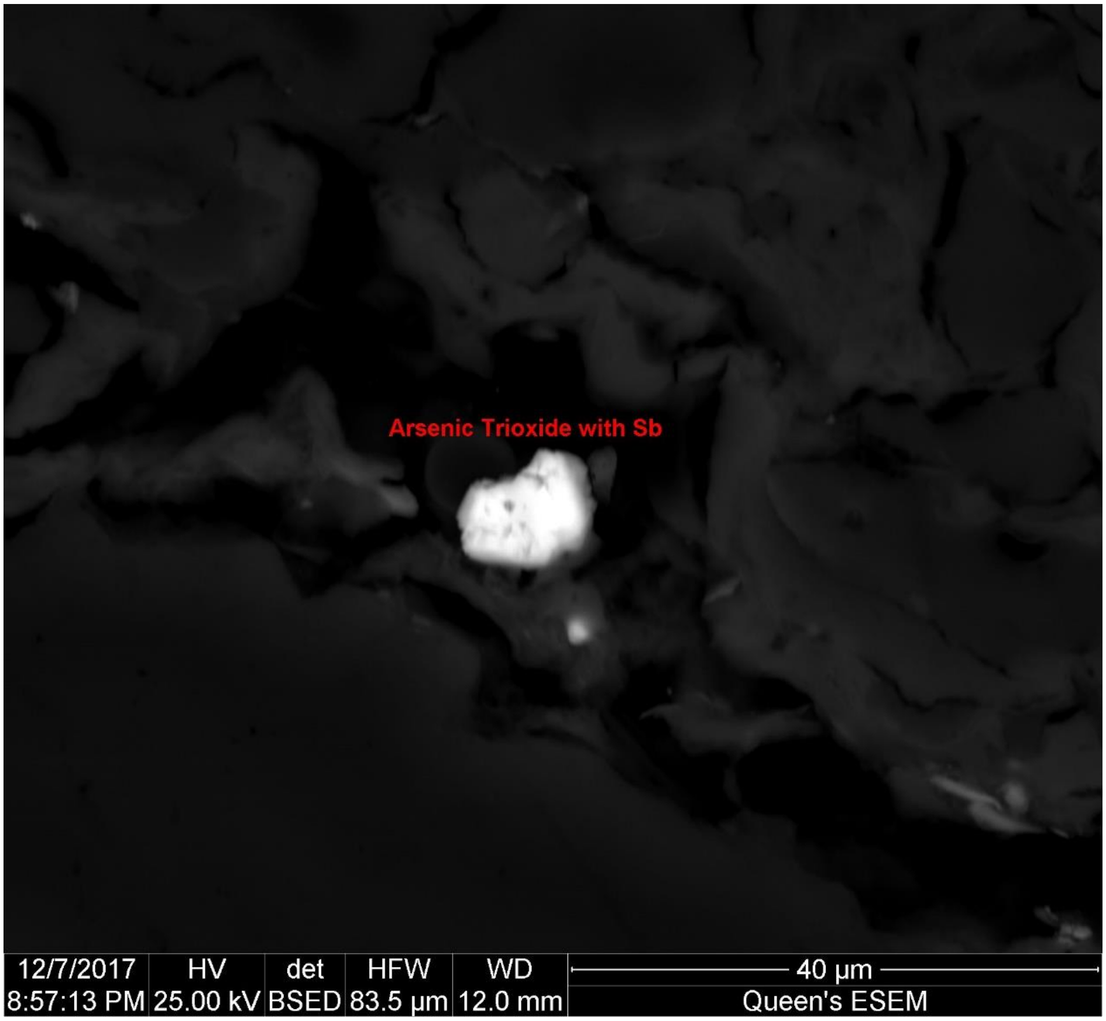


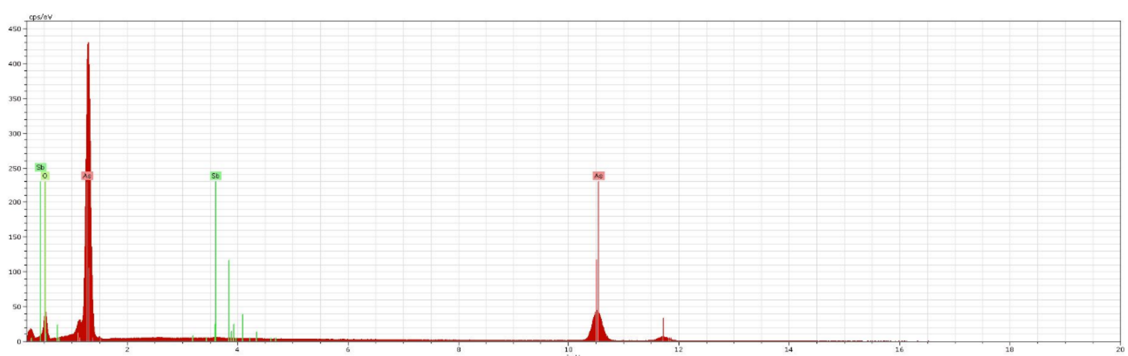
NDILO – FCSC– 25 PH: SEM Image and Associated Spectrum





NDILO – FCSC– 25 PH: SEM Image and Associated Spectrum





Appendix I: Comparison of Measured As Concentrations to Inferred As Concentrations Calculated Using Hocking et al. (1978) Equation

Table I - Relative percent difference (RPD) between measured As and inferred As concentrations calculated using Hocking *et al.* (1978)'s equation.

Sample ID	Distance to Giant Roaster (km)	Direction to Giant Roaster (0 to 360)	Distance to Con Roaster (km)	Direction to Con Roaster (0 to 360)	As Concentration based on Hocking et al. (1978) equation	Measured As	RPD
BC20-FCSC-163 PH	2	264	8	351	579	110	136.14%
BC20-PSC-164.1 PH	2	261	8	350	483	480	0.58%
BERRY-FCOSC-62 PH	13	11	21	8	36	6.1	142.57%
BPR-FCSC-02 PH	2	257	8	353	761	330	79.00%
BPR-FCSC-14 PH	2	227	6	349	328	500	41.60%
BPR-FCSC-17 PH	4	221	5	333	135	53	87.50%
BPR-FCSC-21 PH	1	300	8	357	1415	140	163.99%
BPR-FENC-09 PH	2	253	7	352	675	250	91.84%
BPR-FENC-18 PH	4	221	5	334	138	120	14.20%
BPR-MFENC-22 PH	1	327	9	360	1748	470	115.25%
BPR-OSC-01 PH	1	255	7	353	824	1800	74.36%
BPR-OSC-10 PH	2	229	6	350	382	660	53.29%
BPR-OSC-16 PH	4	221	5	333	134	1400	165.13%
BPR-OSC-20 PH	1	302	8	359	2232	1300	52.78%
BPR-OSC-91 PH	1	303	8	358	2176	240	160.26%
BPR-OSC-92 PH	1	305	8	358	1948	600	105.80%
BPR-OSC-93 PH	1	306	8	359	2133	2300	7.52%
BPR-OSC-94 PH	1	309	8	359	1966	840	80.26%
BPR-PSC-07 PH	2	252	7	352	680	490	32.42%
BPR-PSC-12 PH	2	230	6	349	360	410	12.87%
BPR-PSC-158 PH	2	246	7	353	710	900	23.56%
BPR-PSC-159 PH	2	245	7	352	673	130	135.23%
BPR-PSC-160 PH	2	245	7	353	713	1000	33.45%
BPR-PSC-161 PH	2	245	7	353	760	3400	126.95%
BPR-PSC-19 PH	4	221	5	334	139	1400	163.79%
CHAN-FCSC-61 PH	15	0	22	1	34	34	0.50%
CHAN-PSC-59 PH	15	0	22	2	34	29	15.31%
DETR-FCOSC-35 PH	7	160	3	74	109	160	38.13%
DETR-FCSC-31 PH	10	166	4	125	81	18	127.16%
DETR-FCSC-32 PH	4	126	7	33	153	15	164.35%
DETR-FCSC-34 PH	6	148	5	49	103	270	89.22%
DETR-FCSC-38 PH	7	160	3	73	113	46	84.48%
DETR-FENC-30 PH	5	146	5	47	104	87	17.55%
DETR-OSC-37 PH	7	160	3	73	111	220	65.48%
DETR-PSC-29 PH	5	146	5	48	104	41	86.54%
DUCK-FCSC-71 PH	11	147	6	100	53	15	111.14%
DUF-FCSC-55 PH	18	341	25	348	31	4.9	145.68%
DUF-OSC-54 PH	18	341	25	348	31	52	50.18%
DUF-PSC-53 PH	18	342	25	348	31	65	70.43%
EAST1-FCSC-69 PH	16	107	16	79	33	21	45.32%
EAST1-OSC-70 PH	16	107	16	79	33	15	75.74%
EAST2-FCSC-66 PH	15	113	14	83	35	52	39.31%

EAST2-PSC-68 PH	15	113	14	82	35	20	54.63%
HL- OSC-165 PH	2	246	7	349	429	300	35.36%
HOML-FCSC-56 PH	17	9	25	7	31	26	18.44%
HOML-PSC-58 PH	17	9	25	8	31	19	49.08%
HW3-FCOSC-126 PH	23	271	24	290	29	22	28.26%
HW3-FCOSC-129 PH	19	262	19	285	31	33	6.57%
HW3-FCSC-124 PH	27	274	28	290	28	12	80.08%
HW3-FCSC-125 PH	27	274	28	290	28	3.2	159.00%
HW3-FCSC-130 PH	19	263	19	286	31	1.5	181.49%
HW3-FCSC-131 PH	19	263	19	286	31	6.6	129.64%
HW3-FCSC-132 PH	13	249	12	285	39	14	93.93%
HW3-FCSC-134 PH	13	249	12	286	39	49	22.45%
HW3-FCSC-135 PH	9	242	8	298	56	45	22.61%
HW3-OSC-123 PH	27	274	28	290	28	19	38.37%
HW3-OSC-128 PH	19	262	19	286	31	22	33.77%
HW3-OSC-133 PH	9	242	8	298	56	50	12.16%
HW3-OSC-136 PH	9	242	8	298	56	94	49.97%
HW3-OSG-127 PH	23	271	24	290	29	28	4.32%
INGT-FCOSC-139 PH	10	72	15	43	44	38	14.07%
INGT-FCOSC-141 PH	12	70	16	44	39	23	52.60%
INGT-FCOSC-42 PH	14	73	19	50	35	12	97.02%
INGT-FCOSC-49 PH	3	38	10	13	219	63	110.72%
INGT-FCSC-122 PH	12	71	16	45	39	15	89.46%
INGT-FCSC-28 PH	4	79	9	25	165	220	28.36%
INGT-FCSC-40 PH	19	71	23	53	31	3.6	158.08%
INGT-FCSC-45 PH	3	28	10	10	277	48	140.97%
INGT-FCSC-50 PH	3	37	10	12	248	27	160.78%
INGT-FENC-51 PH	3	64	10	18	247	84	98.56%
INGT-OSC-137 PH	10	72	15	43	44	30	37.58%
INGT-OSC-138 PH	10	72	15	43	44	13	108.58%
INGT-OSC-142 PH	12	71	16	45	39	16	84.34%
INGT-OSC-39 PH	19	71	23	53	31	21	37.44%
INGT-OSC-48 PH	3	41	10	13	231	46	133.51%
INGT-OSC-52 PH	4	89	9	31	125	47	90.51%
LL-FCOSC-116 PH	8	340	15	352	54	69	24.36%
LL-FCOSC-121 PH	7	341	14	353	63	110	54.43%
LL-OSC-106 PH	8	342	15	353	56	200	111.95%
LL-OSC-115 PH	8	340	15	352	54	69	23.74%
LL-OSC-118 PH	7	341	14	353	64	120	61.37%
LL-OSC-119 PH	7	341	14	353	65	95	36.86%
LL-OSC-120 PH	7	341	14	353	66	59	11.55%
LL-PSC-117 PH	8	340	15	352	54	24	76.62%
MASL-OSC-65 PH	16	136	12	106	36	87	84.06%
MASL-PSC-64 PH	16	136	12	106	36	92	88.41%
MIR-FCG-02 PH	26	192	18	195	29	3.8	153.79%
MIR-OSG-01 PH	26	192	18	195	29	8.1	112.91%

MIR-PSG-03 PH	26	192	18	195	29	2.9	163.71%
ML-FCOSC-97 PH	5	328	12	350	91	400	126.12%
ML-FCSC-100 PH	5	325	12	349	99	32	102.43%
ML-FCSC-102 PH	5	314	12	344	93	29	105.21%
ML-OSC-103 PH	5	314	12	345	95	820	158.39%
ML-OSC-98 PH	5	326	12	349	98	210	72.61%
NDILO-FCSC-25 PH	3	154	6	19	245	280	13.53%
NDILO-FCSC-26 PH	3	159	5	18	229	170	29.62%
NDILO-OSC 27 PH	3	166	5	15	212	130	47.89%
NDILO-OSC-23 PH	3	159	5	19	209	220	5.22%
NDILO-OSC-24 PH	3	157	5	19	218	180	19.03%
NWC1-FCOSC-83 PH	8	300	13	332	55	69	21.86%
NWC1-FCSC-82 PH	8	301	13	332	55	250	127.79%
NWC2-FCSC-81 PH	9	293	14	325	46	42	9.86%
NWC3-FCOSC-85 PH	8	273	11	319	57	6.1	161.51%
NWFAR1-FCSC-75 PH	23	289	26	306	29	35	19.10%
NWFAR1-PSC-77 PH	23	289	26	306	29	8.1	112.41%
NWFAR2-PSC-73 PH	15	301	20	322	34	26	27.19%
SW1-PSC-87 PH	12	218	7	255	46	99	72.75%
SW3-PSC-89 PH	18	231	14	256	33	30	9.98%
TX-FCOSC-155 PH	9	1	17	2	48	78	47.64%
TX-FCOSC-157 PH	8	357	15	1	56	60	6.28%
TX-FCSC-144 PH	6	359	14	2	72	130	57.81%
TX-FCSC-148 PH	8	359	16	2	54	14	118.24%
TX-FCSC-154 PH	9	1	17	2	48	22	74.39%
TX-FOCSC-150 PH	8	359	16	1	53	53	0.87%
TX-OSC-145 PH	6	359	14	2	71	43	49.49%
TX-OSC-147 PH	8	358	16	1	54	54	0.59%
TX-OSC-151 PH	9	358	16	1	49	72	37.68%
TX-OSC-153 PH	9	359	16	1	49	44	10.92%
VL-FCOSC-107 PH	11	338	18	349	41	15	92.52%
VL-FCSC-108 PH	11	337	18	348	41	120	98.50%
VL-FCSC-111 PH	10	339	18	350	43	34	22.81%
VL-OSC-110 PH	11	339	18	349	40	130	105.88%
YK67-FCSC-05 PH	3	120	7	28	192	26	152.29%
YK67-FENC-03 PH	3	120	7	28	200	160	22.43%
YK67-OSC-06 PH	3	118	7	30	178	62	96.56%
YK67-PSC-04 PH	3	120	7	28	201	140	35.57%

Appendix J: Relative Percent Difference (RPD) Calculations for Sieved versus Un-sieved Samples

Table J: Relative Percent Difference (RPD) calculations for sieved versus un-sieved samples.

Sample ID	Distance from Giant Roaster (km)	Distance from Con Roaster (km)	As (mg/kg)	RPD
BPR-OSC-20PH	0.9	8.3	1300	0%
BPR-OSC-20PH S	0.9	8.3	1300	
BPR-OSG-95	0.9	8.3	930	-6%
BPR-OSG-95 S	0.9	8.3	870	
BPR-OSC-92PH	0.9	8.3	600	8%
BPR-OSC-92PH S	0.9	8.3	650	
BPR-MFENC-22PH	1.0	8.6	470	21%
BPR-MFENC-22PH S	1.0	8.6	570	
INGT-OSG-47	2.9	10.2	98	22%
INGT-OSG-47 S	2.9	10.2	120	
NDILO-FCSC-25PH	2.9	5.5	280	96%
NDILO-FCSC-25PH S	2.9	5.5	550	
NDILO-OSC-23PH	3.2	5.1	220	-9%
NDILO-OSC-23PH S	3.2	5.1	200	
ML-OSC-103PH	5.0	11.7	820	10%
ML-OSC-103PH S	5.0	11.7	900	
ML-FCOSC-97PH	5.2	12.4	400	-33%
ML-FCOSC-97PH S	5.2	12.4	270	
DETR-FCSC-34PH	5.6	4.6	270	7%
DETR-FCSC-34PH S	5.6	4.6	290	
TX-FCSC-144PH	6.1	13.9	130	-23%
TX-FCSC-144PH S	6.1	13.9	100	
LL-OSC-106PH	7.5	15.1	200	20%
LL-OSC-106PH S	7.5	15.1	240	
NWC3-OSG-86	7.7	11.0	620	-8%
NWC3-OSG-86 S	7.7	11.0	570	
TX-OSG-152	8.6	16.4	210	10%
TX-OSG-152 S	8.6	16.4	230	
DETR-FCSC-31PH	10.2	3.7	18	-17%
DETR-FCSC-31PH S	10.2	3.7	15	
VL-OSC-110PH	11.1	18.5	130	46%
VL-OSC-110PH S	11.1	18.5	190	
BERRY-OSG-63	12.8	20.5	84	11%
BERRY-OSG-63PH S	12.8	20.5	93	
BERRY-FCSC-62PH	12.8	20.6	6.1	-15%
BERRY-FCSC-62PH S	12.8	20.6	5.2	
HOML-OSG-57	17.4	25.2	450	29%
HOML-OSG-57 S	17.4	25.2	580	