DOMINION DIAMOND

ANNEX VIII

GEOCHEMISTRY BASELINE REPORT FOR THE JAY PROJECT

GEOCHEMISTRY BASELINE REPORT FOR THE JAY PROJECT

Prepared for: Dominion Diamond Ekati Corporation

Prepared by: Golder Associates Ltd.

September 2014

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Abbreviations

Abbreviation	Definition
ABA	acid base accounting
Ag	silver
Al	aluminum
AP	acid potential
ARD	acid rock drainage
As	arsenic
ASTM	American Society for Testing and Materials
Au	gold
B	boron
Ba	barium
Be	beryllium
Bi	bismuth
Ca	calcium
CaNP	carbonate neutralization potential
CCME	Canadian Council of Ministers of the Environment
Cd	cadmium
Ce	cerium
Co	cobalt
CO_2	carbon dioxide
Cr	chromium
Cs	caesium
Cu	copper
Dominion Diamond	Dominion Diamond Ekati Corporation
EC	electrical conductivity
e.g.,	for example
Eh	redox
Ekati Mine	Ekati Diamond Mine
et al.	more than one additional author
Fe	iron
Ga	gallium
Ge	germanium
Golder	Golder Associates Ltd.
HCT	humidity cell test
Hf	hafnium
Hg	mercury
ICP	inductively coupled plasma
ID	identification
i.e.,	that is
In	indium
K	potassium

Abbreviation	Definition
La	lanthanum
Li	lithium
Ma	million years ago
MEND	Mine Environment Neutral Drainage
Mg	magnesium
ML	metal leaching
Mn	manganese
Mo	molybdenum
n/a	not available
Na	sodium
NAG	net acid generation
Nb	niobium
Ni	nickel
non-PAG	non-potentially acid generating
NP	neutralization potential
NWT	Northwest Territories
P	phosphorus
PAG	potentially acid generating
Pb	lead
PK	processed kimberlite
Project	Jay Project
PVK	primary volcaniclastic kimberlite
Rb	rubidium
Rh	rhenium
RVK	re-sedimented volcaniclastic kimberlite
S	sulphur
Sb	antimony
Sc	scandium
Se	selenium
SFE	shake flask extraction
Si	silicon
Sn	tin
Sr	strontium
SSWQO	Site-Specific Water Quality Objective
Ta	tantalum
Te	tellurium
Th	thorium
Ti	titanium
Tl	thallium
U	uranium
V	vanadium
VK	volcaniclastic kimberlites

Abbreviation	Definition
W	tungsten
WRSA	waste rock storage area
XRF	X-ray fluorescence
Y	yttrium
Zn	zinc
Zr	zirconium

Units of Measure

Unit	Definition
%	percent
~	approximately
>	greater than
<	less than
≥	greater than or equal to
°C	degrees Celsius
cm	centimetre
g	gram
ha	hectare
kg	kilogram
kg $CaCO_3$/t	kilograms of calcium carbonate equivalent per tonne of material
kg/t	kilograms per tonne
km	kilometre
km^2	square kilometre
m	metre
mg $CaCO_3$/L	milligrams calcium carbonate per litre
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mL	millilitre
mv	millivolts
pH	potential of hydrogen; provides measure of the acidity or alkalinity of a solution on a scale of 0 to 14
ppm	parts per million
t	tonnes
µg/L	micrograms per litre
µS/cm	microsiemens per centimetre
wt%	weight percent

1 INTRODUCTION

1.1 Background and Scope

Dominion Diamond Ekati Corporation (Dominion Diamond) is a Canadian-owned and Northwest Territories (NWT) based mining company that mines, processes, and markets Canadian diamonds from its Ekati Diamond Mine (Ekati Mine). The existing Ekati Mine is located approximately 200 kilometres (km) south of the Arctic Circle and 300 km northeast of Yellowknife, NWT (Map 1.1-1).

Dominion Diamond is proposing to develop the Jay kimberlite pipe (Jay pipe) located beneath Lac du Sauvage. The proposed Jay Project (Project) will be an extension of the Ekati Mine, which is a large, stable, and successful mining operation that has been operating for 16 years. Most of the facilities required to support the development of the Jay pipe and to process the kimberlite currently exist at the Ekati Mine. The Project is located in the southeastern portion of the Ekati claim block approximately 25 km from the main facilities and approximately 7 km to the northeast of the Misery Pit, in the Lac de Gras watershed (Map 1.1-2).

The scope of the geochemical baseline for the Project includes the following:

- compilation of an Ekati geochemical dataset, including results of geochemical characterization of waste rock and kimberlite collected from the Ekati Mine between 1995 and 2012;
- compilation of results of supplemental geochemical testing of waste rock and kimberlite collected from the Jay Project in May 2014 into the Ekati geochemical dataset;
- comparison of the solid phase composition of samples in the Ekati geochemical dataset to determine whether waste rock and kimberlite from the various kimberlite deposits at the Ekati Mine have similar geochemical characteristics; and,
- interpretation of the acid rock drainage (ARD) and metal leaching (ML) potential of waste rock and kimberlite.

This report is primarily based on a detailed review of the existing geochemical dataset from the Ekati Mine, which was provided to Golder Associates Ltd. (Golder) by Dominion Diamond. Supplemental samples from the Project area were collected in 2014. Site-specific geochemical characterization results are interpreted in the context of the Ekati geochemical dataset.

The geochemical characterization report is part of a comprehensive baseline program to document the natural and socio-economic environments in the vicinity of the Project. This report describes characteristics and existing geochemical conditions at the Ekati Mine site, and the results of supplemental geochemical characterization of samples collected from the Project area.

LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY

150 0 150

SCALE 1:6,000,000 KILOMETRES

REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

GEOCHEMISTRY BASELINE REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

LOCATION OF THE JAY PROJECT

Golder Associates

PROJECT		13-1328-0041	FILE No. B_JC_Geochem_001_GIS	
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CHECK	CR	16/09/14		
REVIEW	SM	16/09/14		

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LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- KIMBERLITE PIPE
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (10 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY

REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

GEOCHEMISTRY BASELINE REPORT

3 0 3

SCALE 1:150,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

EKATI PROPERTY MAP

Golder Associates

PROJECT	13-1328-0041		FILE No. B_JC_Geochem_002_GIS
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CHECK	CG	16/09/14	
REVIEW	SM	16/09/14	

1.2 Objectives

The objective of the evaluation presented in the geochemical characterization report is to develop an understanding of the ARD and ML potential of waste rock and kimberlite that will be mined at the Project. The existing Ekati Mine geochemical dataset forms the basis for interpretation of ARD and ML potential included in this report.

To meet these objectives, the report has been organized into the following sections:

- **Section 2** provides a description of the regional and local geology.
- **Section 3** provides an overview of the Ekati Mine geochemical dataset and the Jay pipe samples.
- **Section 4** provides an overview of the geochemical characteristics of the waste rock and kimberlite expected to be encountered as part of the Project.
- **Section 5** provides a summary of the geochemical baseline.
- **Section 6** lists the references cited in this report.
- **Section 7** provides a glossary of terms.

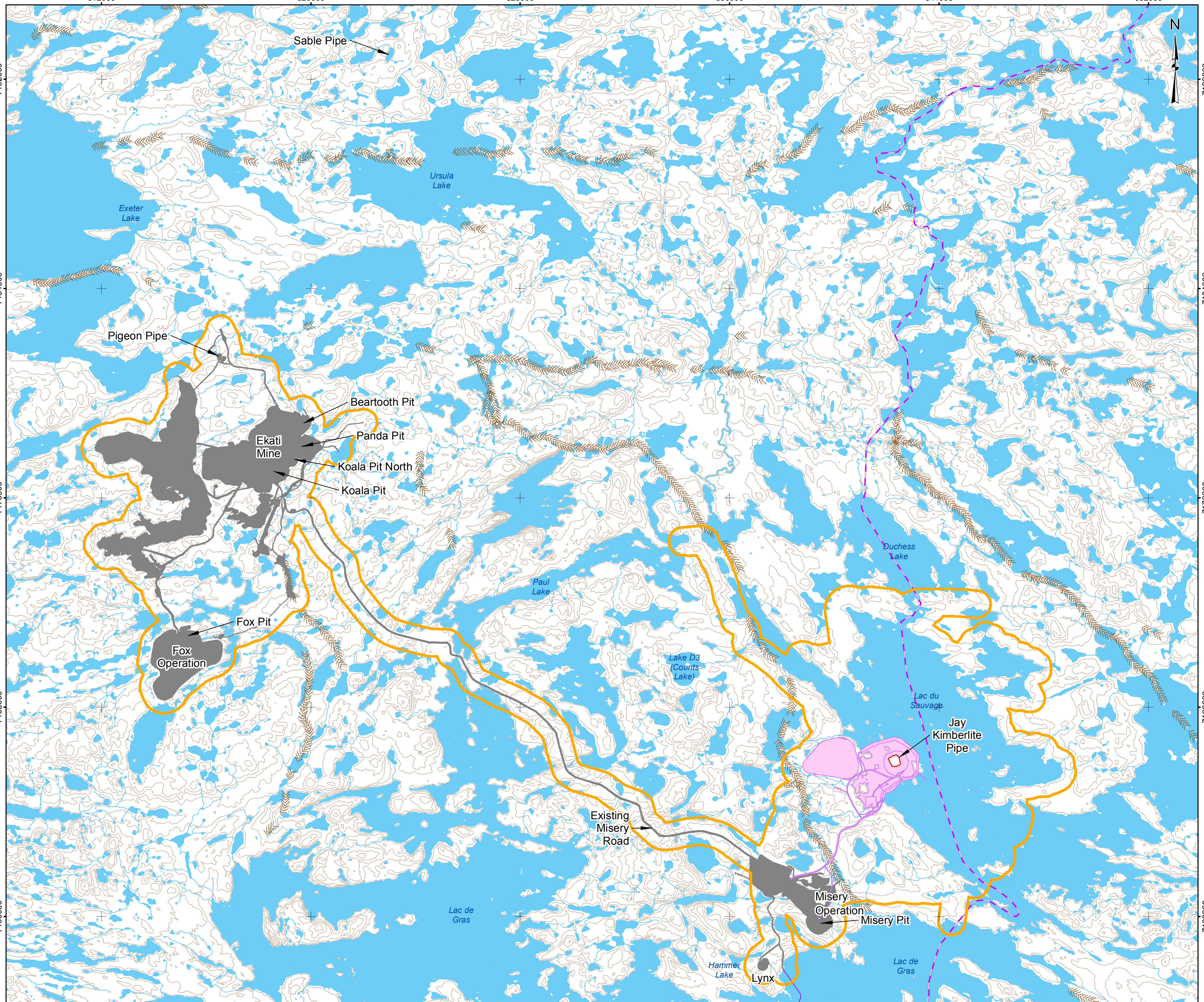
1.3 Baseline Study Area

The proposed new mining operations would develop the Jay kimberlite pipe. The Jay pipe is located in the southeastern portion of the Ekati Mine site, approximately 25 km southeast of the Ekati main camp, and approximately 7 km northeast-east of the Misery Pit, below the waters of Lac du Sauvage.

The baseline study area is approximately 236 square kilometres (km^2) (23,578 hectares [ha]) and includes the existing Ekati operation plus the Project footprint and a 500 metre (m) buffer (Map 1.3-1). The locations of the Ekati Mine, Misery Haul Road, Misery Pit operations, and Jay pipe in Lac du Sauvage are shown in the baseline study area Map (Map 1.3-1).

The centre of the proposed Jay pipe is located at approximately 7,165,733 m Northing, 542,395 m Easting (Universal Transverse Mercator Zone 12), and approximately 1.2 km from the west shoreline of Lac du Sauvage.

This baseline study uses an Ekati geochemical dataset that was compiled using data from the Ekati Mine to provide baseline information for the Project, supplemented with results of analysis of samples collected from the Jay Project area in May 2014.



LEGEND

- EKATI MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- KIMBERLITE PIPE
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WINTER ROAD
- ELEVATION CONTOUR (10 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- BASELINE STUDY AREA

REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

GEOCHEMISTRY BASELINE REPORT

3 0 3
SCALE 1:150,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
LOCATION OF THE GEOCHEMISTRY BASELINE STUDY AREA

Golder Associates

PROJECT		13-1328-0041	FILE No. B_JC_Geochem_005_GIS	
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GIS	ANK	16/09/14	MAP 1.3-1	
CHECK	CG	16/09/14		
REVIEW	SM	16/09/14		

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2 GEOLOGY

The following discussion is summarized from a more detailed description of the Project geology, kimberlite emplacement, and tectonic history presented in the *Geology Baseline Report* (Annex III).

2.1 Geology of the Ekati Claim Block

The Ekati claim block is located above the eastward dipping Archean suture in the central Slave Province (Figure 2.1-1). Rock types within the Slave Province and defining the bedrock units at the Ekati claim block can be assigned to three broad lithostratigraphic groups: metasedimentary schists, migmatites, and various syn- and post-tectonic intrusive inclusions made up predominantly of granite, granodiorite, and tonalite (Nowicki et al. 2003; Nowicki et al. 2004; Helmstaedt 2009; Dominion Diamond 2013). In addition, five mafic Proterozoic dyke swarms intrude the area (Le Cheminant and van Breemen 1994; Kjarsgaard 2001; Nowicki et al. 2003; Nowicki et al. 2004; Helmstaedt 2009; Dominion Diamond 2013). The principal lithological units that are distinguished in the Ekati claim block according to Mineral Services Canada Inc. (2002) and Dominion Diamond (2013) are described in the following sections and Map 2.1-1.

2.1.1 Metasediments

Metasedimentary rocks are described as grey-green weathering psammite-pelite assemblages. The thinly bedded (1 to 20 centimetres [cm]) and moderately sorted psammites (wackes) contain up to 10 percent (%) feldspar and are biotite-rich. Psammite is interlayered with less abundant, finer-grained pelitic layers (phyllites) and with minor occurrences of graphite-bearing schists (Mineral Services Canada Inc. 2002; Dominion Diamond 2013; Helmstaedt 2014).

2.1.2 Granites

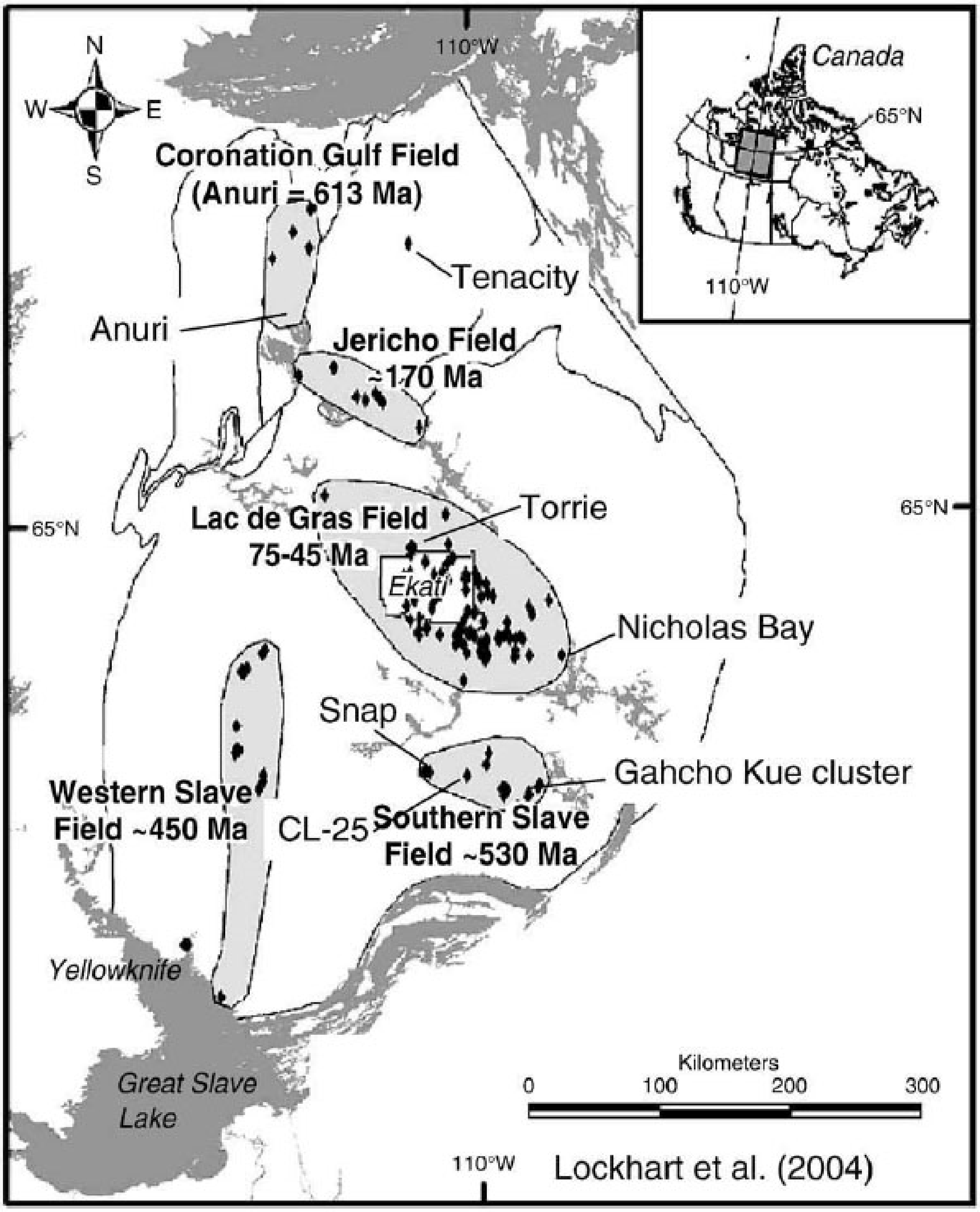
Three different groups of plutons are distinguished based on their timing relative to regional deformation and metamorphism (Davis et al.1994; Mineral Services Canada Inc. 2002; Dominion Diamond 2013). The three groups are described as follows:

- Group 1 is defined by deformed and recrystallized, dominantly tonalitic and trondhjemitic plutons.
- Group 2 (pre- to syn-tectonic intrusions) is made up of massive to foliated, dominantly tonalitic plutons. Syn-tectonic diorites, tonalities, and granodiorites occur predominantly in the central and northern portions of the property, while post-tectonic granites (two-mica granite and biotite granite) form large plutons in the eastern and northeastern portions of the property.
- Group 3 consists of massive biotite- and muscovite-biotite-bearing granites.

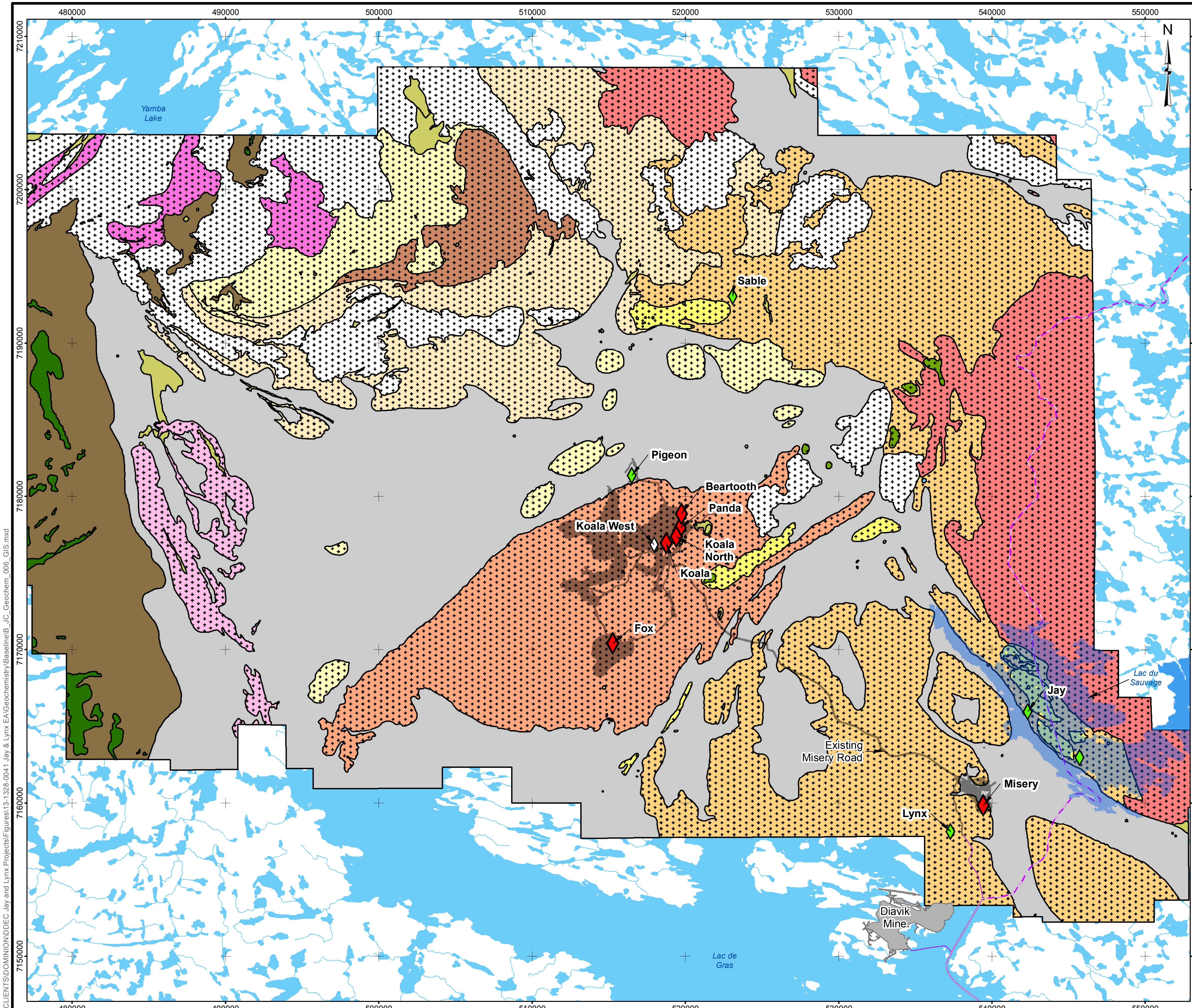
2.1.3 Mafic Dykes (Diabase)

Five major Proterozoic mafic dyke (diabase) swarms on the Ekati claim block were identified based on field geological mapping and aeromagnetic image interpretations (Mineral Services Canada Inc. 2002; Dominion Diamond 2013). Most of the dykes located within the Ekati claim block belong to the MacKenzie dyke swarm (up to 50 m wide) and the 305 dyke swarm (10 to 30 m wide).

Figure 2.1-1 Kimberlite Fields of the Slave Province



Source: Amended from Lockhart et al. (2004) and Helmstaedt (2009).
Note: Kimberlite pipes are indicated by diamond-shaped symbols.
Ma = million years ago; ~ = approximately.



LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY
- MINED KIMBERLITE
- BULK SAMPLED KIMBERLITE
- OTHER KNOWN KIMBERLITE
- BIOTITE GRANITE
- BIOTITE GRANODIORITE
- BIOTITE MUSCOVITE MONZOGRANITE
- DIORITE/QUARTZ DIORITE
- GREYWACKE
- HORNBLENDE TONALITE
- MAFIC INCLUSION
- MAGNETITE BIOTITE GRANODIORITE
- MIGMATITE
- PEGMATITE
- PORPHYRITIC BIOTITE GRANITE
- TONALITE
- TWO MICA GRANITE
- TWO MICA MONZONITE
- UNDEFINED
- WHITE BIOTITE MONZOGRANITE

REFERENCE

BEDROCK GEOLOGY PROVIDED BY MINERAL SERVICES CANADA INC. 2012
NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

GEOCHEMISTRY BASELINE REPORT

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
BEDROCK GEOLOGY MAP
EKATI CLAIM BLOCK

Golder Associates

PROJECT		13-1328-0041	FILE No. B_JC_Geochem_006_GIS	
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GIS	ANK	16/09/14	MAP 2.1-1	
CHECK	CG	16/09/14		
REVIEW	SM	16/09/14		

2.1.4 Kimberlites

Approximately 150 kimberlite bodies have been discovered on the Ekati claim block, including the Panda, Koala, Koala North, Beartooth, Fox, and Misery pipes, which have supported mining operations. Including those on the Ekati claim block, more than 240 kimberlite bodies have been found in the region that has become known as the Lac de Gras kimberlite field (Mineral Services Canada Inc. 2002; Helmstaedt 2009; Dominion Diamond 2013; Map 2.1-1). The majority of the pipes occur beneath lakes and are small, mostly less than 5 ha, but can extend to as much as 20 ha (Nowicki et al. 2004; Dominion Diamond 2013). The infill of the kimberlites on the Ekati claim block can be broadly classified into six rock types (Dominion Diamond 2013):

- magmatic kimberlite – hypabyssal;
- tuffisitic kimberlite;
- primary volcaniclastic kimberlite (PVK);
- olivine-rich volcanoclastic kimberlites (VK);
- mud-rich, re-sedimented volcaniclastic kimberlite (RVK); and,
- kimberlitic sediments.

Economic mineralization is mostly limited to olivine-rich re-sedimented volcaniclastic and primary volcaniclastic types. Approximately 10% of the 150 known kimberlite pipes in the Ekati claim block are of economic interest or have exploration potential (Dominion Diamond 2013). According to SRK Consulting (2007), the Ekati kimberlites contain rare, fine-grained disseminated pyrite (less than 0.5%) and abundant calcite.

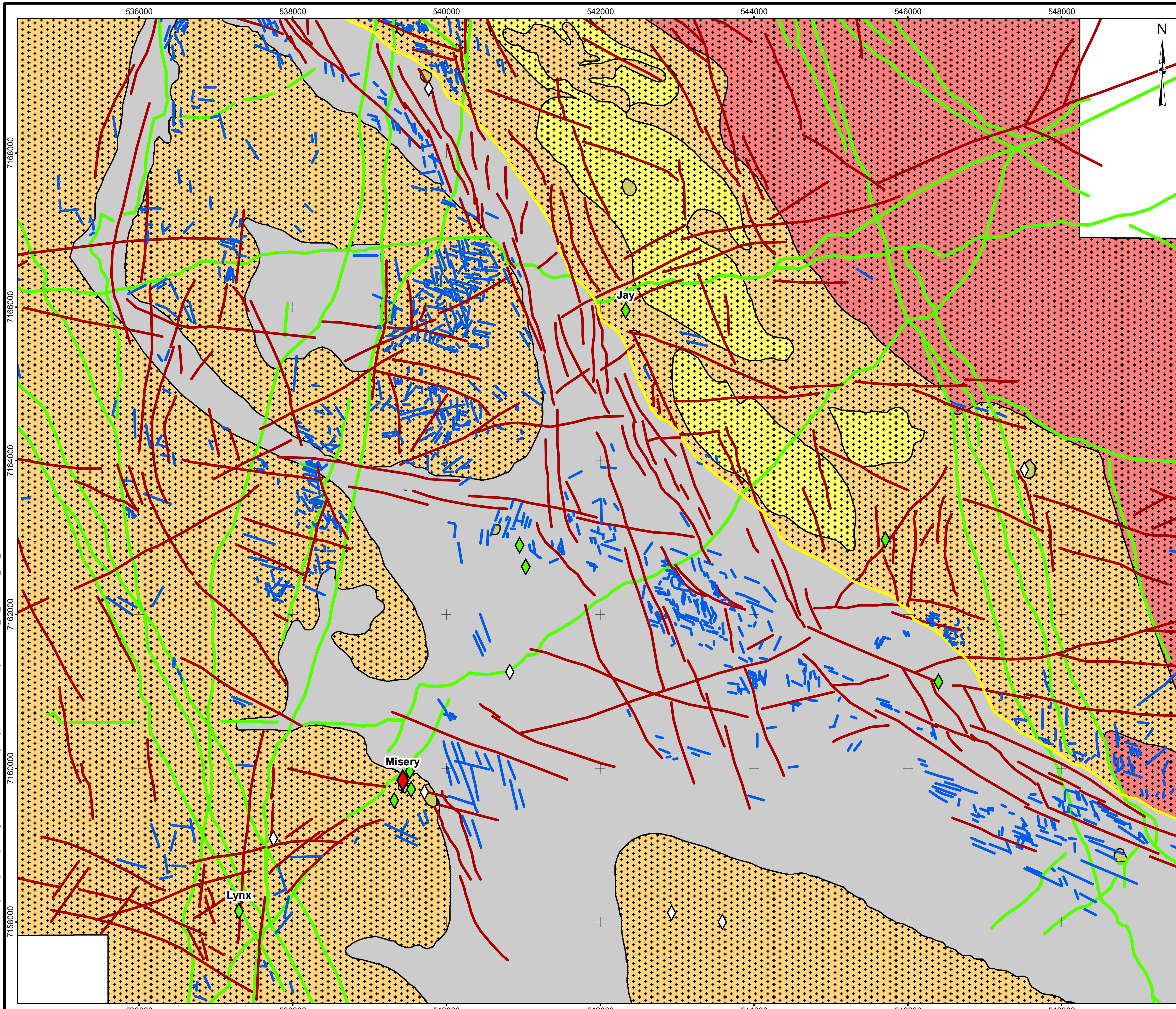
2.2 Project Area Geology

The description of the main lithological units of the Project area is based on Helmstaedt (2002), and data published by Mineral Services Canada Inc. (2002), Nowicki et al. (2003), Nowicki et al. (2004) and Dominion Diamond (2013). The different lithological units are described in the following sections and are shown in Map 2.1-2.

2.2.1 Metasediment

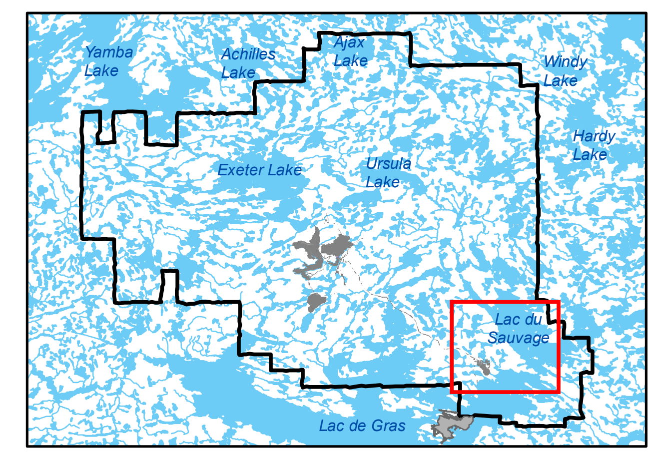
Metasedimentary rocks in the Project area consist of grey-green weathering psammite-pelite assemblages, which were produced by metamorphism of muddy to sandy rocks (Mineral Services Canada Inc. 2002; Dominion Diamond 2013). Psammite (also known as wacke) is thinly bedded, biotite-rich, and contains up to 10% feldspar.

The metasediments typically contain trace (less than 0.5%) fine-grained disseminated pyrite (FeS_2), pyrrhotite ($Fe_{[1-x]}S$), and chalcopyrite ($CuFeS_2$), but can occur locally at concentrations of up to 5% on a centimetre scale (Nowicki et al. 2003; Dominion Diamond 2013). Carbonate minerals, including primarily calcite ($CaCO_3$), dolomite ($[Ca,Mg]CO_3$), and, to a lesser extent, siderite ($FeCO_3$) occur as fracture fillings (Nowicki et al. 2003; Dominion Diamond 2013).



LEGEND

- EKATI CLAIM BLOCK
- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- WATERCOURSE
- WATERBODY
- MINED KIMBERLITE
- BULK SAMPLED KIMBERLITE
- OTHER KNOWN KIMBERLITE
- FAULT
- POTENTIAL STRUCTURAL CONTROLLED CONTACT
- JOINT
- DYKE
- METASEDIMENTS
- PORPHYRITIC BIOTITE GRANITE
- TONALITE
- TWO MICA GRANITE
- UNDEFINED



REFERENCE

BEDROCK GEOLOGY PROVIDED BY MINERAL SERVICES CANADA INC. 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

GEOCHEMISTRY BASELINE REPORT

1 0 1

SCALE 1:50,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BEDROCK GEOLOGY MAP
LAC DU SAUVAGE

Golder Associates

PROJECT		13-1328-0041	FILE No. B_JC_Geochem_007_GIS
DESIGN	CG	11/08/14	SCALE AS SHOWN REV A
GIS	TN	16/09/14	MAP 2.1-2
CHECK	CG	16/09/14	
REVIEW	SM	16/09/14	

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2.2.2 Migmatite

Contact zones between metasedimentary rocks and granitoid bodies are usually defined by sediment-derived migmatites. Near the transition from metasediments to granitoid intrusions, a migmatitic leucosome defines the zone in the metapelitic layers. As the amount of leucosome increases, the psammitic layers are affected, producing a gneissose rock made up of remnants of psammitic layers and foliated lenses of biotite-sillimanite melanosome in a relatively homogeneous matrix of quartz, feldspar, cordierite, and biotite (Mineral Services Canada Inc. 2002).

2.2.3 Granites

The Project area is dominated by the presence of post-tectonic intrusions, composed mainly of two-mica granite and biotite granite. The granitoids are generally medium- to coarse-grained and weakly foliated to massive, with a modal composition of 40% quartz, 45% feldspar, and 15% biotite. Granitoid rocks hosts rare (less than 0.5%), disseminated sulphide minerals, including pyrite and chalcopyrite (SRK 2007).

2.2.3.1 Two-Mica Granite

The two-mica granites are defined as fine- to medium-grained granites with a distinctive white to light-grey weathered surface, and typically consist of approximately equal proportions of quartz, plagioclase, and K-feldspar, and muscovite and biotite. According to Dominion Diamond (2013), the two-mica granite contains 3% to 15% biotite and muscovite.

2.2.3.2 Porphyritic Biotite Granite

The porphyritic biotite granites are described as light red to pinkish white weathering, medium- to coarse-grained, K-feldspar-rich granite. The rocks contain 5% to 10% biotite. Primary biotite appears to be absent, but secondary muscovite, replacing biotite, is common (Mineral Services Canada Inc. 2002).

2.2.3.3 Tonalite

Tonalite occurs in the Project area as elongated bodies within the two-mica granite on the eastern part of the Lac du Sauvage area. It consists of approximately 45% plagioclase, 42% quartz, up to 10% biotite, and traces of K-feldspar (Wright 1999; Mineral Services Canada Inc. 2002; Dominion Diamond 2013).

2.2.4 Pegmatite

The intrusive bodies described in the previous sections are accompanied by pegmatitic bodies. At the contact zones between granitoid units and metasediments, elongate bodies of coarse-grained biotite plus muscovite pegmatite intruded the metasediments along brittle features opened along the foliation planes. Mainly tourmaline-bearing coarse-grained dykes define pegmatites accompanying the two-mica granite intrusions.

2.2.5 Mafic Dykes (Diabase)

The Lac du Sauvage area is intersected by three main mafic dyke swarms (Kjarsgaard 2001; Mineral Services Canada Inc. 2002; Stubley 2005; Aurora Geosciences Ltd. 2013; Dominion Diamond 2013). The dykes within the Project area are very dark grey to black, fine-grained, and contain a variable percentage of magnetite and traces of pyrite and chalcopyrite, with lesser amounts of pyrrhotite (Dominion Diamond 2013).

2.2.6 Jay Kimberlite Pipe

The Jay pipe is hosted within granitic rocks, ranging from granite to granodiorite in composition. A regional contact with meta-sedimentary rocks occurs to the west, and a diabase dyke trending approximately east–west occurs to the north of the pipe. The pipe is divided into the following three domains:

- Re-sedimented volcaniclastic kimberlite (RVK): uppermost 110 to 170 m in stratigraphic thickness. The RVK domain is composed of repeating, large-scale graded mega-beds defined by mud, breccia, and olivine content.
- Transitional kimberlite: 30 to 70 m thick package of interbedded RVK and VK material of varying degrees of alteration.
- Primary volcaniclastic kimberlite (PVK): primarily olivine-rich, competent, grey-blue to green PVK with partially altered olivine set in a serpentinized matrix.

These domains are sub-horizontal and are interpreted to extend the width of the pipe. Boundaries between the domains are transitional in nature (Dominion Diamond 2013).

3 EKATI MINE GEOCHEMICAL DATASET

3.1 Acid Rock Drainage and Metal Leaching

Exposure of minerals that naturally occur in kimberlite and waste rock to oxygen and water during mining enhances natural rates of chemical weathering. Mineral reaction products can, subsequently, be released to water in contact with waste rock. Geochemical characterization is used to evaluate the ARD and ML potential that may result from chemical weathering of waste rock.

Chemical weathering reactions can include dissolution of silicate minerals in granite and metasedimentary rock, such as feldspar, quartz, and mica (e.g., muscovite and biotite). Weathering of silicate minerals releases reaction products such as aluminum, silicon, potassium, sodium, calcium, magnesium, and iron.

Oxidation of sulphide minerals, such as pyrite or pyrrhotite, can result in the development of acidic and/or metal-rich contact waters. The effect of sulphide minerals on drainage chemistry is dependent on several factors, including sulphide mineral abundance, physical properties of sulphide minerals (i.e., grain size, crystallinity, and liberation in the rock matrix), the geochemical characteristics of the host rock, and local environmental conditions. Metals and sulphate can also be released because of sulphide mineral oxidation (e.g., chalcopyrite).

Kimberlite contains large proportions of carbonate minerals, such as calcite. Carbonate mineral dissolution neutralizes the acidity generated by sulphide mineral oxidation. Acidic drainage will result after the depletion of acid-neutralizing minerals, or when the rate of acid neutralization is inadequate relative to the rate of acid generation (MEND 2009).

Geochemical characterization of waste rock and kimberlite at the Ekati Mine has been ongoing since 1995. Baseline characterization studies have been carried out as part of permitting to establish the range of geochemical characteristics at each mining area (i.e., Fox Pit, Misery Pit, Koala Pit, Beartooth Pit, and Panda Pit) and permitting area (i.e., Sable area and Pigeon area). Ongoing geochemical characterization is carried out as part of the Geochemical Characterization and Metal Leaching Plan (BHP Billiton 2007) to confirm the characteristics of material that is encountered during mining.

3.2 Information Sources

A geochemical dataset was compiled using existing data from the Ekati Mine, which was collected between 1995 and 2014, and results of samples that were collected from the Jay pipe area in 2014. Data sources included the following:

- results of pre-mining characterization of waste rock and kimberlite from the Misery Pit (Norecol Dames & Moore 1997);
- routine monitoring of waste rock samples (SRK 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013a);
- permitting studies for the Fox Pit (BHP 2000), Sable area (SRK 2003), Pigeon area (SRK 2003), and Beartooth Pit (SRK 2003);
- geochemical characterization of Pigeon waste rock (EBA 2013; Denholm 2014);

- geochemical characterization of Pigeon waste rock (EBA 2013; Denholm 2014);
- studies conducted as part of the Misery Pit expansion (SRK 2013b); and,
- supplemental samples collected from the Jay pipe in 2014.

3.3 Geochemical Test Methods

Analytical methods used to evaluate waste rock and kimberlite samples in the geochemical dataset included the following:

- mineralogical analysis including X-ray diffraction analysis, elemental analysis, and elemental mapping by X-ray energy dispersive spectrometry and scanning electron microscopy;
- acid base accounting (ABA);
- net acid generation (NAG);
- whole rock and bulk metal analysis, including aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, cerium, cesium, lead, cobalt, copper, chromium, gallium, germanium, gold, hafnium, tin, indium, iron, lanthanum, lithium, magnesium, manganese, mercury, molybdenum, nickel, niobium, potassium, phosphorus, rubidium, rhenium, scandium, strontium, sulphur, silver, selenium, sodium, tantalum, tellurium, thorium, titanium, thallium, uranium (both inductively coupled plasma [ICP] and X-ray fluorescence [XRF]), vanadium, tungsten, yttrium, zinc, and zircon;
- shake flask extraction leach testing, including analysis of leachate for major parameters and metals including pH, alkalinity, chloride, fluoride, sulphate, hardness, aluminum, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silica, silver, sodium, strontium, sulphur, thallium, tin, titanium, uranium, vanadium, zinc, and zirconium;
- NAG leachate analysis, including major parameters and metals including pH, alkalinity, chloride, fluoride, sulphate, hardness, aluminum, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silica, silver, sodium, strontium, sulphur, thallium, tin, titanium, uranium, vanadium, zinc, and zirconium; and,
- kinetic testing according to the humidity cell test (HCT) method, including analysis of pH, redox (Eh), conductivity, sulphate, acidity, alkalinity, silver, aluminum, arsenic, boron, barium, beryllium, bismuth, calcium, cadmium, cobalt, chromium, copper, iron, mercury, potassium, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus, lead, sulphur, antimony, selenium, silicon, tin, strontium, titanium, thallium, uranium, vanadium, and zinc.

The number of geochemical tests performed according to rock type and area are summarized in Table 3.2-1. In total, the geochemical dataset consists of over 3,000 samples, including 641 samples of mixed waste rock collected from the Panda and Koala pits and the waste rock storage area (WRSA). Mixed waste rock samples are grab samples collected from open pits and WRSAs, for which the detailed lithological composition is not known. The analytical results of these samples are included in the Acid Base Accounting Results and the Bulk Metal Analysis Results (Appendices B and C), but are not discussed within the Geochemistry Baseline due to uncertainty in the lithological composition of the samples.

Table 3.2-1 Summary of Existing Geochemical Characterization Dataset for the Ekati Mine

Area	Rock Type	Number of Samples					
		Total Sulphur	Acid Base Accounting	Metals Analysis	Short-Term Leach Tests	Mineralogical Analysis	Humidity Cell Tests
Beartooth Pit	1 - Kimberlite	4	4	5	0	0	2
	2 - Granite	92	90	72	0	0	3
	3 - Metasediment (schist)	1	1	6	0	2	2
	4 - Diabase	2	2	2	0	0	1
Fox Pit	1 - Kimberlite	168	168	150	0	0	1
	2 - Granite	570	475	218	0	0	1
	4 - Diabase	23	17	12	0	0	1
	5 – Mixed Waste Rock	5	5	0	0	0	0
Koala Pit	1 - Kimberlite	58	58	20	0	0	0
	2 - Granite	75	75	13	0	0	1
	3 - Metasediment	38	38	9	0	0	0
	6 - Overburden	22	22	20	0	0	0
	5 – Mixed Waste Rock	192	192	40	0	0	0
Misery Pit	1 - Kimberlite	77	77	27	0	0	2
	2 - Granite	380	380	130	0	0	0
	3 - Metasediment (schist)	400	400	333	0	0	3
	4 - Diabase	54	54	40	0	0	0
Panda Pit	1 - Kimberlite	24	24	0	0	0	0
	2 - Granite	28	28	0	0	0	0
	5 – Mixed Waste Rock	391	391	70	0	0	0
Pigeon Area	1 - Kimberlite	16	15	16	0	0	2
	2 - Granite	13	13	13	0	4	5
	3 - Metasediment (schist)	40	29	40	0	5	6
	4 - Diabase	7	7	7	0	3	4

Table 3.2-1 Summary of Existing Geochemical Characterization Dataset for the Ekati Mine

Area	Rock Type	Number of Samples					
		Total Sulphur	Acid Base Accounting	Metals Analysis	Short-Term Leach Tests	Mineralogical Analysis	Humidity Cell Tests
Sable Area	1 - Kimberlite	13	13	14	0	0	2
	2 - Granite	41	41	41	0	4	6
	4 - Diabase	1	1	1	0	0	1
Jay	1 - Kimberlite	2	2	2	1	0	0
	2 - Granite	30	30	30	12	0	0
	3 - Metasediment (schist)	24	24	24	15	0	0
	4 - Diabase	4	4	4	2	0	0
WRSA Drilling	5 – Mixed Waste Rock	53	53	9	0	0	0
Processed Kimberlite	Coarse Processed Kimberlite	189	189	155	2	22	2
	Fine Processed Kimberlite	39	39	37	0	0	0
	Total	**3,076**	**2,961**	**1,560**	**32**	**40**	**45**

WRSA = waste rock storage area.

The following sections discuss the methods used to interpret geochemical test results.

3.3.1 Acid Base Accounting

The purpose of ABA is to determine the acid generation characteristics of a material. The results of ABA in the Ekati Mine geochemical dataset and the samples collected from the Jay pipe area included the following parameters: paste pH, bulk neutralization potential (NP) according to the modified Sobek method, and carbonate content, total sulphur, sulphide sulphur, and sulphate sulphur.

Paste pH is measured by mixing a solid sample with a fixed amount of distilled water. The paste pH reflects the contribution of readily dissolvable acid-generating and acid-neutralizing minerals in a sample.

The following two methods were used to evaluate the neutralization capacity of a sample:

- Bulk NP is measured by addition of a known excess of hydrochloric acid and back-titration of the amount of unconsumed acid with sodium hydroxide. The amount of hydrochloric acid added to the test is determined by qualitatively rating the visible reaction of hydrochloric acid with a small subsample of the test material. The NP is expressed in units of kilograms of calcium carbonate equivalent per tonne of material (kg $CaCO_3$/t). In most geological materials, calcium and magnesium carbonate minerals (e.g., calcite and dolomite) are the primary source of NP. Bulk NP measurements also account for basic silicate minerals, such as calcic feldspars, olivine, amphiboles, and biotite and, to a lesser degree, felsic silicate minerals, including sodic and potassic feldspars, muscovite, clay minerals, and quartz. Silicate minerals typically do not contribute to NP in ambient conditions, with the exception of certain basic minerals such as calcic feldspars and olivine.

- Carbonate neutralization potential (CaNP) is calculated using either total inorganic carbon content or carbon dioxide (CO_2), depending on what measurement was provided for each sample. The CaNP represents the neutralization capacity of a sample contributed by carbonate minerals only, assuming all carbonates react like calcite. Iron and manganese carbonate mineral (e.g., siderite [$FeCO_3$], ankerite [$CaFe(CO_3)_2$], and rhodochrosite [$MnCO_3$]) do not contribute to the neutralization potential of a sample; hydrolysis of iron and manganese following the dissolution of the carbonates generates acidity that consumes the buffering capacity of the minerals.

If CaNP exceeds the bulk NP of a sample, it is likely that iron and manganese carbonates are present. In this case, CaNP would overestimate the neutralization capacity of a sample. When bulk NP exceeds CaNP, it is likely that silicate minerals contributed to the NP measurement.

Sulphur analyses are used to estimate the acid potential (AP) of a sample. Sulphur analyses included total sulphur, sulphide sulphur, and sulphate sulphur. By convention, the AP calculation uses the stoichiometry of pyrite oxidation to calculate the amount of sulphuric acid that could be generated by the amount of sulphur present in a sample, which requires neutralization by a corresponding amount of calcite. The AP is expressed in units of kg $CaCO_3$/t. For the existing samples in the Ekati Mine geochemical dataset, total sulphur was used to calculate AP. This environmentally conservative approach assumes all sulphur in a sample is present in the form of sulphide minerals, and is capable of generating acidity.

The NP/AP ratio is commonly used to classify the acid generation potential of a sample. The Department of Indian Affairs and Northern Development (DIAND 1992) and Mine Environment Neutral Drainage (MEND 2009) presented guidelines for the interpretation of NP/AP in samples from project sites in the Northwest Territories. The more recent NP/AP guidelines in MEND were used for evaluating the ABA characteristics of samples from the Ekati Mine, as outlined in Table 3.2-2.

Table 3.2-2 Guidelines to Identify the Acid Generation Potential From Acid Base Accounting Results

Acid Generation Potential	NP/AP Guidelines – MEND 2009[(a)]	NP/AP Guidelines – DIAND 1992[(b)]	Comments
Potentially acid generating (PAG)	NP/AP <1	NP/AP <1.2 (tailings) NP/AP <1 (waste rock)	potentially acid generating unless sulphide minerals are non-reactive
Uncertain acid generation potential	1 <NP/AP <2	1 <NP/AP <3	possibly acid generating if NP is insufficiently reactive or is depleted at a rate faster than sulphides
Non-potentially acid generating (non-PAG)	2 <NP/AP	3 <NP/AP	not expected to generate acidity

a) MEND (2009).

b) DIAND (1992).

NP = neutralization potential; AP = acid potential; <= less than.

3.3.2 Net Acid Generation Testing

Samples collected from the Jay pipe area in 2014 were submitted for NAG testing, which was conducted according to the protocols in Australian Minerals Industry Research Association (AMIRA 2002). The purpose of the NAG test is to evaluate potential for acid generation following complete oxidation of all sulphide minerals within the sample. The results of the NAG test were used to provide an initial indication of the propensity of a material to produce acidity after a period of exposure and weathering. The NAG pH is a useful indicator of whether a sample contains sufficient internal buffering capacity to neutralize the acidity produced through sulphide oxidation.

A NAG pH value of less than 4.5 indicates that insufficient NP exists in the tailings to buffer the acidity generated by the complete oxidation of sulphide minerals. However, rates of mineral dissolution are not evaluated by the NAG testing (MEND 2009).

The NAG leachates from Jay pipe samples were submitted for comprehensive analysis. The objective of this analysis was to evaluate effluent composition in fully oxidizing conditions. The NAG leachate concentrations were compared to the Canadian Council of Ministers of the Environment (CCME) *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014). The results of NAG leachate analysis typically do not directly represent effluent chemistry. Therefore, the comparison against the CCME guidelines was principally used as a screening tool to identify parameters that may require further consideration in the context of the Project waste and water management plans. The NAG leachate analyses were also compared to the Site-Specific Water Quality Objectives (SSWQOs) for the Ekati Mine. The SSWQOs were developed for molybdenum, nitrate, potassium, sulphate, and vanadium.

3.3.3 Whole Rock and Bulk Metal Analysis

Metal concentrations were compared to the average crustal abundance of metals in crustal rock (Price 1997). For screening purposes, waste rock samples containing greater than five times the average crustal abundance of each element were considered to have elevated concentrations of that parameter. The objective of this comparison was to identify parameters that may require further consideration with regard to metal leaching potential.

3.3.4 Shake Flask Extraction Leach Testing

Short-term static leachate extraction tests are used to determine the readily soluble component of a sample. These tests, commonly known as shake flask extractions, are useful for indicating the short-term leaching characteristics and potential for metal release from a sample. Shake flask extraction tests cannot be used to evaluate long-term processes, such as dissolution of refractory minerals and sulphide oxidation.

A modified version of the British Columbia solid waste extraction procedure (Province of British Columbia 1992), using distilled water as the leaching agent and a 3:1 mass ratio (750 millilitres [mL] of water with 250 grams [g] of rock), was used. Leachates were then submitted for comprehensive analysis and leachate concentrations were compared to the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014). The objective of this comparison was to utilize the CCME guidelines as a screening tool to identify parameters that may require further consideration in the context of the Project waste and water management plans. The results of short-term leach tests do not directly represent the expected effluent chemistry of the test material under ambient conditions.

Short-term leach test concentrations were also compared to the Ekati Mine SSWQOs for molybdenum, nitrate, potassium, sulphate, and vanadium.

3.3.5 Humidity Cell Testing

Laboratory humidity cell testing was conducted on a sub-selection of samples of the granite, diabase, metasediment, kimberlite, and coarse processed kimberlite (PK). The kinetic tests were performed according to the American Society for Testing and Materials (ASTM) *D5744-96 Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell* (ASTM 2001).

A humidity cell is a weathering chamber designed to provide simple control over air, temperature, and moisture, while allowing for the removal of weathering products (principally oxidation products) in solution. The HCTs typically consist of a 1 kilogram (kg) sample (dry equivalent), which undergoes a weekly leaching cycle. The weekly cycles include a three-day period where dry air is circulated in the cell, followed by a three-day period where humid air is circulated in the cell and a final leach day when the cell is flooded with 1 litre of distilled water. The water is then drained from the cell, filtered, and submitted for analysis.

Four samples presented by Norecol Dames & Moore (1997) underwent a carbonic leach during the initial weeks of testing. These samples are labelled *leach* in the results datasets. The HCT was initiated as described above after several weeks of leaching with carbonic acid.

The results of kinetic testing were used to evaluate the effects of weathering of waste rock and kimberlite as follows:

- Long-term metal leachability was evaluated by measuring the change in composition of kinetic testing leachates over time. Changes in pH and concentrations of sulphate, alkalinity/acidity, and key trace metals provide insight with respect to mineral reaction rates in laboratory conditions. The HCT leachate concentrations were compared to the Ekati Mine SSWQOs and the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) to qualitatively identify parameters that occur at elevated concentrations relative to reference guidelines. Parameters requiring further consideration with respect to the Project water and waste management plans were identified.
- The results of HCT were used in conjunction with ABA data to calculate total sulphur and NP depletion rates. Total sulphur and NP depletion calculations, based on the relative rate of production of sulphate and alkalinity, are commonly used to predict the time to onset of acid generation in a sample. If acid-producing minerals (e.g., sulphide) are depleted before soluble, neutralizing minerals (e.g., calcite), it is unlikely that acid-generating conditions will be realized in the long term. However, if the rate of dissolution of carbonate minerals exceeds the rate of oxidation of sulphide minerals, acid generation could occur.

4 GEOCHEMICAL CHARACTERISTICS OF WASTE ROCK AND KIMBERLITE

4.1 Statistical Evaluation of the Geochemical Dataset

Results of solid phase analysis of waste rock and kimberlite samples in the Ekati Mine geochemical dataset were evaluated statistically. The objective of the statistical analysis was to determine whether the distributions of concentrations of key parameters in each rock type were the same for each sampling area (Beartooth, Fox, Koala, Misery, Panda, Pigeon, Sable) at the Ekati Mine, as well as samples from the Jay pipe.

The geochemical dataset, including samples collected in 2014 from the Jay pipe, was organized according to Project area/mining area and rock type. Non-detect measurements were assumed to equal one-half the limit of detection. Four parameters were included in the statistical analysis: total sulphur (S [total]), aluminum, magnesium, potassium, molybdenum, and nickel. The rationale for parameter selection was as follows:

- **total sulphur:** Total sulphur includes sulphide minerals (i.e., pyrite, pyrrhotite, and chalcopyrite). Sulphide mineralization has direct implications with respect to the acid rock drainage (ARD) potential of waste rock and, therefore, it is of key importance to understand whether the distribution of total sulphur is similar between mining areas.
- **aluminum:** Aluminum content will vary as a function of plagioclase, feldspar, and muscovite content.
- **magnesium:** Magnesium is hosted by biotite and hornblende in diorite, biotite granite, and two-mica granite, but is present in very low quantities in tonalite and monzonite. Magnesium was also be used to evaluate compositional variability in biotite-rich metasedimentary rocks.
- **potassium:** Potassium is hosted by biotite, muscovite, and k-feldspar in diorite, biotite granite, and two-mica granite, as well as the potassium-rich granite in the Fox Pit. Potassium was used to evaluate the compositional variability of the granites.
- **molybdenum:** Molybdenum concentrations were elevated relative to average crustal abundances in Jay pipe granite, kimberlite, and metasediment samples.
- **nickel:** Nickel can occur in the silicate mineral olivine in the kimberlite (Ketchum et al. 2012) and in sulphide minerals. Nickel concentrations were used to evaluate the variability in kimberlite composition in the geochemical dataset. Nickel concentrations were also used to evaluate the variability in sulphide mineral content.

The null hypothesis for the statistical analysis was that the statistical distribution of aluminum, total sulphur, molybdenum, potassium, nickel, and magnesium concentrations (respectively) was the same in each rock type, regardless of sampling area (Beartooth, Fox, Koala, Misery, Panda, Pigeon, Sable, and Jay pipes).

The solid phase results for the six elements in each material at each sampling area were analyzed using an analysis of variance test. The calculations were performed using the program ProUCL, a statistical software package developed by the United States Environmental Protection Agency for analysis of datasets with and without non-detect measurements. A detailed summary of the output from ProUCL is presented in the Statistical Analysis of Geochemical Dataset (Appendix A).

The Kruskal-Wallis analysis of variance test method was used to determine whether the variation in solid phase composition of materials *within* one pit is greater than the variation in solid phase composition *between* pits. Additionally, the Tukey-Kramer method was used to compare the mean values of pairs of sample sets of various sizes. The results are summarized in Appendix A. The results of the statistical evaluation indicated statistically significant differences in mean concentrations of the six test parameters by rock type and by sampling area at the 95% confidence level.

As stated in the Geochemical Characterization and Metal Leaching Management Plan, the general composition of granite, kimberlite, and metasediment are predictable at the Ekati Mine (BHP Billiton 2007). Routine monitoring tracks the bulk geochemical characteristics of waste rock annually. Furthermore, the Waste Rock and Ore Storage Management Plan for the Ekati Mine classifies all granite as non-potentially acid generating (non-PAG) and metasediment as potentially acid generating (PAG); material types are not distinguished by area for the purpose of waste rock management (BHP Billiton 2007). Therefore, for the purpose of this evaluation, the Ekati Mine geochemical dataset has been used to develop general conclusions regarding the ARD/ML potential of the various rock types from the Project area. The analytical results of supplemental samples collected from the Jay Project have been used to confirm site-specific waste rock geochemical characteristics.

4.2 Static Geochemical Tests

Detailed results of static geochemical testing, including ABA, metals analysis, short-term leach testing, and mineralogical analysis, are presented in Appendices B and C and in the Short-Term Leach Testing Results and Mineralogy Results (Appendices D and E).

The statistical summary of the ABA for overburden, waste rock, and kimberlite samples is presented in Table 4.2-1, and the overall summary of potentially acid generating, uncertain, and non-acid generating samples of overburden, waste rock, and kimberlite is presented in Table 4.2-2. The summary of the metal analysis results for overburden, waste rock, and the individual components of waste rock (diabase, granite, and metasediment) samples is presented in Table 4.2-3; a similar summary of kimberlite, coarse processed kimberlite, and fine processed kimberlite is presented in Table 4.2-4. The interpretation of solid phase metal analyses in the context of the average crustal abundance of each element is presented in Table 4.2-5. A summary of the results of shake flask extraction leach testing of Jay pipe samples is presented in Table 4.2-6, and a summary of the results of NAG leachate analysis of Jay pipe samples is presented in Table 4.2-7.

In the following sections, the static geochemical test results for the supplemental samples collected from the Jay pipe are discussed in the context of the general characteristics of each rock type as derived from the Ekati Mine geochemical dataset, described in Section 3.2.

Table 4.2-1 Statistical Summary of Acid Base Accounting of Overburden, Waste Rock, and Kimberlite Samples From the Ekati Mine

	Paste pH	Total Sulfur (TS)	Maximum Acid Potential (MAP)	Sulphate (SO_4)	Sulphide (S^{2-})	Neutralization Potential (NP)	Net Neutralization Potential (NNP)	Neutralization Potential Ratio (NP/AP)	Carbon	Inorganic Carbon (CO_2)	Carbonate Neutralization Potential (Ca-NP)	NAG pH
	unit	%	kg $CaCO_3$/t	%	%	kg $CaCO_3$/t	kg $CaCO_3$/t	-	%	%	kg $CaCO_3$/t	unit
Overburden												
Median	7.7	0.36	11	0.075	0.20	—	—	—	—	6.0	135	—
Minimum	7.2	0.005	0.16	0.005	0.15	—	—	—	—	3.0	68	—
Maximum	8.7	0.93	29	0.12	0.67	—	—	—	—	7.7	175	—
N	22	22	22	20	20	0	0	0	0	20	20	0
Diabase												
Median	9.0	0.09	2.8	0.005	0.08	10	8.0	3.8	0.010	0.10	2.3	6.1
Minimum	8.1	0.005	0.156	0.005	0.005	2.5	1.2	1.2	0.005	0.01	0.23	5.7
Maximum	9.8	1.3	42	0.060	1.3	68	47	60	0.03	0.80	18	6.4
N	85	91	91	84	47	75	75	75	9	61	69	4
Granite												
Median	9.2	0.02	0.63	0.005	0.01	5.0	4.8	19	0.005	0.10	2.3	5.1
Minimum	6.5	0.001	0.031	0.005	0.0	0.0	-6.8	0.0	0.005	0.01	0.23	4.7
Maximum	10.2	0.42	13	0.070	0.80	331	323	496	0.080	19	428	5.6
N	1132	1229	1229	279	191	481	481	481	47	283	319	30
Kimberlite												
Median	8.3	0.26	8.1	0.030	0.19	280	272	34	0.67	2.5	57	4.8
Minimum	5.1	0.0025	0.08	0.005	0.0	2.5	-51	0.16	0.02	0.05	1.1	4.5
Maximum	10.3	1.9	61	0.38	1.4	465	452	1600	1.01	8.2	187	6.0
N	361	362	362	358	174	188	188	188	8	203	211	2
Coarse PK												
Median	8.4	0.28	8.8	0.030	0.37	237	225	19	—	2.3	52	—
Minimum	6.5	0.04	1.3	0.005	0.16	75	64	6.9	—	0.90	20	—
Maximum	9.8	0.61	19	0.12	0.64	264	255	32	—	4.2	96	—
N	189	189	189	164	79	23	23	23	0	175	175	0
Fine PK												
Median	8.2	0.29	9.1	0.05	—	286	275	29	0.58	2.1	48	—
Minimum	7.9	0.1	3.1	0.01	—	251	239	22	0.37	1.4	31	—
Maximum	8.5	0.6	18	0.14	—	320	311	35	0.95	3.5	79	—
N	39	39	39	39	0	2	2	2	37	39	39	0
Metasediment												
Median	8.8	0.15	4.7	0.005	0.13	9.0	4.4	2.0	0.025	0.10	2.3	4.9
Minimum	7.1	0.0025	0.08	0.005	0.005	0.10	-14	0.023	0.005	0.02	0.40	4.0
Maximum	10.0	1.0	31	0.090	0.78	406	402	117	0.18	7.6	173	5.9
N	492	503	503	447	382	454	454	454	53	408	434	24

Note:AP calculated using total sulphur.

PK = processed kimberlite; % = percent; kg $CaCO_3$/t = kilograms calcium carbonate per tonne; - = unitless; N = number of samples; AP = acid potential; NAG = net acid generation.; — = not available (analysis was not completed for a specific parameter).

Table 4.2-2 Summary of Number of Potentially Acid Generating, Uncertain, and Non-Potentially Acid Generating Samples From the Ekati Mine

	Overburden	Diabase	Granite	Metasediments	Kimberlite	Coarse Processed Kimberlite	Fine Processed Kimberlite
Total Number of Samples	n/a	75	481	454	188	23	2
Percent of Samples with NP/AP >2	n/a	96%	93%	49%	98%	100%	100%
Percent of Samples with NP/AP >1 and <2	n/a	4%	4%	39%	2%	0%	0%
Percent of Samples with NP/AP <1	n/a	0%	4%	12%	1%	0%	0%

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
NP = neutralization potential; AP = acid potential; > = greater than; < = less than; % = percent; n/a = not available.

Table 4.2-3 Summary of Metal Analysis Results of Overburden, Waste Rock, Diabase, Granite, and Metasediment Samples From the Ekati Mine Part A

Parameter	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn
Price Crustal Abundance	**0.075**	**8.23**	**1.8**	**0.004**	**10**	**425**	**3**	**0.01**	**4.15**	**3**	**-**	**25**	**102**	**-**	**60**	**5.63**	**19**	**-**	**-**	**0.08**	**-**	**2.085**	**39**	**20**	**2.33**	**950**
Unit	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**%**	**ppm**
Overburden																										
Median	0.25	4.0	5.0	-	-	2,010	2.0	1.0	6.0	0.38	-	37	746	-	49	3.9	-	-	-	15	-	1.3	-	-	9.0	990
Minimum	0.25	3.5	2.5	-	-	1,270	1.5	1.0	3.5	0.25	-	19	406	-	27	3.0	-	-	-	10	-	0.78	-	-	4.8	630
Maximum	0.25	4.6	30	-	-	2,910	2.5	8.0	7.7	2.0	-	48	1,265	-	58	4.3	-	-	-	50	-	1.8	-	-	11	1,785
Number of samples	20	20	20	0	0	20	20	20	20	20	0	20	20	0	20	20	0	0	0	20	0	20	0	0	20	20
Diabase																										
Median	0.11	6.3	2.5	4.2	10	77	0.25	0.4	4.5	0.25	14	31	86	1.81	227	8.3	7.0	0.05	0.34	0.0050	0.01	0.4	10	16	2.4	1,190
Minimum	0.050	0.42	0.30	0.25	10	5.0	0.05	0.010	0.16	0.050	14	1.4	36	0.54	0.90	0.67	2.0	0.05	0.25	0.0050	0.01	0.14	5.0	14	0.26	139
Maximum	1.0	8.1	11	13	20	360	2.0	14	7.5	2.0	16	61	239	2.17	370	12	23	0.15	2.7	5.0	0.084	2.7	31	17	4.2	2,030
Number of samples	66	66	66	22	26	66	44	66	66	66	5	66	66	5	66	66	35	5	5	56	5	66	35	5	66	66
Granite																										
Median	0.25	7.8	2.5	0.25	10	610	1.4	1.0	2.4	0.25	31	15	89	2	18	3.1	4	0.05	0.39	5.0	0.010	2.0	11	25	1.7	373
Minimum	0.0050	0.060	0.20	0.25	5	5.0	0.05	0.010	0.030	0.010	3	0.40	5	0.2	0.50	0.18	0.50	0.05	0.06	0.0050	0.010	0.050	1.2	7	0.030	20
Maximum	1.0	12	205	12	60	1,240	5.0	26	12	1.0	91	60	644	14	333	8.7	24	0.31	4.3	20	0.064	4.7	42	127	7.4	3,330
Number of samples	517	517	517	29	59	517	488	517	517	517	39	517	517	39	517	517	103	39	39	456	39	517	103	39	517	517
Metasediment																										
Median	0.25	8.0	8.5	2.6	10	540	1.5	1.0	0.89	0.25	49	21.05	163.5	9.9	46	3.8	14	0.16	2.2	5.0	0.042	2.3	21.6	83	1.6	400
Minimum	0.0050	0.66	0.10	0.25	5	18	0.05	0.010	0.090	0.010	1	0.7	25	0.3	0.60	0.405671	0.9	0.05	0.05	0.0050	0.01	0.28	0.6	6	0.11	77
Maximum	1.0	12	940	7.6	60	1,190	4.5	16	6.9	1.5	87	72	847	24	359	11	30	0.30	4.9	30	0.19	4.3	42.4	144	16	1,865
Number of samples	398	412	412	29	53	412	382	412	412	412	49	412	412	49	412	412	92	49	49	385	49	412	92	49	412	412

Ag = silver; Al = aluminum; As = arsenic; Au = gold; B = boron; Ba = barium; Be = beryllium; Bi =bismuth; Ca = calcium; Cd = cadmium; Ce = cerium; Co = cobalt; Cr = chromium; Cs = caesium; Cu = copper; Fe = iron; Ga = gallium; Ge = germanium; Hf = hafnium; Hg = mercury; In = indium; K = potassium; La = lanthanum; Li = lithium; Mg = magnesium; Mn = manganese; ppm = parts per million; % = percent; n/a = average crustal abundance not provided;- = not available (analysis was not completed for a specific parameter).

Table 4.2-3 Summary of Metal Analysis Results of Overburden, Waste Rock, Diabase, Granite, and Metasediment Samples from the Ekati Mine Part B

Parameter	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U (ICP)	U (XRF)	V	W	Y	Zn	Zr
Price Crustal Abundance	**1.3**	**2.355**	**n/a**	**84**	**1,050**	**19**	**n/a**	**n/a**	**0.035**	**0.2**	**22**	**0.05**	**2.3**	**100**	**n/a**	**n/a**	**1.2**	**5.65**	**2.3**	**3**	**3**	**120**	**1.25**	**40**	**70**	**n/a**
Unit	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Overburden																										
Median	2.0	0.22	-	484	1,800	41	-	-	0.39	2.5	-	-	-	910	-	-	-	0.31	-	-	-	100	5.0	-	79	-
Minimum	0.50	0.10	-	236	1,180	10	-	-	0.36	2.5	-	-	-	536	-	-	-	0.24	-	-	-	72	5.0	-	44	-
Maximum	9.0	0.67	-	681	2,090	56	-	-	0.88	5.0	-	-	-	1055	-	-	-	0.39	-	-	-	118	5.0	-	90	-
Number of samples	20	20	0	20	20	20	0	0	20	20	0	0	0	20	0	0	0	20	0	0	0	20	20	0	20	0
Diabase																										
Median	0.60	1.49	30	52	930	6.0	12.2	0.0020	0.090	0.08	3.0	0.50	5.0	145	0.025	0.10	1.5	0.667	0.10	0.24	-	288	0.7	18	98	90
Minimum	0.20	0.031	4.8	3.5	60	0.7	6.8	0.0020	0.025	0.025	0.30	0.25	0.15	7.0	0.025	0.025	0.50	0.027	0.05	0.16	-	4.0	0.050	8.0	12	80
Maximum	2.4	2.4	30	97	2,550	24	23.6	0.0020	0.14	12	45	3.0	5.0	314	0.32	0.10	25	1.2	5.0	5.4	-	435	5.0	30	164	90
Number of samples	66	66	5	66	66	66	5	1	44	66	44	34	14	66	5	34	35	66	35	35	0	66	66	14	66	5
Granite																										
Median	1.0	2.7	10.0	46	830	10	30	0.0010	0.0225	2.5	1.0	0.5	5.0	555	0.025	0.03	8	0.29	0.29	5.0	-	76	5.0	6.5	62	70
Minimum	0.10	0.010	2.8	1.0	20	0.9	8	0.0010	0.0050	0.025	0.10	0.25	0.15	1.0	0.025	0.025	0.50	0.0020	0.040	0.55	-	1.0	0.050	0.50	0.50	10
Maximum	14	6.8	20	479	2,260	229	104	0.0020	0.24	15	19	2.0	5.0	932	0.8	0.10	27	0.90	5.0	17	-	381	20	20	424	140
Number of samples	517	517	39	517	517	517	39	9	234	517	155	71	91	517	39	71	103	516	103	103	0	517	517	91	517	39
Metasediment																										
Median	1.8	1.9	10	74	560	14	84	0.0010	0.15	2.5	13.7	0.50	1.2	226	0.26	0.025	6.1	0.32	0.60	2.55	-	103	5.0	10.0	80	120
Minimum	0.30	0.018	4.8	0.50	0.039	1.0	5	0.0010	0.0050	0.025	0.30	0.25	0.15	3.0	0.025	0.025	0.2	0.0050	0.03	0.60	-	1.0	0.050	5.6	6.0	10
Maximum	14	4.1	20	1,363	2,487.6	38	270	0.0020	1.0	15	30	2.0	8.0	842	1.26	0.30	16	1.1	5.0	10	-	380	190	24	182	180
Number of samples	412	412	49	412	412	412	49	25	364	412	94	86	51	412	49	86	92	412	92	92	0	412	412	51	412	49

Mo = molybdenum ; Na = sodium; Nb = niobium; Ni = nickel ; P = phosphorus ; Pb = lead; Rb = rubidium; Re = Rhenium; S = sulphur; Sb = antimony; Sc = scandium; Se = selenium; Sn = tin; Sr = strontium; Ta = tantalum; Te = tellurium; Th = thorium; Ti = titanium; Tl =thallium; U = uranium; V = vanadium; W = tungsten; Y = yttrium; Zn = zinc; Zr = zirconium; ppm = parts per million; % = percent; ICP = inductively coupled plasma; XRF = X-ray fluorescence; n/a = average crustal abundance not provided;- = not available (analysis was not completed for a specific parameter).

Table 4.2-4 Summary of Metal Analysis Results of Kimberlite Samples From the Ekati Mine Part A

Parameter	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn
Price Crustal Abundance	**0.075**	**8.23**	**1.8**	**0.004**	**10**	**425**	**3**	**0.01**	**4.15**	**3**	**n/a**	**25**	**102**	**n/a**	**60**	**5.63**	**19**	**n/a**	**n/a**	**0.08**	**n/a**	**2.085**	**39**	**20**	**2.33**	**950**
Unit	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**%**	**ppm**
Kimberlite																										
Median	0.25	3.6	5.0	0.85	10	1,505	0.90	1.0	3.4	0.25	108.95	42	519	0.79	35	3.8	4.0	0.05	0.44	0.030	0.015	1.96	92	16	10	679
Minimum	0.0300	0.68	0.50	0.25	10	90	0.25	0.030	0.272	0.050	78.9	13	58	0.54	8.0	2.2	2.0	0.05	0.4	0.0050	0.01	0.24	20	6	0.8	196
Maximum	0.7	11	30	12	20	7,000	1.5	18	9.3	1.3	139	95	1,368	1.04	91	5.5	30	0.05	0.48	120	0.02	4.2	141	26	20	1,810
Number of samples	232	234	234	20	22	234	214	234	234	234	2	234	234	2	234	234	25	2	2	201	2	234	25	2	232	234
Coarse Processed Kimberlite																										
Median	0.25	4.0	2.5	-	-	890	0.8	1.0	2.39	0.25	-	52	586	-	28	4.1	-	-	-	10.0	-	1.1	-	-	12.4	692
Minimum	0.0050	1.65	2.00	-	-	380	0.25	0.060	1.200	0.180	-	29.0	231	-	15.00	3	-	-	-	0.0200	-	0.47	-	-	6.37	500
Maximum	1.1	7	19	-	-	1,270	2	10	4.0	2.5	-	82	1,510	-	48	5	-	-	-	50	-	1.7	-	-	16	880
Number of samples	155	155	155	0	0	155	155	155	155	155	0	155	155	0	155	155	0	0	0	146	0	155	0	0	151	155
Fine Processed Kimberlite																										
Median	0.5	2.6	5.0	-	-	740	0.60	2.0	1.8	0.50	-	68	787	-	24	4.4	-	-	-	0.010	-	0.61	-	-	15	695
Minimum	0.5000	0.78	5.00	-	-	470	0.5	2.000	1.24	0.500	-	50	557	-	15.0	3.7	-	-	-	0.0100	-	0.25	-	-	11.4	568
Maximum	0.5	4	14	-	-	1,320	0.9	2	3.0	0.5	-	93	1,080	-	41	5.0	-	-	-	0.03	-	1.1	-	-	21	782
Number of samples	37	37	37	0	0	37	37	37	37	37	0	37	37	0	37	37	0	0	0	37	0	37	0	0	37	37

Ag = silver; Al = aluminum; As = arsenic; Au = gold; B = boron; Ba = barium; Be = beryllium; Bi =bismuth; Ca = calcium; Cd = cadmium; Ce = cerium; Co = cobalt; Cr = chromium; Cs = caesium; Cu = copper; Fe = iron; Ga = gallium; Ge = germanium; Hf = hafnium; Hg = mercury; In = indium; K = potassium; La=lanthanum; Li = lithium; Mg = magnesium; Mn = manganese; ppm = parts per million; % = percent; n/a = average crustal abundance not provided;- = not available (analysis was not completed for a specific parameter).

Table 4.2-4 Summary of Metal Analysis Results of Kimberlite Samples From the Ekati Mine Part B

Parameter	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U (ICP)	U (XRF)	V	W	Y	Zn	Zr
Price Crustal Abundance	**1.3**	**2.355**	**n/a**	**84**	**1050**	**19**	**n/a**	**n/a**	**0.035**	**0.2**	**22**	**0.05**	**2.3**	**100**	**n/a**	**n/a**	**1.2**	**5.65**	**2.3**	**3**	**3**	**120**	**1.25**	**40**	**70**	**n/a**
Unit	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Kimberlite																										
Median	2.0	0.31	80	656	1260	11	24.55	-	0.15	2.5	7.0	0.25	5.0	701.5	0.025	0.10	6.8	0.26	0.20	3.4	-	94.5	5.0	5.0	65.5	55
Minimum	0.05	0.00050	80	67	270	1.0	18.2	-	0.005	0.050	2.5	0.25	0.2	10	0.025	0.03	0.60	0.013	0.050	1.9	-	21	0.050	3.0	38	30
Maximum	22	2.4	80	1,765	5,440	111	30.9	-	1.7	10	18	5.5	5.0	2,967	0.025	0.20	20	0.49	5.0	9	-	186	10	15	306	80
Number of samples	234	234	2	234	234	234	2	0	51	234	58	22	35	234	2	22	25	234	25	25	0	234	234	35	234	2
Coarse Processed Kimberlite																										
Median	1	0.77	-	861.0	860	8	-	-	0.2	2.5	-	-	-	460	-	-	10.0	0.2	5	5	4	69	5	-	56	-
Minimum	0.5	0.1200	-	410	510	1	-	-	0.050	0.1	-	-	-	215	-	-	10.0	0.1	5	5	2	47	0.6	-	38	-
Maximum	11	2.25	-	1,530	1,240	47	-	-	0.69	8.0	-	-	-	691	-	-	20.0	0.25	5	10	5	91	10.0	-	117	-
Number of samples	155	155	0	155	155	155	0	0	133	155	0	0	0	155	0	0	4	155	4	4	4	155	155	0	155	0
Fine Processed Kimberlite																										
Median	2	0.12	-	1,310	590	5	-	-	0.3	5	-	-	-	311	-	-	-	0	-	-	-	56	10.0	-	53	-
Minimum	1	0.0400	-	937	330	2	-	-	0.100	5.000	-	-	-	206	-	-	-	0.1	-	-	-	31	10	-	45	-
Maximum	6	0.5	-	1,870	970	14	-	-	0.6	5.0	-	-	-	480	-	-	-	0	-	-	-	97	10.0	-	65	-
Number of samples	37	37	0	37	37	37	0	0	37	37	0	0	0	37	0	0	0	37	0	0	0	37	37	0	37	0

Mo = molybdenum ; Na = sodium; Nb = niobium; Ni = nickel ; P = phosphorus ; Pb = lead; Rb = rubidium; Re = Rhenium; S = sulphur; Sb = antimony; Sc = scandium; Se = selenium; Sn = tin; Sr = strontium; Ta = tantalum; Te = tellurium; Th = thorium; Ti = titanium; Tl =thallium ; U = uranium ;V = vanadium ; W = tungsten; Y = yttrium ; Zn = zinc; Zr = zirconium; ppm = parts per million; % = percent; ICP = inductively coupled plasma; XRF = X-ray fluorescence; n/a = average crustal abundance not provided;- = not available (analysis was not completed for a specific parameter).

Table 4.2-5 Percent of Waste Rock, Kimberlite, and Overburden Samples From the Ekati Mine in Which Metal Concentrations Exceed Five Times the Price Crustal Abundance

	Parameter	Ag	As	Ba	Bi	Cr	Cu	Hg	Mg	Mo	Ni	Pb	Sb	Se	Sr	Th	W	Zn
	Price Crustal Abundance	0.075	1.8	425	0.01	102	60	0.08	2.33	1.3	84	19	0.2	0.05	100	1.2	1.25	70
Area	Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Beartooth	Granite	1%	3%	—	100%	1%	—	72%	—	—	1%	—	100%	—	—	100%	6%	—
	Kimberlite	—	—	—	100%	—	—	—	100%	—	100%	—	100%	—	—	—	—	—
	Diabase	—	—	—	100%	—	—	—	—	—	—	—	100%	—	—	—	—	—
	Metasediments	—	—	—	100%	—	17%	100%	—	17%	—	—	100%	—	—	—	—	—
Koala	Granite	—	—	—	100%	—	—	8%	—	—	—	—	100%	—	—	—	46%	—
	Kimberlite	70%	25%	—	100%	95%	—	100%	94%	—	100%	—	100%	—	—	—	70%	—
	Metasediments	—	—	—	100%	—	—	100%	—	—	—	—	100%	—	—	—	—	—
	Overburden	—	20%	35%	100%	85%	—	100%	—	5%	85%	—	100%	—	—	—	—	—
Fox	Diabase	50%	8%	—	100%	—	—	100%	—	—	—	—	67%	—	—	100%	—	—
	Granite	7%	9%	—	100%	—	0%	65%	—	—	—	0%	95%	—	—	100%	3%	—
	Kimberlite	3%	15%	1%	100%	57%	—	7%	1%	8%	94%	1%	97%	—	—	100%	9%	—
Misery	Diabase	—	5%	—	53%	—	15%	28%	—	—	—	—	25%	52%	—	3%	—	—
	Granite	2%	13%	—	95%	—	—	64%	—	2%	—	—	65%	9%	—	49%	7%	—
	Kimberlite	—	33%	26%	52%	37%	—	26%	81%	7%	96%	—	26%	30%	—	45%	—	—
	Metasediments	6%	59%	—	100%	2%	0%	80%	2%	5%	4%	—	75%	32%	—	40%	13%	—
Panda	Granite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pigeon	Diabase	—	14%	—	86%	—	29%	—	—	—	—	—	86%	100%	—	—	—	—
	Granite	—	—	—	31%	—	—	—	—	—	—	—	31%	100%	—	78%	—	—
	Kimberlite	—	19%	19%	100%	38%	—	100%	63%	—	69%	—	100%	—	19%	—	13%	—
	Metasediments	—	3%	—	43%	—	—	100%	—	—	—	—	38%	100%	—	72%	18%	—
Sable	Granite	—	—	—	100%	—	—	—	—	7%	—	—	100%	—	—	—	—	2%
	Diabase	—	—	—	100%	—	—	—	—	—	—	—	100%	—	—	—	—	—
	Kimberlite	—	—	7%	100%	—	—	—	100%	—	100%	—	100%	—	—	—	—	—
Jay	Diabase	—	—	—	—	—	—	—	—	—	—	—	—	100%	—	—	—	—
	Granite	—	3%	—	73%	—	—	—	—	7%	—	—	—	100%	—	50%	—	—
	Kimberlite	50%	—	—	50%	100%	—	—	50%	100%	100%	—	—	100%	—	100%	—	—
	Metasediments	—	21%	—	100%	—	—	—	—	13%	—	—	—	100%	—	50%	—	—
Processed Kimberlite	Coarse Processed Kimberlite	4%	8%	—	100%	68%	—	97%	70%	4%	99%	—	85%	—	—	100%	5%	—
	Fine Processed Kimberlite	100%	5%	—	100%	100%	—	—	97%	—	100%	—	100%	—	—	—	100%	—

Note: "—"indicates that no samples had concentrations greater than 5 times the average crustal abundance in Price (1997).

Ag = silver; As = arsenic; Ba = barium; Bi =bismuth; Cr = chromium; Cu = copper; Hg = mercury; Mg = magnesium; Mo = molybdenum; Ni = nickel; Pb = lead; Sb = antimony; Se = selenium; Sr = strontium; Th = thorium; W=tungsten; Zn = zinc; ppm = parts per million; % = percent.

Table 4.2-6 Summary of Results of Shake Flask Extraction Leach Testing of Samples From the Jay Pipe Part A

Sample ID	pH	Alkalinity	Cl	F	SO_4	Hardness	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li
Unit	-	mg CaCO3/L	mg/L	mg/L	mg/L	mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CCME Guideline[(a)]	6.5–9	---	120	0.12	---	---	0.1[(b)]	---	0.005	---	---	---	1.5[(c)]	0.00009[(d)]	---	---	---	0.002[(e)]	0.3	0.001[(h)]	---
Metasediment																					
Median	7.4	12	0.70	0.08	7.0	6.0	0.12	0.0002	0.02	0.002	0.000007	0.000007	0.06	0.000003	0.95	0.0001	0.0001	0.00026	0.03	0.00002	0.01
Minimum	7.2	8	0.40	0.06	4.0	1.7	0.04	0.0002	0.0004	0.0004	0.000007	0.000007	0.007	0.000003	0.40	0.00003	0.00003	0.00015	0.002	0.00001	0.003
Maximum	7.7	39	1.4	0.14	14	28	0.22	0.0003	0.21	0.005	0.00001	0.000007	0.11	0.00002	8.1	0.0003	0.0009	0.001	0.08	0.00003	0.02
N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Granite																					
Median	7.46	10	1.2	0.06	4.0	3.5	0.07	0.0002	0.002	0.001	0.000007	0.000007	0.008	0.000006	0.98	0.00003	0.00006	0.0004	0.01	0.00005	0.003
Minimum	7.1	5	0.70	0.06	2.0	1.0	0.01	0.0002	0.0007	0.0003	0.000007	0.000007	0.006	0.000003	0.22	0.00003	0.00002	0.0003	0.002	0.00002	0.002
Maximum	7.7	33	3.0	0.10	8.0	25	0.30	0.0002	0.02	0.02	0.00001	0.000007	0.02	0.00002	8.5	0.0002	0.00008	0.0008	0.08	0.0003	0.009
N	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Diabase																					
2014-DD-040	7.81	26.2	0.5	0.06	4	10.7	0.187	0.0002	0.0003	0.00046	0.000007	0.000007	0.0292	0.000003	2.95	0.00003	0.000036	0.00022	0.011	0.00001	0.00172
2014-DD-049	7.63	27.1	0.5	0.06	5	15.2	0.178	0.0002	0.0002	0.00111	0.000007	0.000007	0.0312	0.000003	5.05	0.00003	0.000039	0.00028	0.004	0.00001	0.00243
Kimberlite																					
2014-DD-042	7.67	70.4	5.7	0.09	600	553	0.0019	0.0054	0.0035	0.0414	0.000007	0.000033	0.131	0.000104	82.4	0.00004	0.00160	0.00324	0.002	0.00001	0.0409

Note:

0.01	Indicates parameter concentration is greater than CCME guidelines.
0.01	Indicates parameter concentration is below the analytical detection limit.

a) CCME (2014).
b) Aluminum guideline = 0.005 mg/L for pH <6.5 and 0.01 mg/L for pH ≥ 6.5.
c) Boron guideline = 29 mg/L long term and 1.5 mg/L short term.
d) Cadmium guideline = 0.001 mg/L short term and hardness dependent and 0.00009 mg/L long term and hardness dependent.
e) Copper guideline is hardness dependent and is 0.002 mg/L when hardness is unknown.
f) See Part B.
g) See Part B.
h) Lead guideline is hardness dependent and is 0.001 mg/L when hardness is unknown.
i) See Part B.

Cl = chloride; F = fluoride; SO_4 = sulphate; Al = aluminum; Sb = antimony; As = arsenic; Ba = barium; Be = beryllium; Bi = bismuth; B = boron; Cd = cadmium; Ca = calcium; Cr = chromium; Co = cobalt; Cu = copper; Fe = iron; Pb = lead; Li = lithium; mg $CaCO_3$/L = milligrams calcium carbonate per litre; mg/L = milligrams per litre; N= number of samples; - = unitless; --- = no guidelines; < = less than; ≥ = greater than or equal to.

Table 4.2-6 Summary of Results of Shake Flask Extraction Leach Testing of Samples From the Jay Pipe Part B

Sample ID	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	S	Tl	Sn	Ti	U	V	Zn	Zr
Unit	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CCME Guideline[a]	---	---	0.026	0.073	0.025[f]	0.004[g]	---	0.001	---	0.0001	---	---	---	0.0008	---	---	0.015[i]	---	0.03	---
Metasediment																				
Median	0.86	0.0021	0.01	0.003	0.001	0.02	3.7	0.001	1.8	0.000002	5.8	0.01	3.2	0.000006	0.00001	0.0005	0.00005	0.001	0.001	0.002
Minimum	0.16	0.0004	0.01	8E-05	0.0002	0.009	1.4	0.00004	0.74	0.000002	1.3	0.004	0.98	0.000005	0.00001	0.0002	0.00002	0.0003	0.001	0.002
Maximum	1.9	0.007	0.01	0.02	0.006	0.06	8.9	0.003	2.8	0.000003	8.5	0.06	7.8	0.0001	0.00039	0.002	0.0001	0.003	0.001	0.002
N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Granite																				
Median	0.32	0.006	0.01	0.0005	0.0002	0.03	1.7	0.00004	1.1	0.000004	1.8	0.006	0.14	0.000005	0.00003	0.0001	0.0009	0.0005	0.001	0.002
Minimum	0.12	0.002	0.01	0.0003	0.0001	0.01	0.90	0.00004	0.52	0.000002	1.1	0.003	0.08	0.000005	0.00001	0.0001	0.0001	0.0001	0.001	0.002
Maximum	0.85	0.03	0.01	0.001	0.002	0.06	3.4	0.0001	1.9	0.00002	3.3	0.03	2.3	0.00003	0.0001	0.0009	0.007	0.003	0.002	0.002
N	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Diabase																				
2014-DD-040	0.813	0.0019	0.01	0.00007	0.0001	0.009	1.80	0.00010	1.96	0.000002	4.61	0.0213	0.14	0.000005	0.00003	0.00013	0.000113	0.00634	0.001	0.002
2014-DD-049	0.639	0.0037	0.01	0.00026	0.0001	0.015	2.44	0.00015	1.73	0.000006	2.52	0.0203	0.28	0.000013	0.00005	0.00006	0.000049	0.00295	0.001	0.002
Kimberlite																				
2014-DD-042	84.5	0.0731	0.01	0.411	0.123	0.009	74.6	0.0116	5.43	0.00275	60.0	1.34	293	0.000185	0.00002	0.00032	0.00210	0.00406	0.004	0.002

Note:
0.01 Indicates parameter concentration is greater than CCME guidelines
0.01 Indicates parameter concentration is below the analytical detection limit
a) CCME (2014).
b) See Part A.
c) See Part A.
d) See Part A.
e) See Part A.
f) Nickel guideline is hardness dependent and is 0.025 mg/L when hardness is unknown.
g) Phosphorus guideline is dependent on nature of waterbody, and is 0.004 mg/L at its lowest for ultra-oligotrophic bodies.
h) See Part A.
i) Uranium guideline = 0.03 mg/L long term and 0.015 mg/L short term.
Mg = magnesium; Mn = manganese; Hg = mercury; Mo = molybdenum; Ni = nickel; P = phosphorous; K = potassium; Se = selenium; Si = silicon; Ag = silver; Na = sodium; Sr = strontium; S =sulphur; Sn= tin; Ti = titanium; Tl = thallium; U = uranium; V = vanadium; Zn = zinc; Zr = zirconium; mg/L = milligrams per litre; µg/L = micrograms per litre; N= number of samples; --- = no guidelines.

Table 4.2-7 Summary of Results of Net Acid Generation Leach Testing of Samples From the Jay Pipe Part A

Sample ID	pH	Alkalinity	Cl	F	SO_4	Hardness	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li
Unit	-	mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CCME Guideline[a]	6.5–9	---	120	0.12	---	---	0.1[b]	---	0.005	---	---	---	1.5[c]	0.00009[d]	---	---	---	0.002[e]	0.3	0.001[h]	---
Metasediment																					
Median	4.67	0.1	5.3	0.06	52	31	0.22	0.001	0.02	0.01	0.00005	0.000007	0.05	0.0004	5.4	0.05	0.01	0.03	0.05	0.0001	0.06
Minimum	4.03	0.1	4.9	0.06	4	17	0.11	0.0008	0.002	0.005	0.00002	0.000007	0.02	0.0003	4.0	0.04	0.0002	0.004	0.03	0.00004	0.005
Maximum	4.97	6.12	6.6	0.08	64	45	0.61	0.003	0.05	0.03	0.0003	0.0002	0.11	0.0006	12	0.07	0.06	0.22	0.35	0.0008	0.13
N	15	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Granite																					
Median	5.2	17	5.3	0.06	4	17	0.36	0.001	0.002	0.004	0.00004	0.000007	0.02	0.0003	4.3	0.06	0.0003	0.003	0.10	0.0005	0.01
Minimum	4.7	0.10	4.9	0.06	4	16	0.30	0.001	0.0008	0.002	0.00001	0.000007	0.01	0.0003	4.0	0.05	0.0001	0.001	0.06	0.00008	0.005
Maximum	5.5	30	6.2	0.06	39	32	0.56	0.002	0.07	0.02	0.00009	0.00006	0.07	0.0005	7.9	0.07	0.01	0.04	0.20	0.004	0.10
N	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Diabase																					
2014-DD-040	6.37	43.6	4.8	0.06	17	36.6	0.0817	0.0011	0.0019	0.00056	0.000007	0.000007	0.0327	0.000279	5.84	0.0585	0.00130	0.00950	0.144	0.00006	0.00941
2014-DD-049	6.35	43.9	5.0	0.06	11	30.2	0.0216	0.0011	0.0041	0.00043	0.000007	0.000007	0.0293	0.000333	5.97	0.0537	0.00147	0.0148	0.009	0.00004	0.00810
Kimberlite																					
2014-DD-042	6.30	65.7	4.7	0.10	201	310	0.0313	0.0050	0.0230	0.0620	0.000007	0.000007	0.0361	0.000466	50.0	0.229	0.00431	0.00256	0.040	0.00006	0.0123

Note:

0.01 Indicates parameter concentration is greater than CCME guidelines

0.01 Indicates parameter concentration is below the analytical detection limit

a) CCME (2014).

b) Aluminum guideline = 0.005 mg/L for pH <6.5 and 0.01 mg/L for pH ≥ 6.5.

c) Boron guideline = 29 mg/L long term and 1.5 mg/L short term.

d) Cadmium guideline = 0.001 mg/L short term and hardness dependent and 0.00009 mg/L long term and hardness dependent.

e) Copper guideline is hardness dependent and is 0.002 mg/L when hardness is unknown.

f) See Part B.

g) See Part B.

h) Lead guideline is hardness dependent and is 0.001 mg/L when hardness is unknown.

i) See Part B.

Cl = chloride; F = fluoride; SO_4 = sulphate; Al = aluminum; Sb = antimony; As = arsenic; Ba = barium; Be = beryllium; Bi = bismuth; B = boron; Cd = cadmium; Ca = calcium; Cr = chromium; Co = cobalt; Cu = copper; Fe = iron; Pb = lead; Li = lithium; mg $CaCO_3$/L = milligrams calcium carbonate per litre; mg/L = milligrams per litre; N= number of samples; - = unitless; --- = no guidelines; < = less than; ≥ = greater than or equal to.

Table 4.2-7 Summary of Results of Net Acid Generation Leach Testing of Samples From the Jay Pipe Part B

Sample ID	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	S	Tl	Sn	Ti	U	V	Zn	Zr
Unit	**mg/L**	**mg/L**	**µg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
CCME Guideline[a]	**---**	**---**	**0.026**	**0.073**	**0.025[f]**	**0.004[g]**	**---**	**0.001**	**---**	**0.0001**	**---**	**---**	**---**	**0.0008**	**---**	**---**	**0.015[i]**	**---**	**0.03**	**---**
Metasediment																				
Median	4.0	0.06	0.01	0.02	0.12	29	12	0.001	7.4	0.0003	42	0.03	19	0.0002	0.02	0.03	0.002	0.02	0.009	0.002
Minimum	1.5	0.0037	0.01	0.007	0.009	24	6.4	0.0002	6.4	0.00002	40	0.02	2.4	0.00006	0.006	0.01	0.0007	0.0004	0.002	0.002
Maximum	6.3	0.14	0.01	0.03	0.33	40	13	0.002	8.9	0.0008	45	0.04	29	0.0005	0.25	0.14	0.006	0.03	0.06	0.002
N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Granite																				
Median	1.6	0.01	0.01	0.009	0.01	38	6.5	0.00008	5.6	0.00003	43	0.02	2.4	0.0001	0.20	0.04	0.008	0.002	0.006	0.002
Minimum	1.3	0.006	0.01	0.007	0.008	33	5.9	0.00004	4.4	0.00001	41	0.01	2.3	0.00007	0.05	0.02	0.003	0.0004	0.002	0.002
Maximum	4.9	0.07	0.01	0.03	0.05	39	11	0.001	7.8	0.0004	44	0.03	15	0.0003	0.52	0.08	0.05	0.02	0.06	0.002
N	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Diabase																				
2014-DD-040	5.34	0.0271	0.01	0.00805	0.0054	32.9	2.74	0.00269	7.99	0.000058	40.9	0.0105	6.81	0.000087	0.0140	0.132	0.00110	0.0424	0.002	0.002
2014-DD-049	3.71	0.0236	0.01	0.00834	0.0073	35.0	2.72	0.00238	6.31	0.000052	44.1	0.0097	6.05	0.000083	0.00768	0.112	0.000739	0.0231	0.002	0.002
Kimberlite																				
2014-DD-042	44.9	0.197	0.01	0.0573	0.375	26.0	13.6	0.0217	32.5	0.000111	43.7	0.511	86.4	0.001082	0.00458	0.0407	0.00298	0.0846	0.005	0.002

Note:

0.01 Indicates parameter concentration is greater than CCME guidelines

0.01 Indicates parameter concentration is below the analytical detection limit

a) CCME (2014).
b) See Part A.
c) See Part A.
d) See Part A.
e) See Part A.
f) Nickel guideline is hardness dependent and is 0.025 mg/L when hardness is unknown.
g) Phosphorus guideline is dependent on nature of waterbody, and is 0.004 mg/L at its lowest for ultra-oligotrophic bodies.
h) See Part A.
i) Uranium guideline = 0.03 mg/L long term and 0.015 mg/L short term.

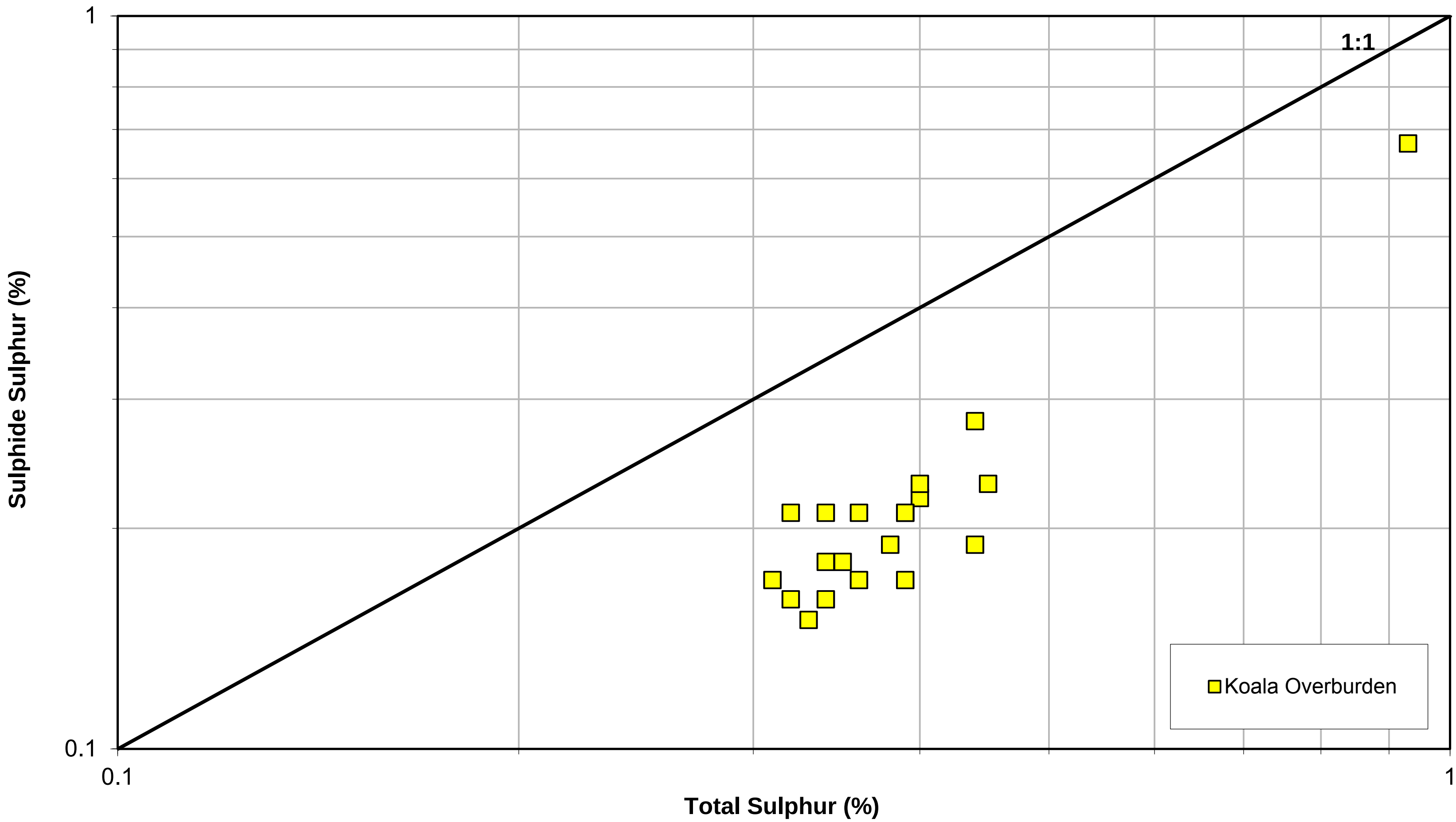
Mg = magnesium; Mn = manganese; Hg = mercury; Mo = molybdenum; Ni = nickel; P = phosphorous; K = potassium; Se = selenium; Si = silicon; Ag = silver; Na = sodium; Sr = strontium; S =sulphur; Sn = tin; Ti = titanium; Tl = thallium; U = uranium; V = vanadium; Zn = zinc; Zr = zirconium; mg/L = milligrams per litre; µg/L = micrograms per litre; N= number of samples; --- = no guidelines.

4.2.1 Overburden

The Ekati Mine geochemical dataset includes 20 samples of black clay overburden and 2 samples of till collected from the Koala pipe in 2002. The ABA results for the overburden are presented in Table 4.2-1 and are summarized as follows:

- Overburden had a near-neutral paste pH, ranging from 7.2 to 8.7.
- Total sulphur concentrations ranged from 0.005 to 0.93 weight percent (wt%). Sulphide was the primary sulphur species (0.15% to 0.67% sulphide-sulphur) (Figure 4.2-1). The lowest total sulphur concentrations were reported in the till, where sulphur species were not measured individually.
- The AP of the overburden, calculated using total sulphur, ranged from 0.16 to 29 kg $CaCO_3$/t.
- The NP of the overburden was not measured. The carbonate neutralization potential (CaNP), calculated using total inorganic carbon, ranged from 68 to 175 kg $CaCO_3$/t.

Figure 4.2-1 Sulphide-Sulphur vs. Total Sulphur in Overburden Samples



Note: All values below detection were assigned a value of half their respective detection limit.
% = percent.

The neutralization potential/acid potential (NP/AP) ratio could not be calculated because NP was not measured in overburden samples. Instead, CaNP calculated from total inorganic carbon was used in place of NP to evaluate the acid generation potential of overburden. Given that NP is typically higher than CaNP for the principal rock types at the Project, this is a conservative approach. The CaNP was greater than twice the AP for all samples. Based on the high carbonate neutralization potential ratio, the overburden is classified as unlikely to generate acidity.

The 20 black clay overburden samples were analyzed for bulk metal composition. The results of metal analysis of the overburden samples are summarized in Table 4.2-3. The percentage of samples that had trace metal concentrations greater than five times the crustal abundance (Price 1997) is listed in Table 4.2-5. This comparison was performed as a screening-level tool to identify parameters that may require further consideration with respect to metal leaching potential. Elements reported at elevated concentrations relative to crustal abundance in more than 10% of the overburden samples included arsenic, barium, bismuth, chromium, mercury, nickel, antimony, and strontium.

4.2.2 Diabase

4.2.2.1 Ekati Mine Dataset – Diabase

The geochemical dataset consists of 91 diabase samples, including 87 samples collected from the Beartooth, Misery, Pigeon, Sable, and Fox areas at the Ekati Mine, and 4 samples collected from the Jay pipe area.

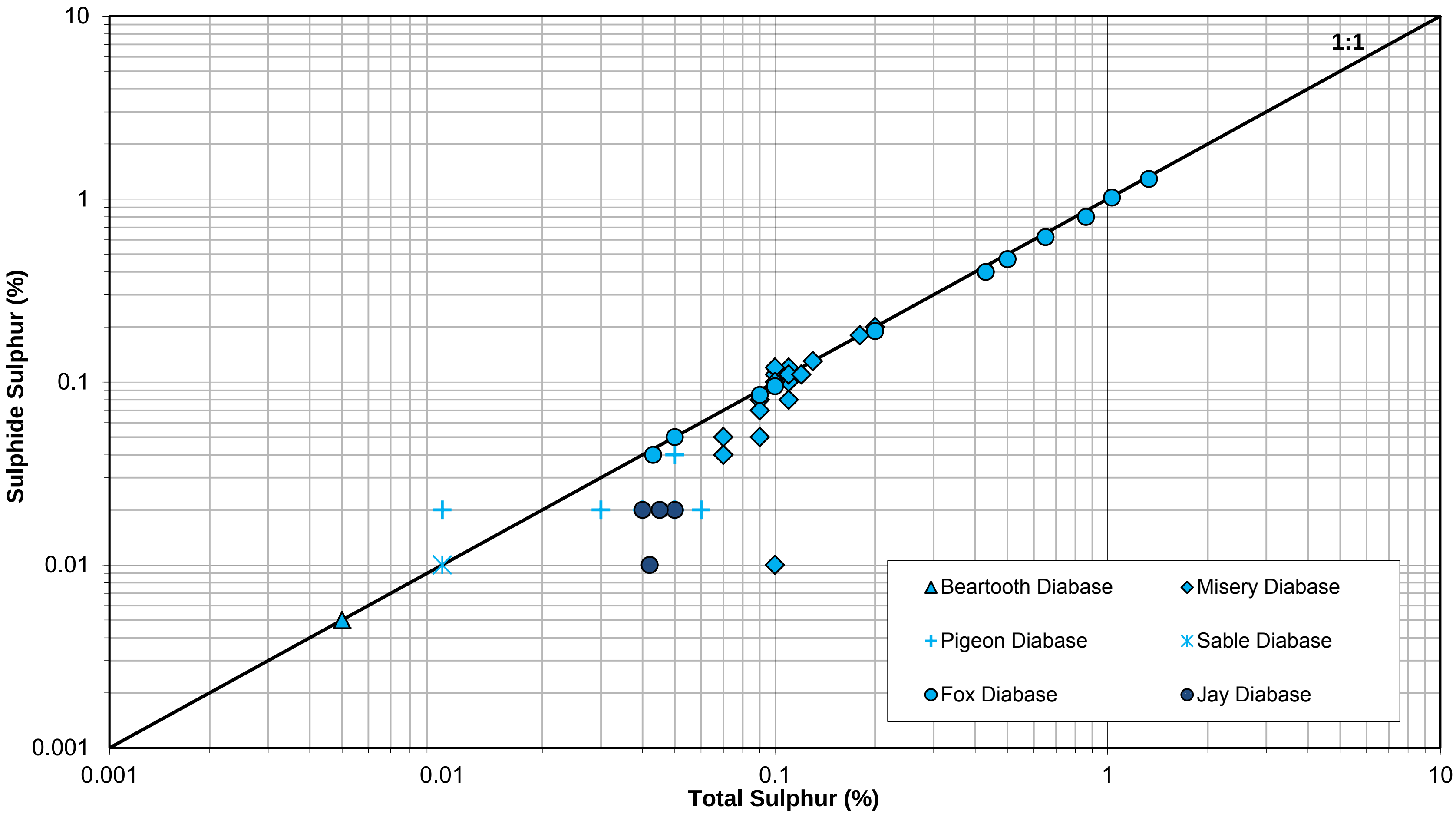
One sample of diabase was submitted for mineralogical analysis (Appendix E). Minerals present in the diabase sample included plagioclase feldspar, augite, illite, ilmenite, kaolinite, phlogopite, and quartz.

The ABA results for the diabase samples are summarized in Table 4.2-1. Key findings include the following:

- The paste pH of diabase samples ranged from 8.1 to 9.8.
- Total sulphur concentrations ranged from 0.005% to 1.3%, with a median concentration of 0.09% sulphur. Generally, the highest total sulphur concentrations were observed in diabase samples collected from the Fox Pit (Figure 4.2-2). Sulphide was the main sulphur species.
- The AP ranged from 0.16 to 42 kg $CaCO_3$/t.
- The NP of the diabase samples ranged from 2.5 to 68 kg $CaCO_3$/t, and the CaNP ranged from 0.23 to 18 kg $CaCO_3$/t. Diabase samples reported a large variation in ratio of NP to CaNP (Figure 4.2-3). The NP was typically 6 times greater than CaNP, with values up to 45 times greater than CaNP. The excess of NP indicates a contribution from silicate minerals, which are typically unlikely to contribute buffering capacity in ambient site conditions.

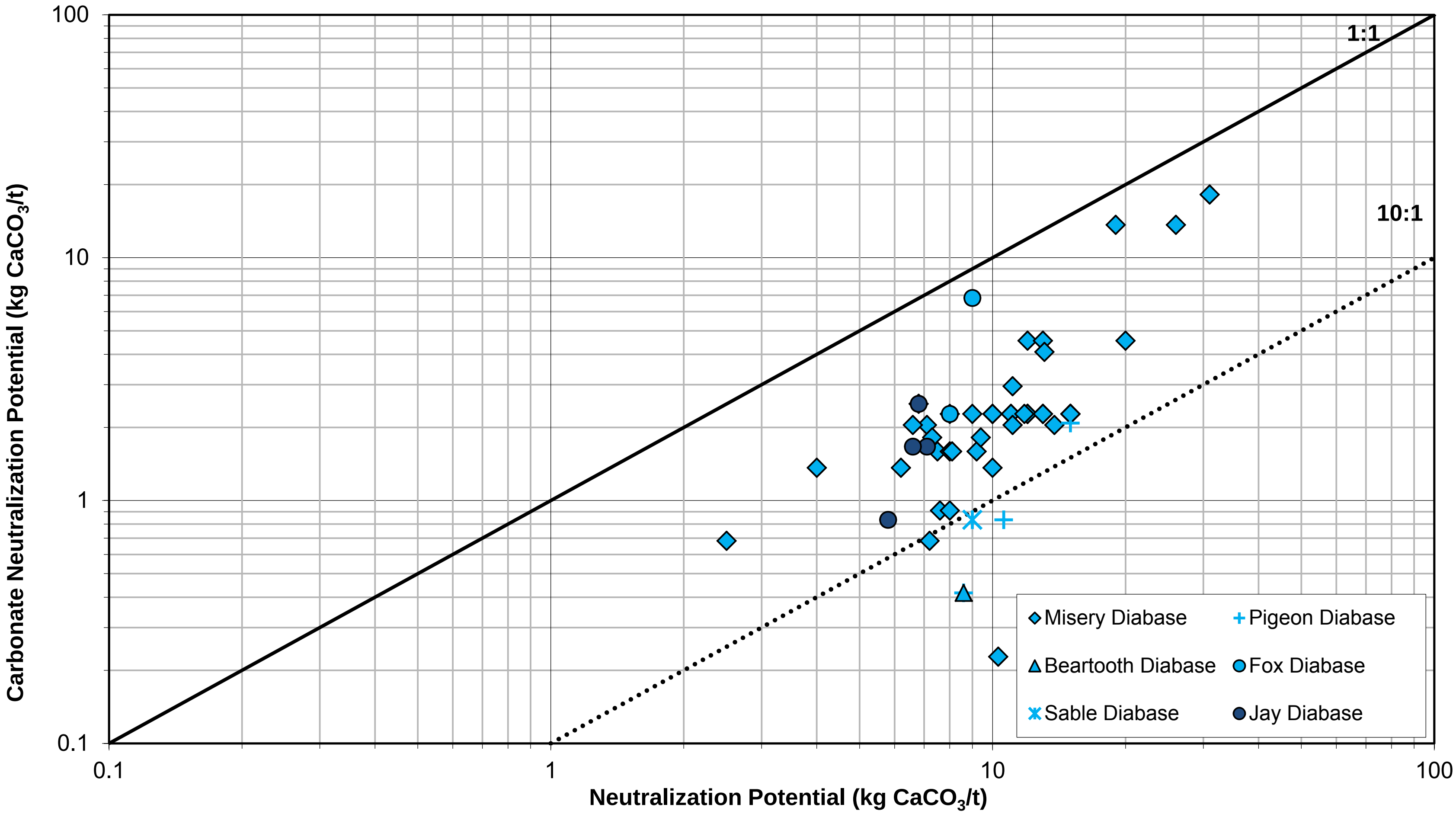
The NP/AP ratio of diabase samples is presented in Figure 4.2-3. A total of 75 diabase samples were analyzed for NP and AP, of which 72 diabase samples (96%) had NP/AP ratios greater than 2 and are classified as non-PAG (Table 4.2-2). Four diabase samples had NP/AP ratios between 1 and 2. Therefore, diabase is non-PAG.

Figure 4.2-2 Sulphide-Sulphur vs. Total Sulphur in Diabase Samples



Note: All values below detection were assigned a value of half their respective detection limit.
% = percent.

Figure 4.2-3 Carbonate Neutralization Potential vs. Neutralization Potential in Diabase Samples



kg $CaCO_3$/t = kilograms calcium carbonate per tonne.

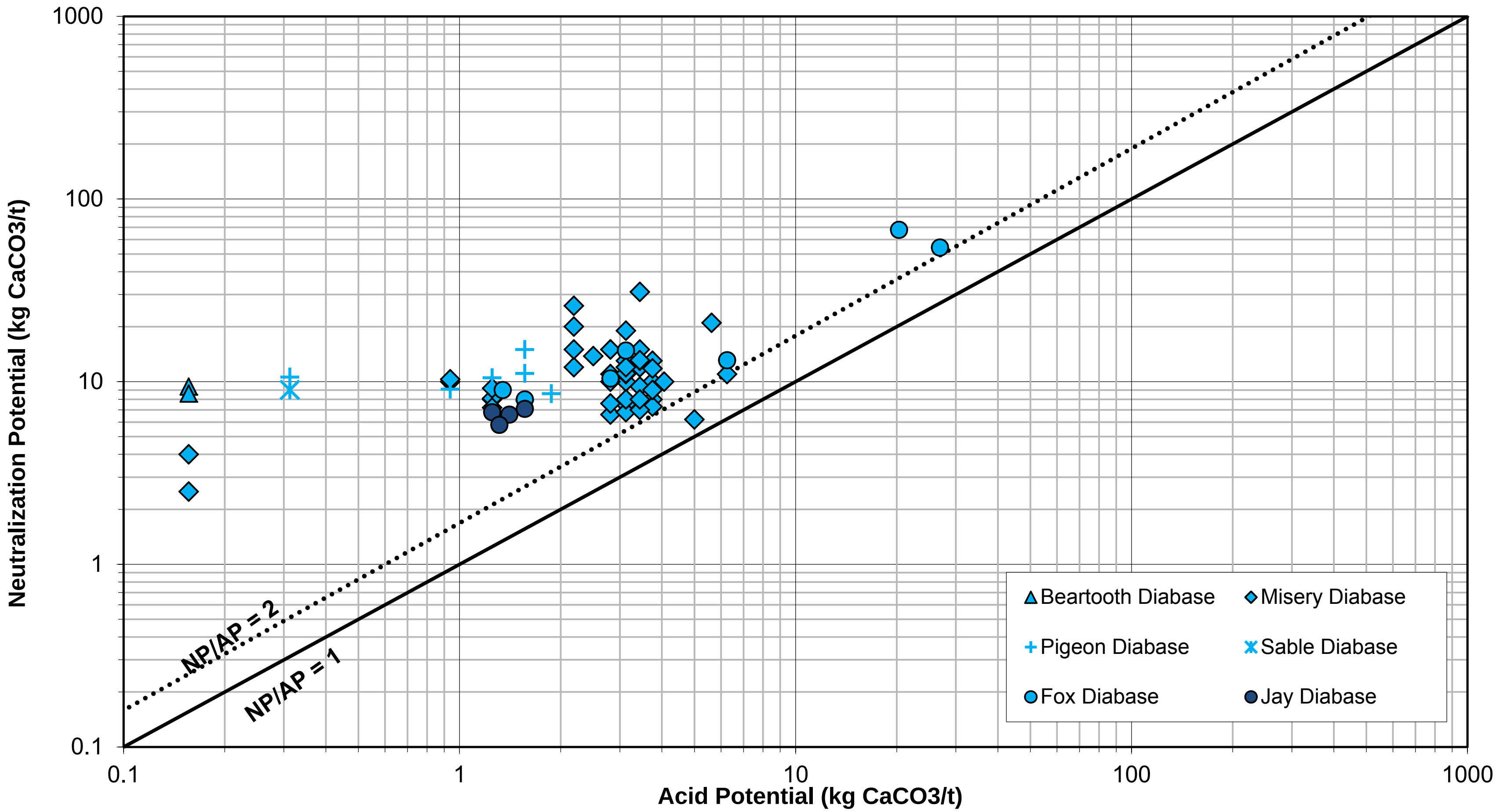
The results of bulk metal analysis of 66 diabase samples are summarized in Table 4.2-3. The percentage of samples that had element concentrations greater than five times crustal abundance (Price 1997) is presented in Table 4.2-5. This screening-level comparison was performed to identify parameters that may require further consideration with respect to metal leaching potential. Parameters that occurred at concentrations greater than five times the crustal abundance in more than 10% of the samples in the diabase dataset included silver (Fox Pit only), bismuth (all sampled areas), arsenic (Pigeon), copper (Misery and Pigeon), mercury (Fox and Misery), antimony (all sampled areas), selenium (Jay, Misery and Pigeon), and thallium (Fox). A small number of samples (less than 10%) had elevated concentrations of arsenic (Fox and Misery), and thallium (Pigeon). Diabase samples collected from the Jay pipe generally had lower bulk metal concentrations than samples collected from the other pits. Based on the results of bulk metal analysis, the composition of diabase varies spatially, between pit areas and within pit areas.

4.2.2.2 Jay Pipe Dataset – Diabase

Four diabase samples were collected from the Jay pipe area and analyzed for ABA, NAG, and bulk metal composition.

Diabase samples collected from the Jay pipe area had ABA characteristics within the range of data for diabase samples in the Ekati Mine dataset. Generally, the range of total sulphur concentrations (0.04% to 0.05%) and neutralization potentials (5.8 to 7.1 kg $CaCO_3$/t) was less than the median values in the datasets for the other areas at the Ekati Mine. All Jay pipe diabase samples were classified as non-PAG based on NP/AP values greater than 2 (Figure 4.2-4).

Figure 4.2-4 Acid Potential vs. Neutralization Potential in Diabase Samples



Note: Acid potential was calculated using total sulphur values. All values below detection were assigned a value of half their respective detection limit.
kg CaCO3/t = kilograms calcium carbonate per tonne; AP = acid potential; NP = neutralization potential.

The NAG results for the Jay pipe diabase samples are summarized in Table 4.2-1. The NAG pH values of the four diabase samples ranged from 5.7 to 6.4. All NAG pH values exceeded 4.5, indicating the presence of sufficient NP to buffer the acidity generated by the complete oxidation of sulphide minerals. The NAG pH values are shown relative to total sulphur (Figure 4.2-5) and the NP/AP ratio (Figure 4.2-6). The results of NAG testing confirm the results of ABA testing, and the Jay pipe diabase samples are classified as non-PAG.

The proportion of samples with concentrations of metals in the solid phase exceeding five times crustal abundance (Price 1997) is presented in Table 4.2-5. Generally, diabase samples had lower concentrations of solid phase metals identified as elevated in diabase samples from the other pits, including bismuth, arsenic, silver, copper, mercury, antimony, and thorium.

Two diabase samples from the Jay pipe were submitted for short-term leach testing. The leach test results were compared to the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) to qualitatively identify parameters that may require further consideration in the context of the Project waste and water management plans. The results of short-term leach tests typically do not directly represent the expected effluent chemistry of the test material under ambient conditions.

The results of shake flask extraction (SFE) testing of the diabase samples are shown in Table 4.2-6. The only parameter exceeding the CCME guidelines is aluminum. Aluminum concentrations were 0.19 and 0.18 milligrams per litre (mg/L) in the two samples, greater than the CCME guidelines of 0.1 mg/L. Concentrations of all parameters were less than the SSWQOs for the Ekati Mine.

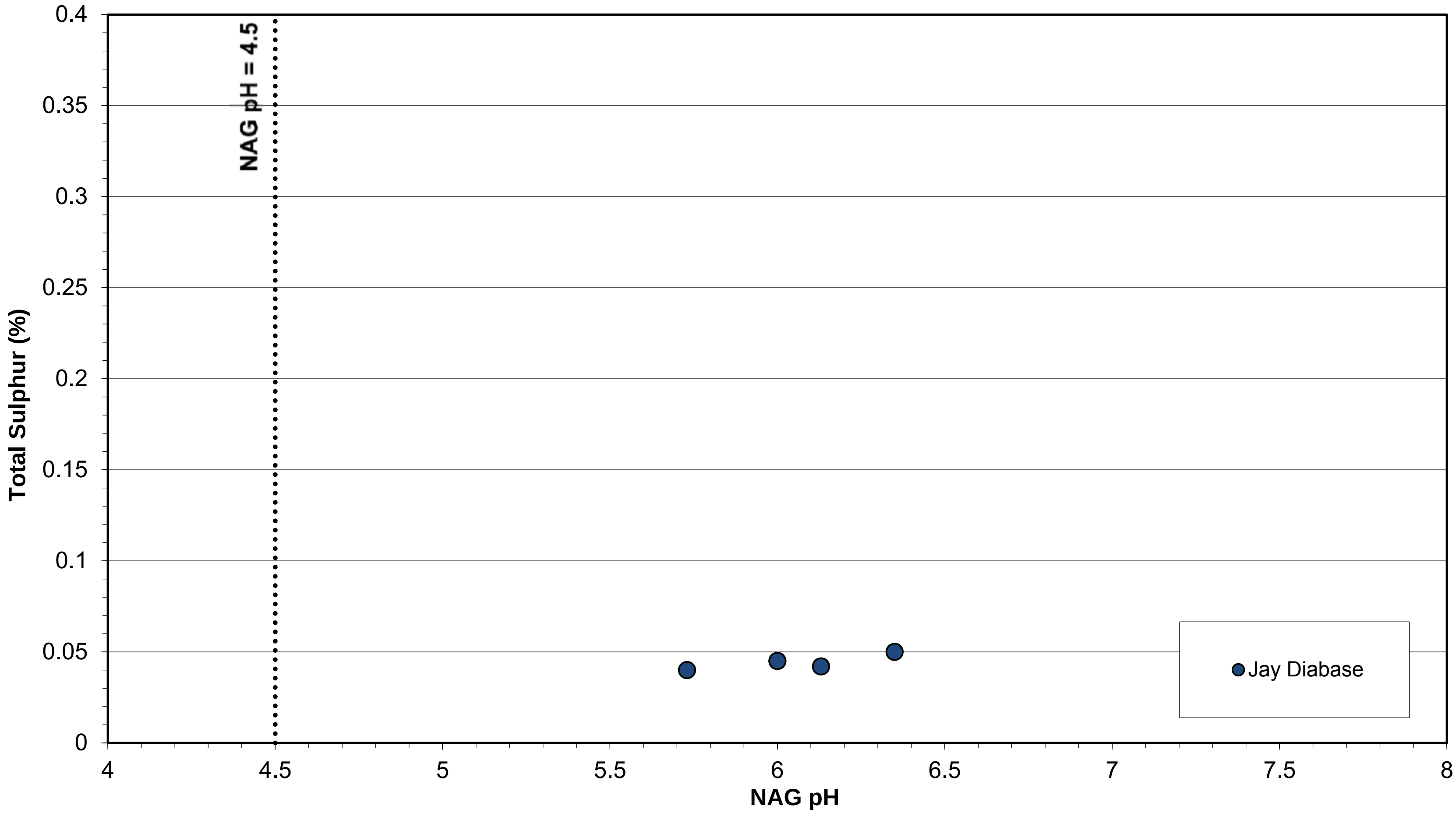
The results of NAG leachate testing are shown in Table 4.2-7. Parameters that occurred at concentrations greater than the CCME guidelines in diabase NAG leachates included the following:

- pH values were 6.4 in both samples, below the CCME guideline of 6.5.
- Aluminum concentrations were 0.02 and 0.08 mg/L, greater than the CCME guideline of 0.005 mg/L (pH values below 6.5).
- Cadmium concentrations were 0.0003 mg/L in both samples, greater than the CCME guideline of 0.00009 mg/L.
- Copper concentrations were 0.01 mg/L in both samples, greater than the CCME guideline of 0.002 mg/L.
- Selenium concentrations were 0.002 and 0.003 mg/L, greater than the CCME guideline of 0.001 mg/L.

Vanadium concentrations were greater than the long-term SSWQO for the Ekati Mine (0.03 mg/L) in the NAG leachate of one of the diabase samples (0.04 mg/L). All other parameters were below the SSWQOs for the Ekati Mine.

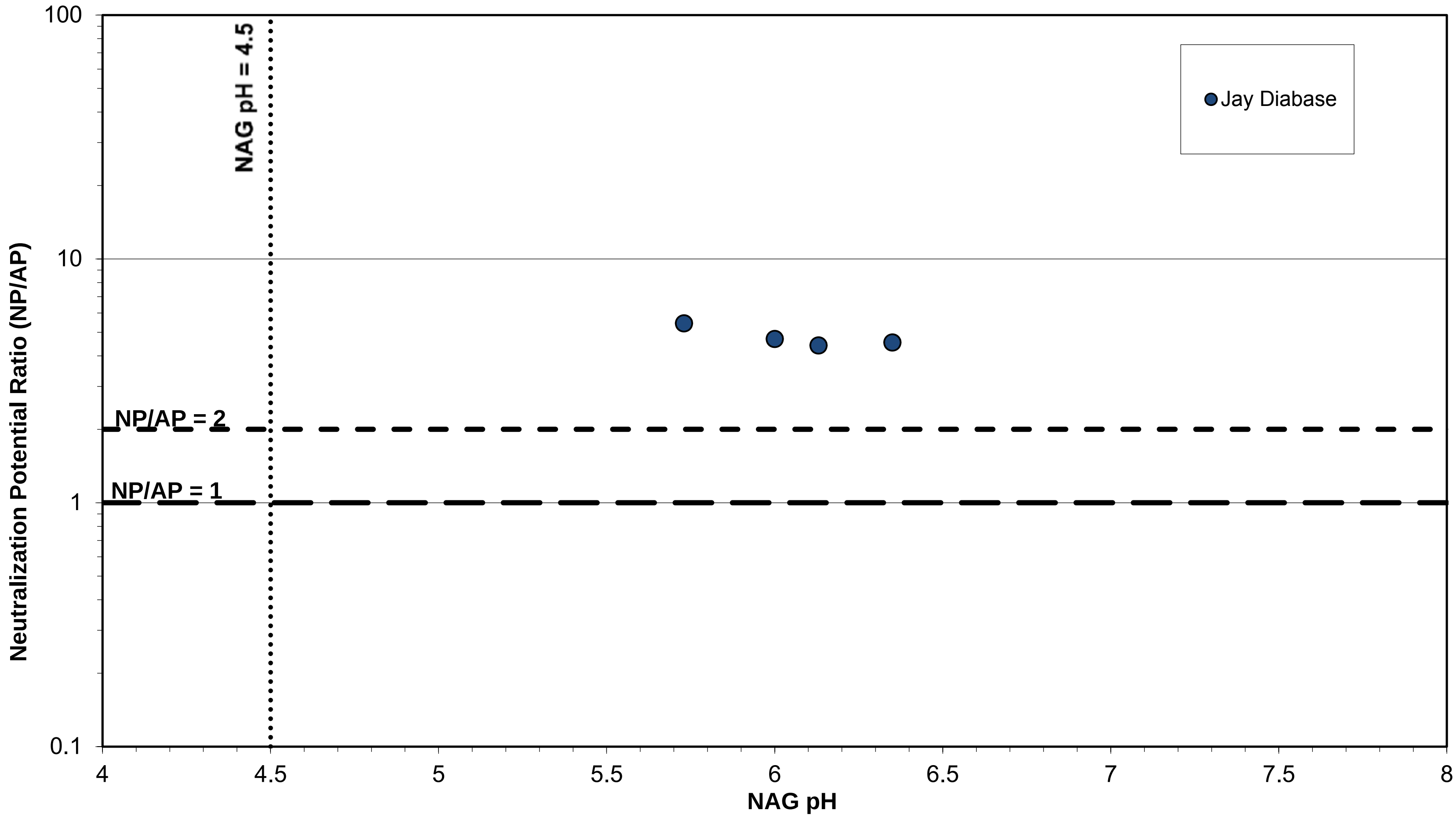
Phosphorous concentrations were elevated in NAG leachate samples owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test. Therefore, the phosphorous results of the NAG leachates do not represent the concentrations of phosphorous that would be released by the complete oxidation of diabase samples.

Figure 4.2-5 Net Acid Generation pH vs. Total Sulphur in Diabase Samples



Note: All values below detection were assigned a value of half their respective detection limit.
NAG = net acid generation;% = percent.

Figure 4.2-6 Net Acid Generation pH vs. Neutralization Potential Ratio in Diabase Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
NP = neutralization potential; AP = acid potential; NAG = net acid generation;% = percent.

4.2.3 Granite

4.2.3.1 Ekati Mine Dataset – Granite

The geochemical dataset includes 1,229 granite samples, including 1,199 samples collected from the Beartooth, Misery, Pigeon, Sable, Fox, Koala, and Panda areas, and 30 samples from the Jay pipe.

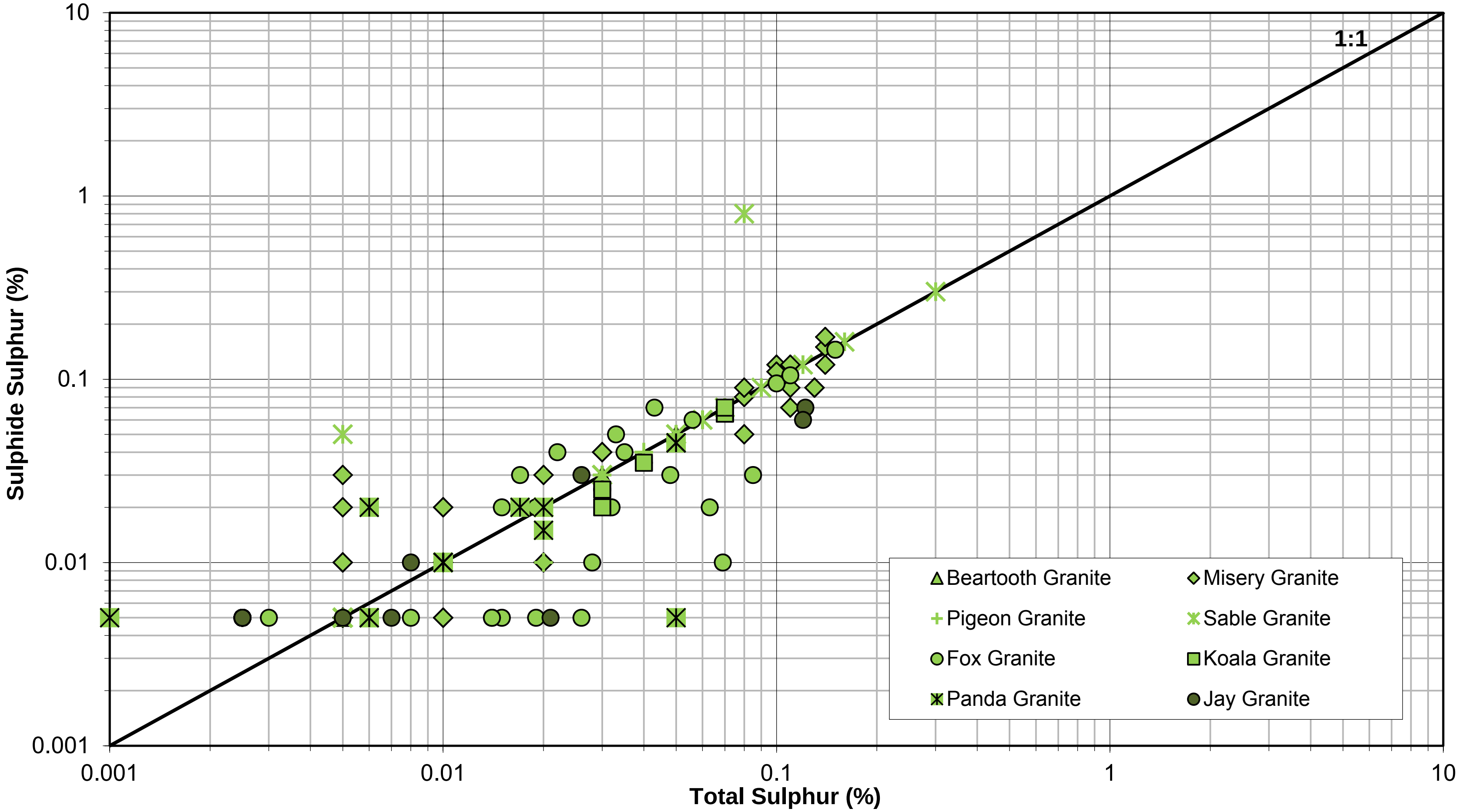
Five samples of three granite lithologies underwent mineralogical analysis (Appendix E). Minerals identified in granitic rock included the following:

- **granodiorite:** quartz, feldspar, phlogopite, illite, chlorite, kaolinite, and ilmenite;
- **two-mica granite:** plagioclase, quartz, kaolinite, biotite, pyrite (1%), and trace quantities of carbonate, epidote, magnetite, rutile, tourmaline, and chlorite; and,
- **biotite granite:** quartz, plagioclase, kaolinite, biotite, chlorite, muscovite, epidote, hematite, ilmenite, and trace magnetite, apatite, and pyrite.

The ABA results for the granite samples are summarized in Table 4.2-1. Key findings include the following:

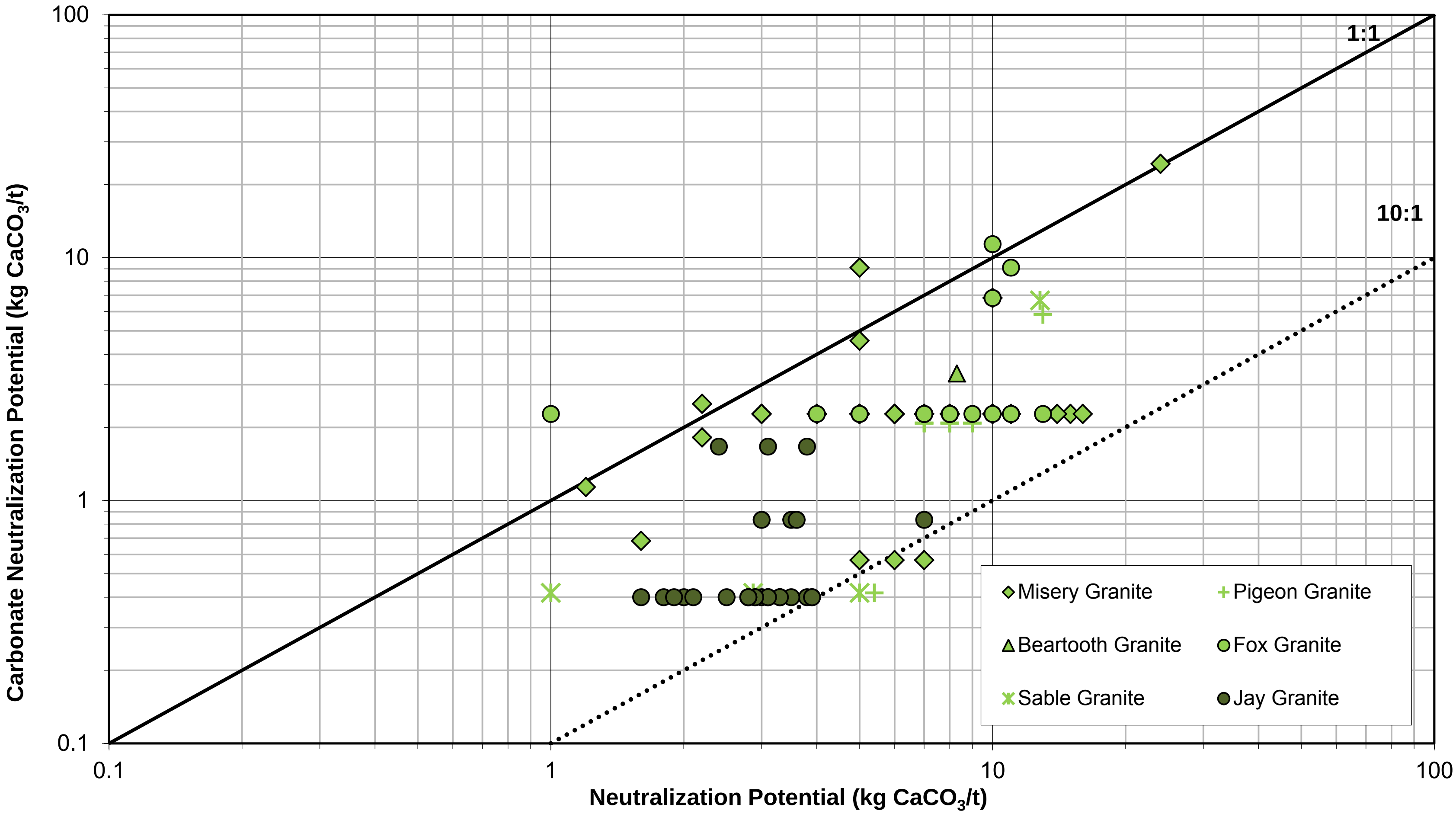
- Granite had near-neutral to alkaline paste pH values ranging from 6.5 to 10.2.
- Total sulphur concentrations ranged from 0.001% to 0.42% by weight, with a median concentration of 0.02% sulphur. Generally, the highest total sulphur concentrations were observed in granite samples collected from the Sable Pit (Figure 4.2-7). The results of total sulphur and sulphide sulphur analysis did not agree at low concentrations (less than 0.1%), which is a common effect of decreasing analytical accuracy as concentrations approach the detection limit.
- The AP of the granite samples ranged from 0.03 to 13 kg $CaCO_3$/t.
- The NP of the granite samples ranged from 0 to 331 kg $CaCO_3$/t, and the CaNP ranged from 1.1 to 187 kg $CaCO_3$/t. On average, NP was approximately three times greater than CaNP (Figure 4.2-8).
- The NP/AP ratio of the granite samples is presented in Figure 4.2-9. A total of 481 granite samples were analyzed for NP and AP; 446 granite samples (93%) had NP/AP ratios greater than 2 and are classified as non-PAG (Table 4.2-2). Samples reporting NP/AP between 1 and 2 are primarily granites from the Fox Pit, Koala Pit, and Sable Pit, with two samples from the Jay pipe. Samples with NP/AP below 1 that are classified as PAG include 17 granite samples from the Sable Pit.

Figure 4.2-7 Sulphide-Sulphur vs. Total Sulphur in Granite Samples



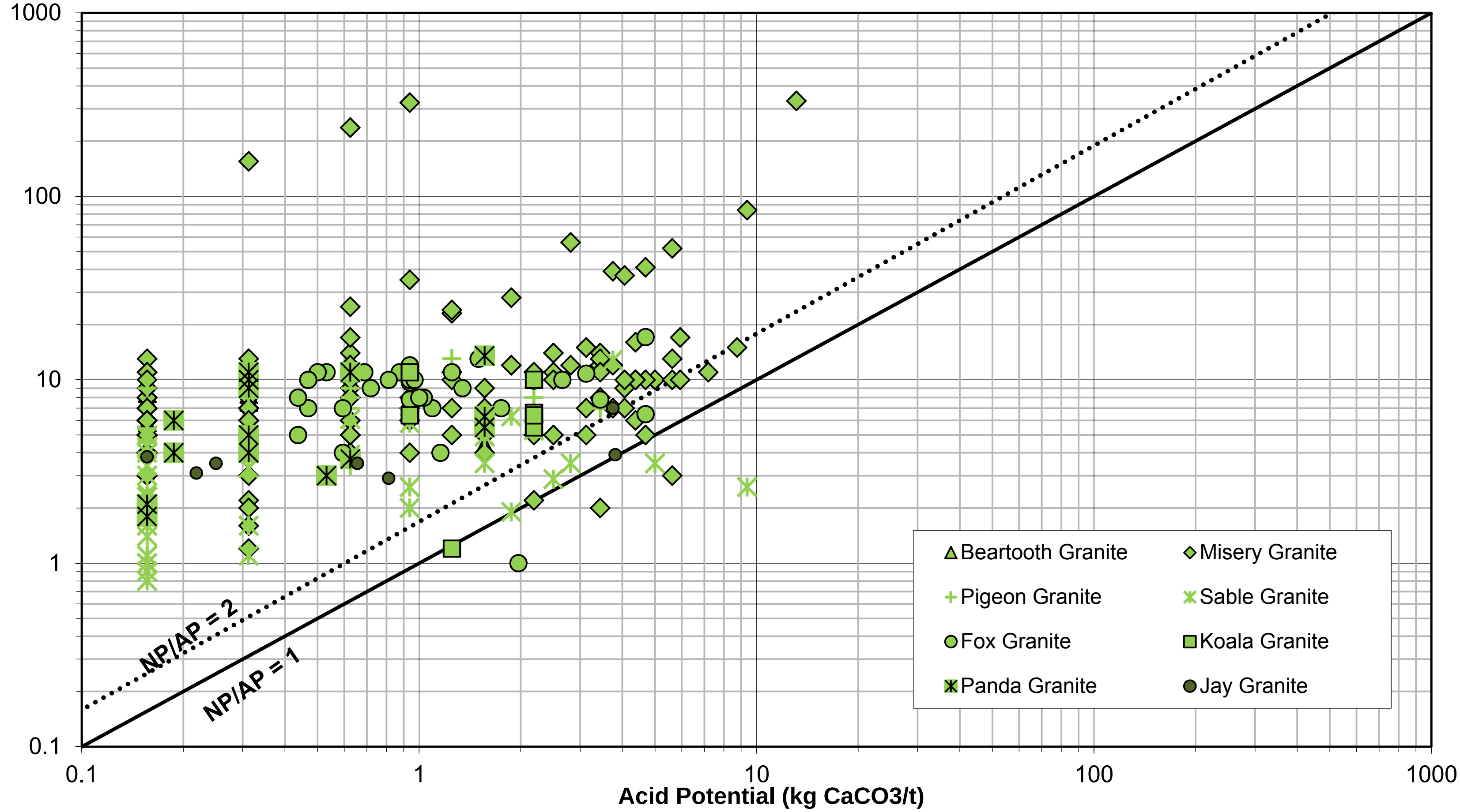
Note: All values below detection were assigned a value of half their respective detection limit.
% = percent.

Figure 4.2-8 Carbonate Neutralization Potential vs. Neutralization Potential in Granite Samples



kg $CaCO_3$/t = kilograms calcium carbonate per tonne.

Figure 4.2-9 Acid Potential vs. Neutralization Potential in Granite Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
kg $CaCO_3$/t = kilograms calcium carbonate per tonne; AP = acid potential; NP = neutralization potential.

The results of bulk metal analysis of 517 granite samples are summarized in Table 4.2-3. As presented in Table 4.2-5, several parameters had elevated concentrations relative to the average crustal abundances. Bismuth and antimony concentrations were elevated in samples from the Beartooth, Koala, Fox, and Misery pits, and the Pigeon and Sable areas. The detection limit for bismuth was greater than crustal abundance in many samples. Selenium and thorium were elevated in samples from the Pigeon area and Jay pipe. Strontium was elevated in samples from the Beartooth, Koala, Fox, and Misery pits. Arsenic concentrations were elevated in several samples from the Misery, Fox, and Jay areas.

The results of bulk metal analysis confirm that the composition of granite varies by sample collection area, which is related to the variability of granite rock types within the Ekati claim block.

4.2.3.2 Jay Pipe Dataset – Granite

In 2014, 30 granite samples were collected from the Jay pipe area and analyzed for ABA, NAG, and bulk metal composition.

Granite samples collected from the Jay pipe area had ABA characteristics within the range of the samples collected from the other pits for total sulphur (0.0025% to 0.12%) and neutralization potential (1.6 to 7.0 kg $CaCO_3$/t). Two granite samples from the Jay pipe were classified as having unknown acid generation potential with NP/AP values of 1.0 and 1.8, and the remaining 28 samples were classified as non-PAG with NP/AP values greater than 2 (Figure 4.2-9).

The NAG results for the Jay pipe granite samples are summarized in Table 4.2-1. The NAG pH values of the 30 granite samples ranged from 4.7 to 5.6. All NAG pH values exceeded 4.5, indicating the presence of sufficient NP to buffer the acidity generated by the complete oxidation of sulphide minerals. The NAG pH values are shown relative to total sulphur (Figure 4.2-10) and the NP/AP ratio (Figure 4.2-11). The results of NAG testing confirm the results of ABA testing and the Jay pipe granite samples are classified as non-PAG.

The proportion of samples with concentrations of metals in the solid phase exceeding five times crustal abundance (Price 1997) is reported in Table 4.2-5. Generally, Jay pipe granite samples had lower concentrations of solid phase metals identified as elevated than in granite samples from the other sampling areas in the Ekati Mine dataset, including silver, mercury, nickel, antimony, tungsten, and zinc. Similar to granite collected from the Misery and Sable pits, molybdenum concentrations were elevated in the solid phase, and similar to most other granites, arsenic, thorium, and bismuth were elevated in the solid phase.

The geochemical dataset includes 12 granite samples from the Jay pipe that were submitted for short-term leach testing. The leach test results were compared to the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) to qualitatively identify parameters that may require further consideration in the context of the Project waste and water management plans. The results of short-term leach tests typically do not directly represent the expected effluent chemistry of the test material under ambient conditions.

The results of SFE testing of the granite samples are summarized in Table 4.2-6 and shown in Appendix D. Median concentrations of all parameters are below the CCME guidelines. Two samples reported arsenic concentrations of 0.02 and 0.006 mg/L, greater than the CCME guideline of 0.005 mg/L.

Four samples reported aluminum concentrations ranging from 0.11 to 0.30 mg/L, greater than the CCME guideline of 0.1 mg/L. All SFE leachate concentrations were below the SSWQOs for the Ekati Mine.

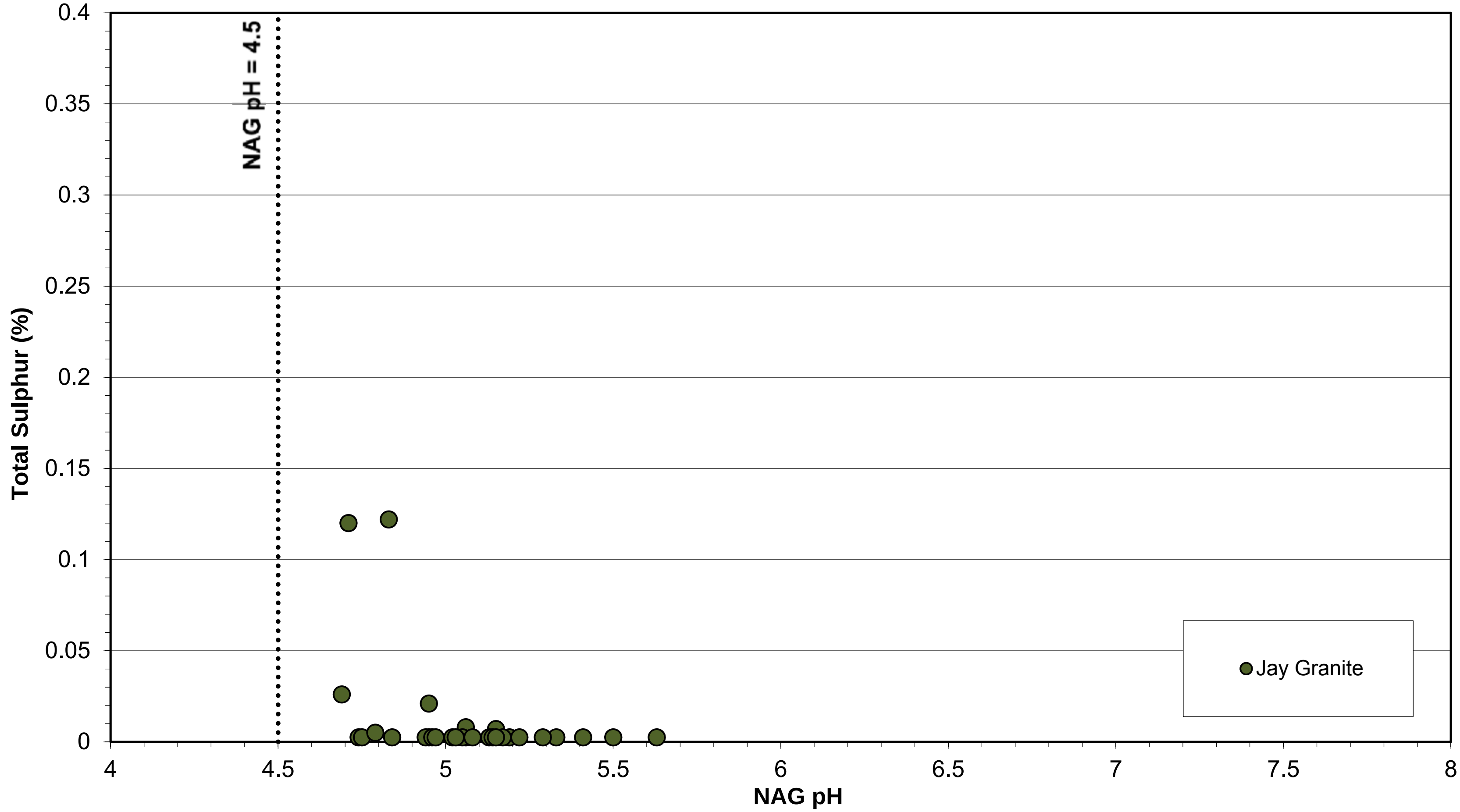
The results of NAG leachate analysis are summarized in Table 4.2-7 and shown in full in Appendix D. Parameters that occurred at concentrations in excess of the CCME guidelines included the following:

- pH values ranged from 4.7 to 5.5, below the CCME guideline of 6.5 in all samples.
- Aluminum concentrations ranged from 0.30 to 0.56 mg/L, greater than the CCME guideline of 0.1 mg/L in all samples.
- Arsenic concentrations ranged from 0.0008 to 0.07 mg/L, greater than the CCME guideline of 0.005 mg/L in three samples.
- Cadmium concentrations ranged from 0.0003 to 0.0005 mg/L, greater than the CCME guideline of 0.00009 mg/L in all samples.
- Copper concentrations ranged from 0.001 to 0.04 mg/L, greater than the CCME guideline of 0.002 mg/L in seven samples.
- Lead concentrations ranged from 0.00008 to 0.004 mg/L, greater than the CCME guideline of 0.001 mg/L in two samples.
- Nickel concentrations ranged from 0.008 to 0.05 mg/L, greater than the CCME guideline of 0.025 mg/L in two samples.
- Selenium concentrations ranged from 0.00004 to 0.0012 mg/L, greater than the CCME guideline of 0.001 mg/L in one sample.
- Silver concentrations ranged from 0.00001 to 0.0004 mg/L, greater than the CCME guideline of 0.0001 mg/L in two samples.
- Zinc concentrations ranged from 0.002 to 0.06 mg/L, greater than the CCME guideline of 0.03 mg/L in one sample.

All NAG leachate concentrations were below the SSWQOs for the Ekati Mine, with the exception of one granite sample. One granite sample reported a sulphate concentration of 39 mg/L, greater than the short-term SSWQO of 35 mg/L at a hardness below 40 mg/L as $CaCO_3$.

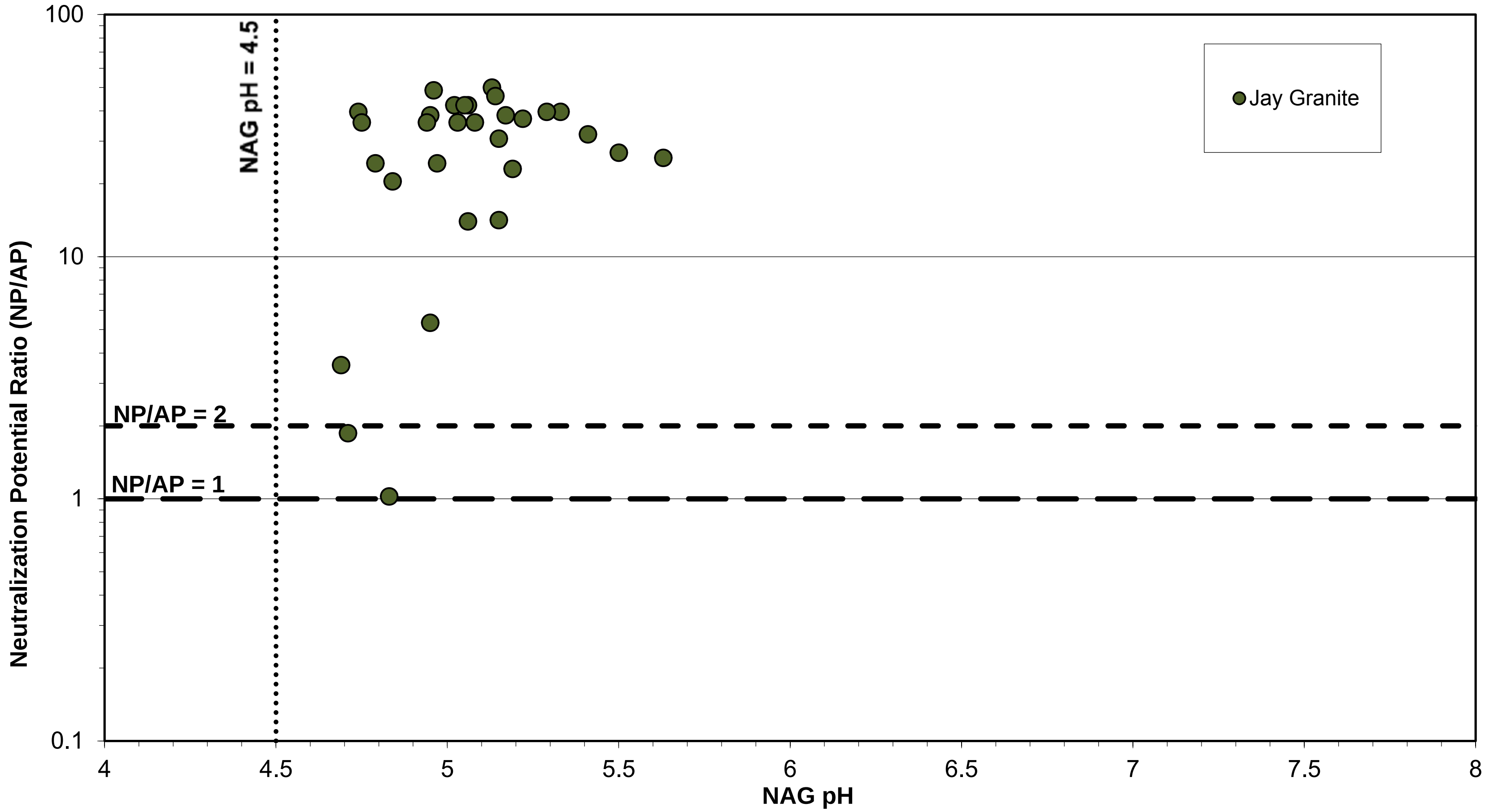
Phosphorous concentrations were elevated in NAG leachate samples owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test. Therefore, the phosphorous results in the NAG leachates do not represent the concentrations of phosphorous that would be released by the complete oxidation of granite samples.

Figure 4.2-10 Net Acid Generation pH vs. Total Sulphur in Granite Samples



Note: All values below detection were assigned a value of half their respective detection limit.
NAG = net acid generation;% = percent.

Figure 4.2-11 Net Acid Generation pH vs. Neutralization Potential Ratio in Granite Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
NP = neutralization potential; AP = acid potential ; NAG = net acid generation.

4.2.4 Metasediment

4.2.4.1 Ekati Mine Dataset – Metasediment

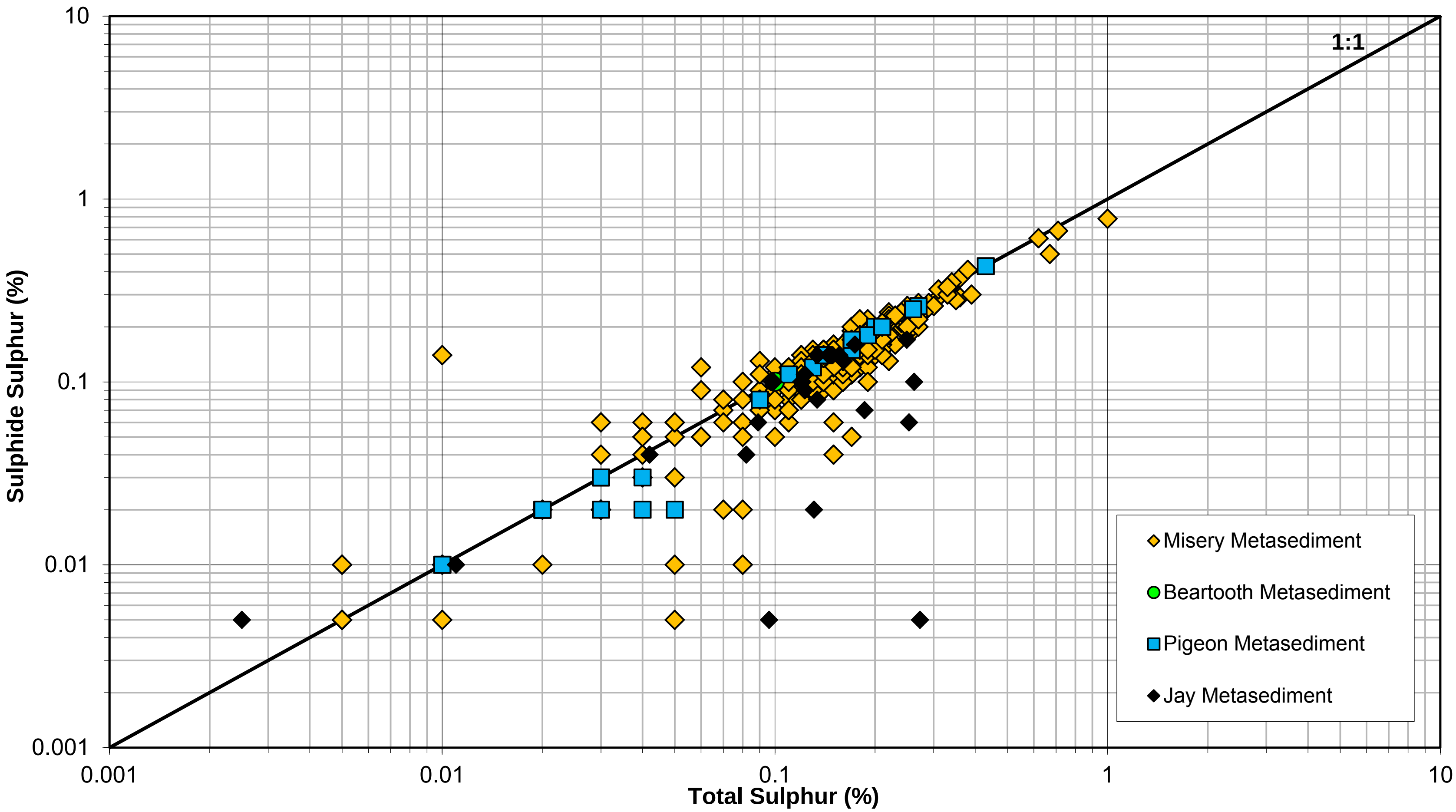
The geochemical dataset consists of 503 metasediment samples, including 479 samples collected from the Beartooth, Koala, Misery, and Pigeon pit areas, and 24 samples from the Jay pipe.

Six samples of metasediment were submitted for mineralogical analysis (Appendix E). Minerals present in metasedimentary rock included quartz, chlorite, amphibole, phlogopite, illite, feldspar, calcite, dolomite, siderite, and kaolinite, with trace pyrite and pyrrhotite.

The ABA results for the metasediment samples are summarized in Table 4.2-1. Key findings included the following:

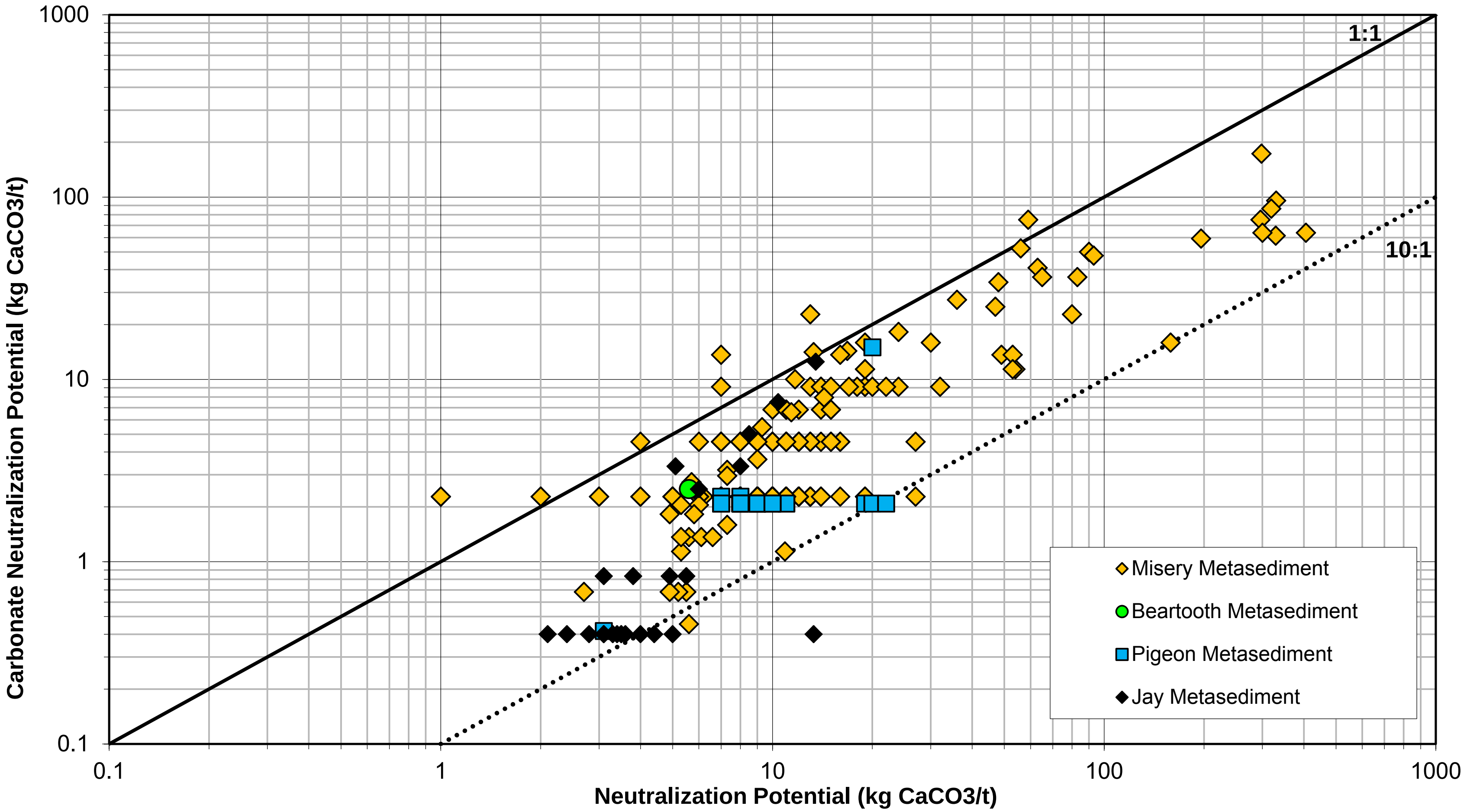
- Metasediment samples had near-neutral to alkaline pH values, ranging from 7.1 to 10.
- Total sulphur concentrations ranged from 0.0025% to 1.0% and the median total sulphur concentration was 0.15%. There is generally no trend in total sulphur concentrations differentiating the metasediment samples collected from different areas at the Ekati Mine (Figure 4.2-12). Sulphide is the main sulphur species (Figure 4.2-12).
- The AP of the metasediment samples ranged from 0.08 to 31 kg $CaCO_3$/t.
- The NP of the metasediment samples ranged from 0.10 to 406 kg $CaCO_3$/t, and the CaNP ranged from 0.40 to 173 kg $CaCO_3$/t. On average, NP was approximately four times greater than CaNP (Figure 4.2-13).
- The NP/AP ratio of the metasediment samples is presented in Figure 4.2-14. A total of 454 metasediment samples were analyzed for NP and AP, of which 224 samples (49%) had NP/AP ratios greater than 2 and are classified as non-PAG (Table 4.2-2). A total of 175 samples (39%) reported NP/AP between 1 and 2 and are classified as having uncertain acid generation potential, and 55 samples (12%) are classified as PAG, with NP/AP less than 1.

Figure 4.2-12 Sulphide-Sulphur vs. Total Sulphur in Metasediment Samples



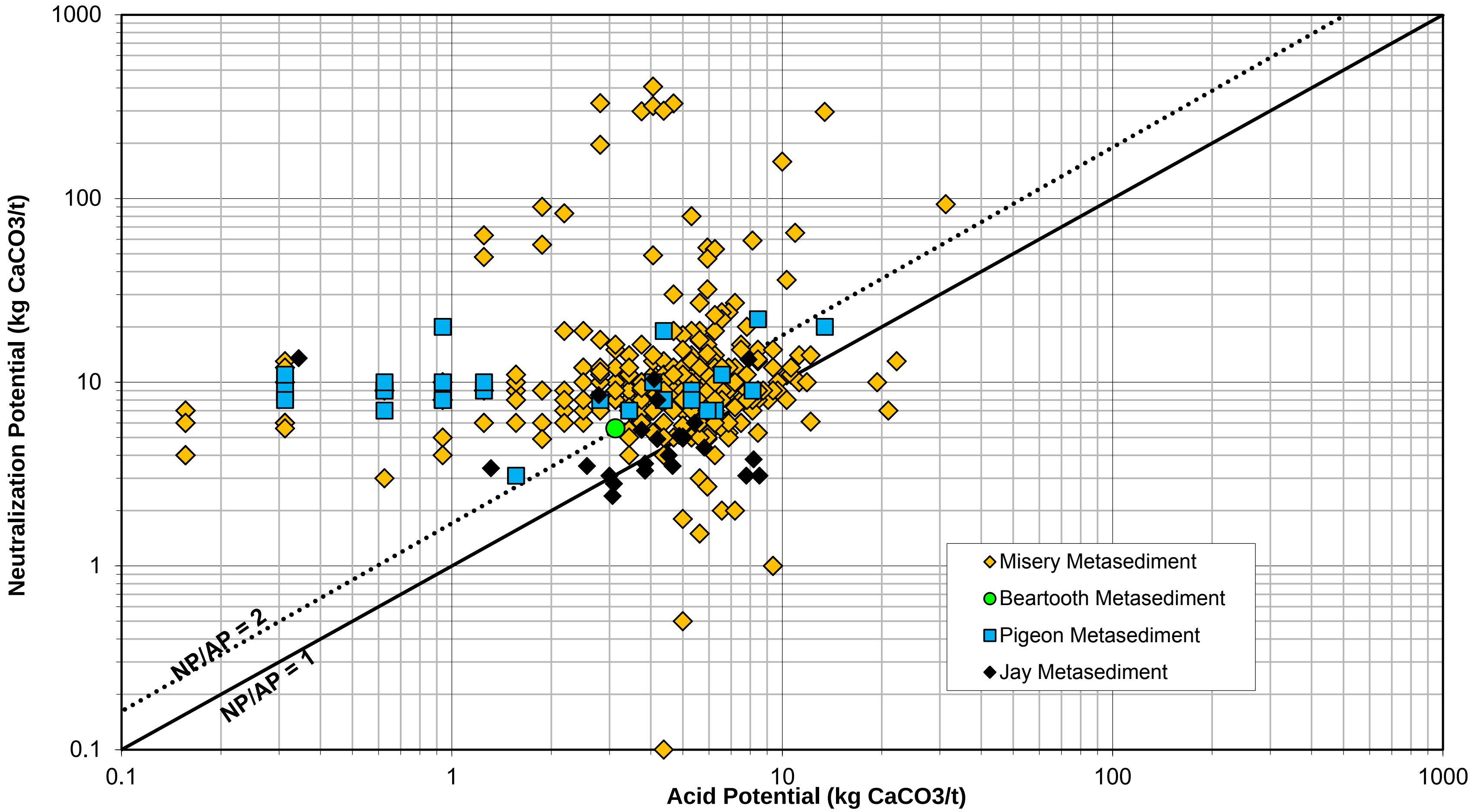
Note: All values below detection were assigned a value of half their respective detection limit.
% = percent.

Figure 4.2-13 Carbonate Neutralization Potential vs. Neutralization Potential in Metasediment Samples



kg $CaCO_3$/t = kilograms calcium carbonate per tonne.

Figure 4.2-14 Acid Potential vs. Neutralization Potential in Metasediment Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
kg $CaCO_3$/t = kilograms calcium carbonate per tonne; AP = acid potential; NP = neutralization potential.

The geochemical dataset includes 412 metasediment samples submitted for bulk metal analysis. The results of the bulk metal analysis are summarized in Table 4.2-3, and parameters that occurred at concentrations greater than five times the average crustal abundance in Price (1997) are presented in Table 4.2-5. This screening-level comparison was performed to identify parameters that may require further consideration with respect to metal leaching potential. Parameters that occurred at elevated concentrations in greater than 10% of the metasediment samples in the geochemical dataset included bismuth (all areas sampled), copper (Beartooth Pit), mercury (all areas), arsenic (Jay pipe), molybdenum (Beartooth Pit and Jay pipe), antimony (all areas), selenium (Pigeon area and Jay pipe), strontium (Beartooth and Koala pits), thorium (Pigeon area and Jay pipe), and zinc (Misery Pit and Pigeon area). Elevated concentrations of silver, arsenic, chromium, magnesium, nickel, and thorium were also measured in certain samples.

Based on the results of bulk metal analysis, the composition of metasediment varies between the pits, and within the pits. Metasediments collected from the Misery and Koala pits generally reported lower solid phase metal concentrations than those reported in the Beartooth and Pigeon pits.

4.2.4.2 Jay Pipe Dataset – Metasediment

In 2014, 24 metasediment samples were collected from the Jay pipe area and analyzed for ABA, NAG, and bulk metal composition.

Metasediment samples collected from the Jay pipe area had ABA characteristics within the range of the samples collected from the other pits for total sulphur (0.0025% to 0.27%), acid potential (0.15 to 5.3 kg $CaCO_3$/t), and neutralization potential (2.1 to 14 kg $CaCO_3$/t). A total of 24 metasediment samples from the Jay pipe were analyzed for NP and AP, of which 5 samples (21%) had NP/AP ratios greater than 2 and are classified as non-PAG (Table 4.2-2). A total of 9 samples (38%) reported NP/AP between 1 and 2 and are classified as having uncertain acid generation potential, and 10 samples (42%) are classified as PAG, with NP/AP less than 1 (Figure 4.2-14).

The NAG results for the Jay pipe metasediment samples are summarized in Table 4.2-1. The NAG pH values of the 24 metasediment samples ranged from 4.0 to 5.9. Three of the 24 metasediment samples collected from the Jay pipe had NAG pH values below 4.5, indicating the presence of insufficient NP to buffer the acidity generated by the complete oxidation of sulphide minerals.

The NAG pH values are shown relative to total sulphur (Figure 4.2-15) and the NP/AP ratio (Figure 4.2-16). The results of NAG testing show partial agreement with the ABA results in terms of acid generation potential. The three samples with NAG pH values less than 4.5 all had NP/AP ratios less than 1, and total sulphur concentrations that ranged from 0.19% to 0.27%. The total sulphur content of the remaining 21 samples with NAG pH values greater than 4.5 was 0.0025% to 0.25%; only two samples had total sulphur concentrations greater than 0.17%. A total of eight samples had NP/AP ratios less than 1, eight samples had NP/AP ratios between 1 and 2, and five samples had NP/AP ratios greater than 2.

The proportion of samples with concentrations of metals in the solid phase exceeding five times crustal abundance (Price 1997) is provided in Table 4.2-5. Generally, metal concentrations in Jay pipe metasediment samples were similar to the concentrations measured in samples from the other areas at the Ekati Mine. Metals that occurred at concentrations 5 times greater than the average crustal abundance, which may require further consideration in the context of metal leaching potential, included arsenic, bismuth, and thorium.

The geochemical dataset includes 15 metasediment samples from the Jay pipe that were submitted for short-term leach testing. The leach test results were compared to the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) to qualitatively identify parameters that may require further consideration in the context of the Project waste and water management plans. The results of short-term leach tests typically do not directly represent the expected effluent chemistry of the test material under ambient conditions.

The results of SFE are summarized in Table 4.2-6 and shown in Appendix D. Parameters that occurred at concentrations in excess of the CCME guidelines included the following:

- Fluoride concentrations ranged from 0.06 to 0.14 mg/L, greater than the CCME guideline of 0.12 mg/L in one sample.
- Aluminum concentrations ranged from 0.04 to 0.22 mg/L, greater than the CCME guideline of 0.1 mg/L in 10 samples.
- Arsenic concentrations ranged from 0.0004 to 0.21 mg/L, greater than the CCME guideline of 0.005 mg/L in nine samples.
- Selenium concentrations ranged from 0.00004 to 0.003 mg/L, greater than the CCME guideline of 0.001 mg/L in eight samples.

All metasediment SFE leachate concentrations were below the SSWQOs for the Ekati Mine.

The results of NAG leachate analysis are summarized in Table 4.2-7 and shown in full in Appendix D. Parameters that occurred at concentrations in excess of the reference guidelines included the following:

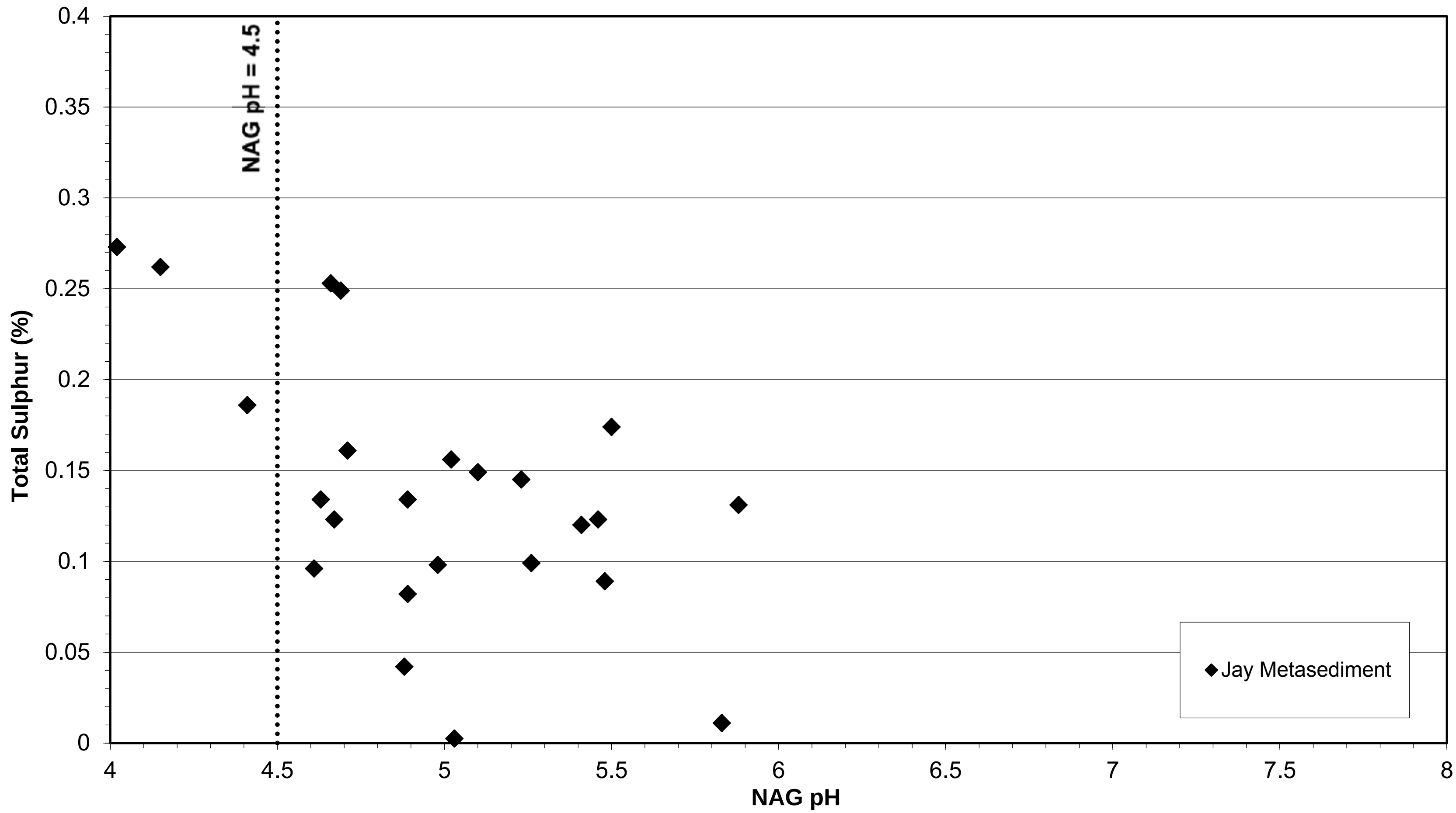
- pH values ranged from 4.0 to 5.0, below the CCME guideline of 6.5 in all samples.
- Aluminum concentrations ranged from 0.11 to 0.22 mg/L, greater than the CCME guideline of 0.1 mg/L in all samples.
- Arsenic concentrations ranged from 0.002 to 0.05 mg/L, greater than the CCME guideline of 0.005 mg/L in 13 samples.
- Cadmium concentrations ranged from 0.0003 to 0.0006 mg/L, greater than the CCME guideline of 0.00009mg/L in all samples.
- Copper concentrations ranged from 0.004 to 0.22 mg/L, greater than the CCME guideline of 0.002 mg/L in all samples.
- Nickel concentrations ranged from 0.009 to 0.33 mg/L, greater than the CCME guideline of 0.025 mg/L in 12 samples.

- Selenium concentrations ranged from 0.0002 to 0.002 mg/L, greater than the CCME guideline of 0.001 mg/L in 13 samples.
- Silver concentrations ranged from 0.00002 to 0.0008 mg/L, greater than the CCME guideline of 0.0001mg/L in nine samples.
- Zinc concentrations ranged from 0.002 to 0.06 mg/L, greater than the CCME guideline of 0.03 mg/L in three samples.

All metasediment NAG leachate concentrations were below the SSWQOs for the Ekati Mine.

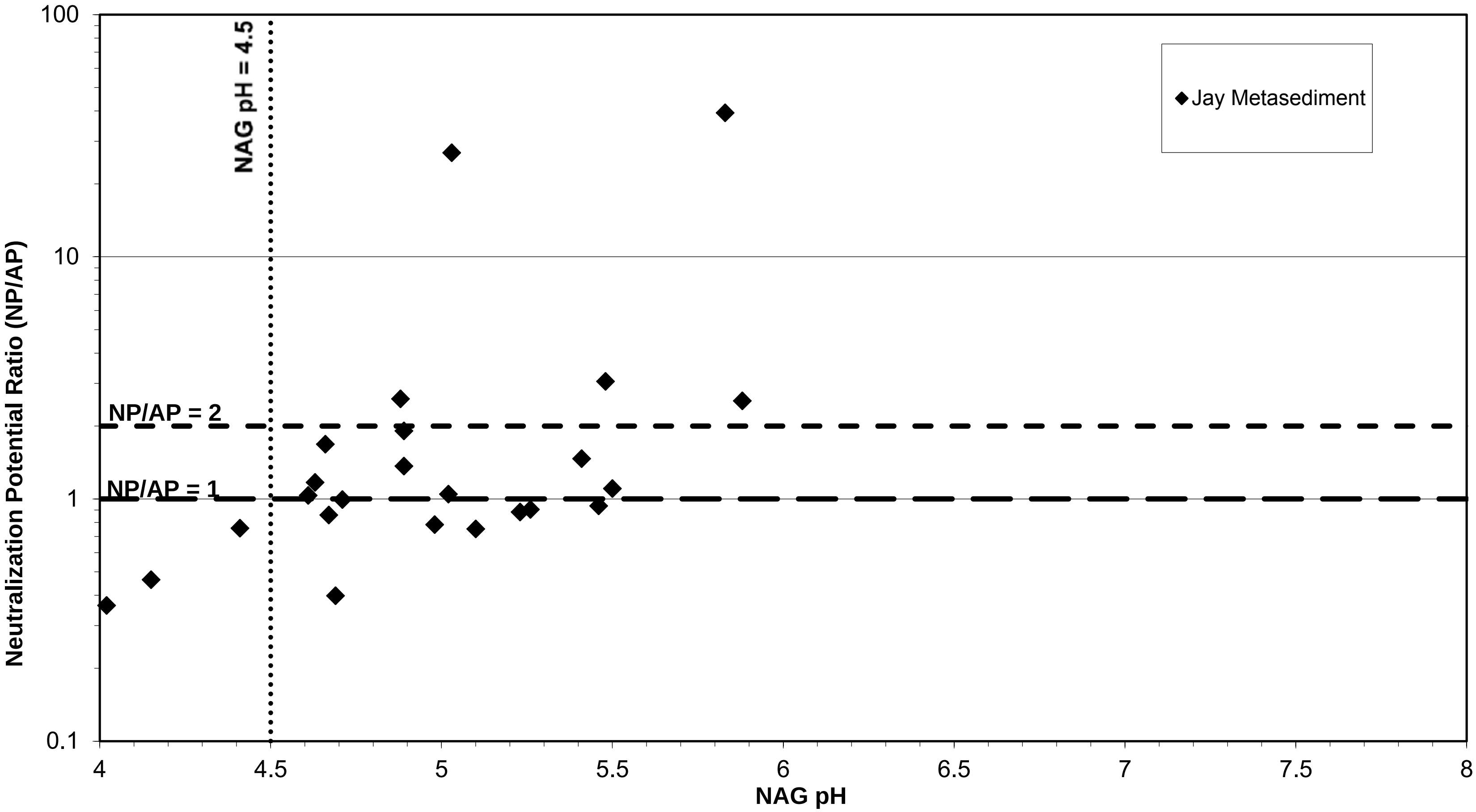
Phosphorous concentrations were elevated in NAG leachate samples owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test. Therefore, the phosphorous results in the NAG leachates do not represent the concentrations of phosphorous that would be released by the complete oxidation of metasediment samples.

Figure 4.2-15 Net Acid Generation pH vs. Total Sulphur in Metasediment Samples



Note: All values below detection were assigned a value of half their respective detection limit.
NAG = net acid generation;% = percent.

Figure 4.2-16 Net Acid Generation pH vs. Neutralization Potential Ratio in Metasediment Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
NP = neutralization potential; AP = acid potential ; NAG = net acid generation.

4.2.5 Kimberlite and Processed Kimberlite

The geochemical dataset includes 360 samples of kimberlite collected from the Beartooth, Misery, Pigeon, Sable, Fox, and Koala areas, and 2 samples from the Jay pipe. In addition, 189 samples of coarse PK and 39 samples of fine PK were submitted for geochemical testing.

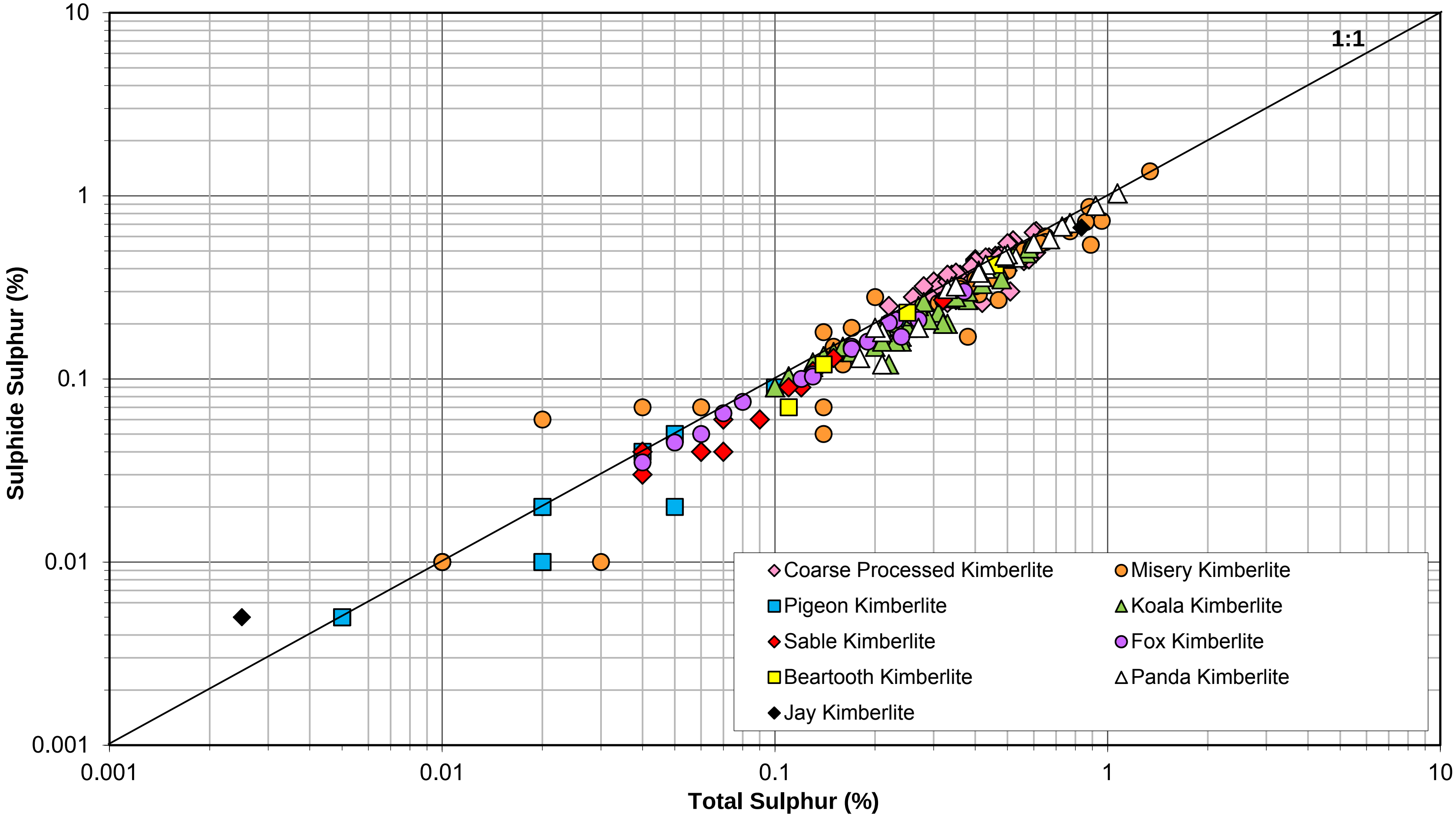
4.2.5.1 Ekati Mine Dataset – Kimberlite

A total of 362 kimberlite samples collected from the Jay pipe and the Beartooth, Misery, Pigeon, Sable, Fox, and Koala pits were analyzed as part of the geochemical dataset.

The ABA results for the kimberlite samples are summarized in Table 4.2-1. Key findings included the following:

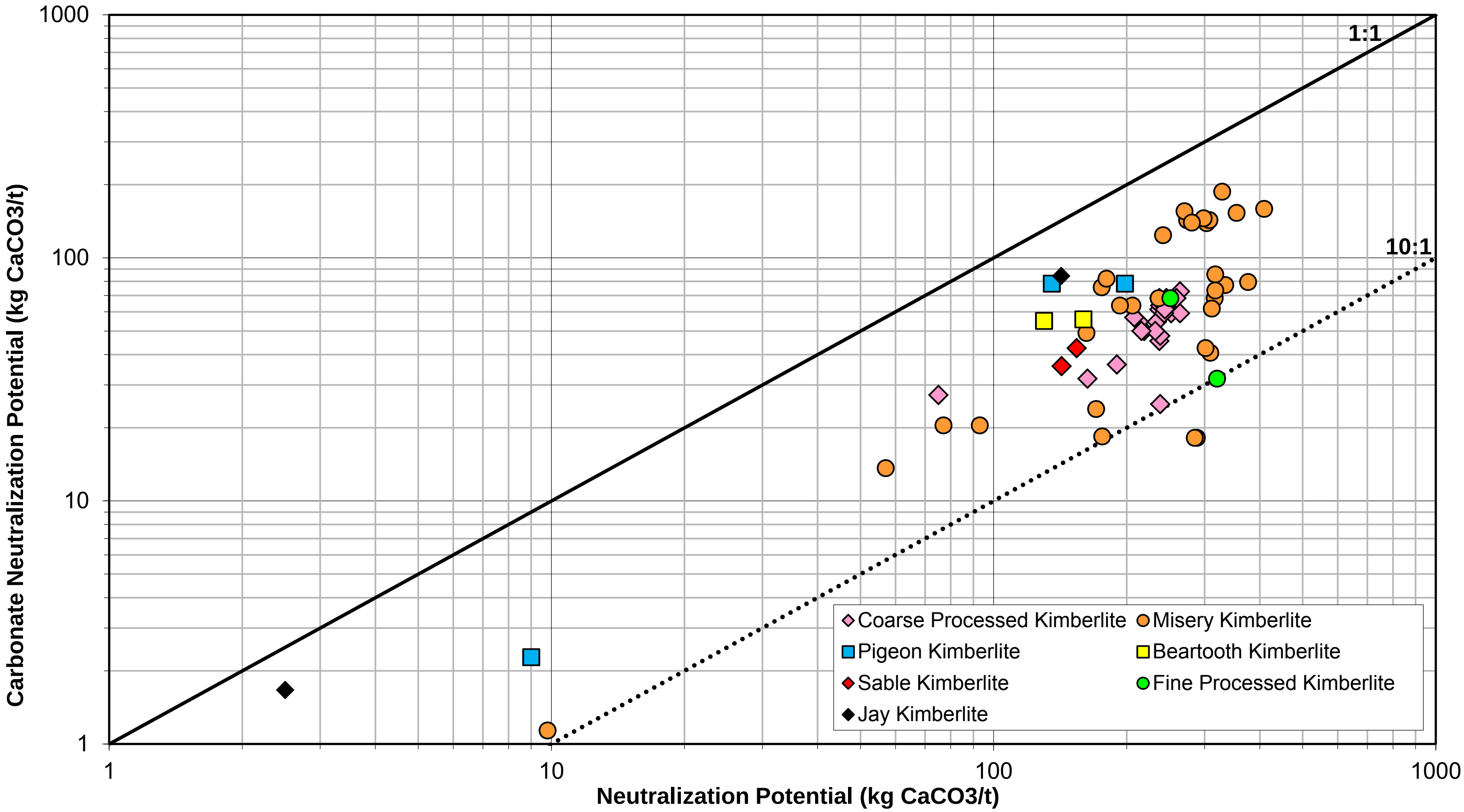
- Kimberlite had paste pH values ranging from 5.1 to 10.
- Total sulphur concentrations ranged from 0.0025% to 1.9%, with a median concentration of 0.26%. Generally, the highest total sulphur concentrations were observed in kimberlite samples collected from the Misery Pit and the Panda Pit, and the lowest sulphur concentrations were observed in samples from the Pigeon area (Figure 4.2-17).
- Sulphur is primarily in the form of sulphide in the kimberlite samples (Figure 4.2-17).
- The AP of the kimberlite samples ranged from 0.08 to 61 kg $CaCO_3$/tonne.
- The highest AP values were reported in samples from the Misery and Panda pits with the highest sulphide-sulphur concentrations (Figure 4.2-19).
- The NP of the kimberlite samples ranged from 2.5 to 465 kg $CaCO_3$/tonne and the CaNP ranged from 1.1 to 187 kg $CaCO_3$/tonne. Kimberlite samples reported a large variation in the NP to CaNP ratio (Figure 4.2-18). On average, NP was four times greater than CaNP.
- The NP/AP ratio of the kimberlite samples is presented in Figure 4.2-19. A total of 188 kimberlite samples were analyzed for NP and AP, of which 184 samples (98%) had NP/AP ratios greater than 2 (Table 4.2-2). Kimberlite is classified as non-PAG.

Figure 4.2-17 Sulphide-Sulphur vs. Total Sulphur in Kimberlite and Processed Kimberlite Samples



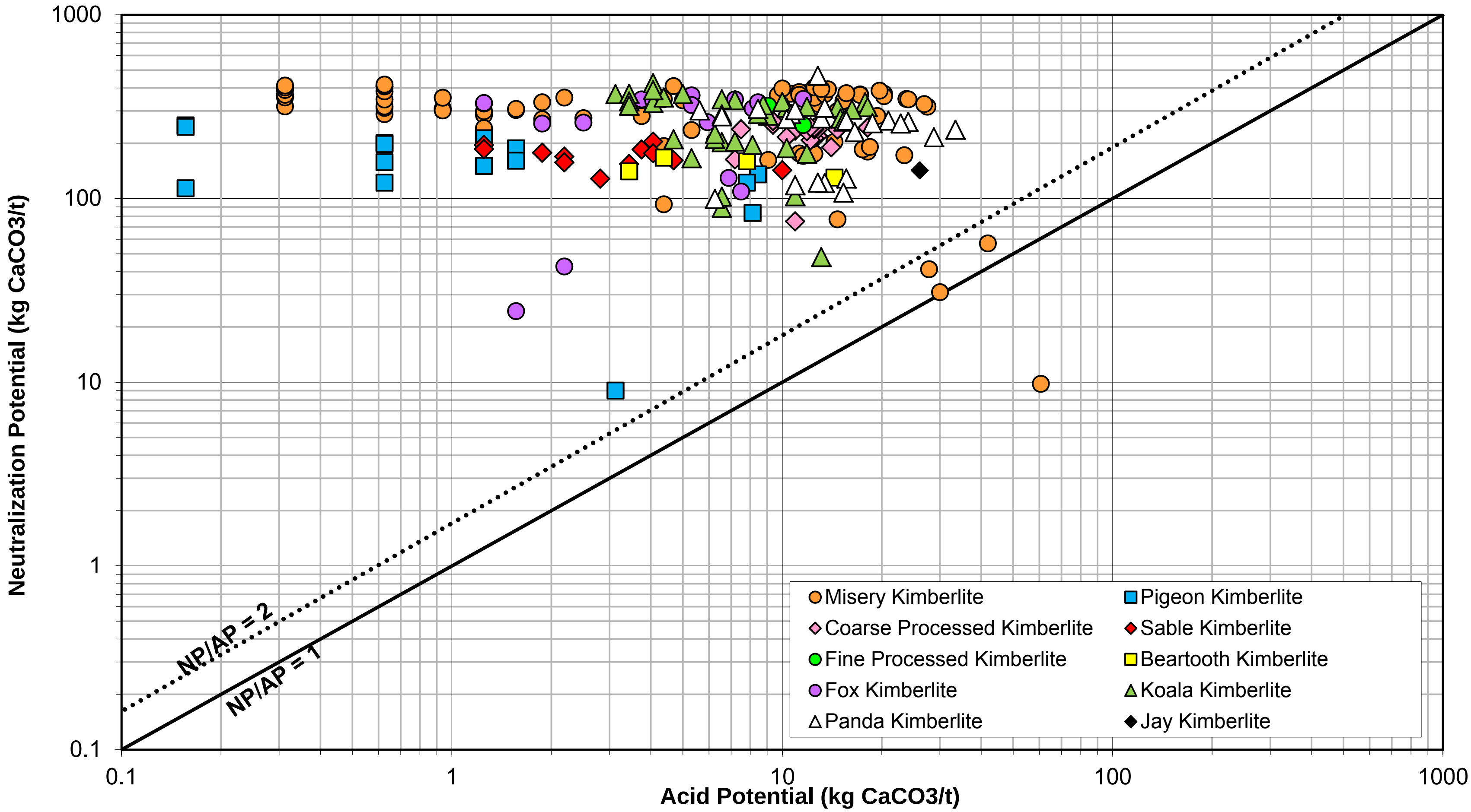
Note: All values below detection were assigned a value of half their respective detection limit.
% = percent.

Figure 4.2-18 Carbonate Neutralization Potential vs. Neutralization Potential in Kimberlite and Processed Kimberlite Samples



kg $CaCO_3$/t = kilograms calcium carbonate per tonne.

Figure 4.2-19 Acid Potential vs. Neutralization Potential in Kimberlite and Processed Kimberlite Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
kg $CaCO_3$/t = kilograms calcium carbonate per tonne; AP = acid potential; NP = neutralization potential

The results of bulk metal analysis of 234 kimberlite samples are summarized in Table 4.2-4. Parameters that occurred at concentrations greater than five times the average crustal abundance in more than 10% of the kimberlite samples from all areas include bismuth, magnesium, nickel, and antimony (Table 4.2-5). Certain samples also had elevated concentrations of chromium, mercury, strontium, and tungsten. Fewer samples had elevated concentrations of silver, arsenic, barium, molybdenum, phosphorus, lead, thorium, and tungsten.

Based on the results of bulk metal analysis, the composition of kimberlite varies between areas. Kimberlite collected from the Jay, Koala, and Beartooth areas generally reported lower solid phase metal concentrations than those collected from the Misery and Pigeon areas. Samples from the Misery Pit and Pigeon area had elevated concentrations of many of the same parameters.

4.2.5.2 Jay Pipe Kimberlite

In 2014, two kimberlite samples were collected from the Jay pipe area and analyzed for ABA, NAG, and bulk metal composition.

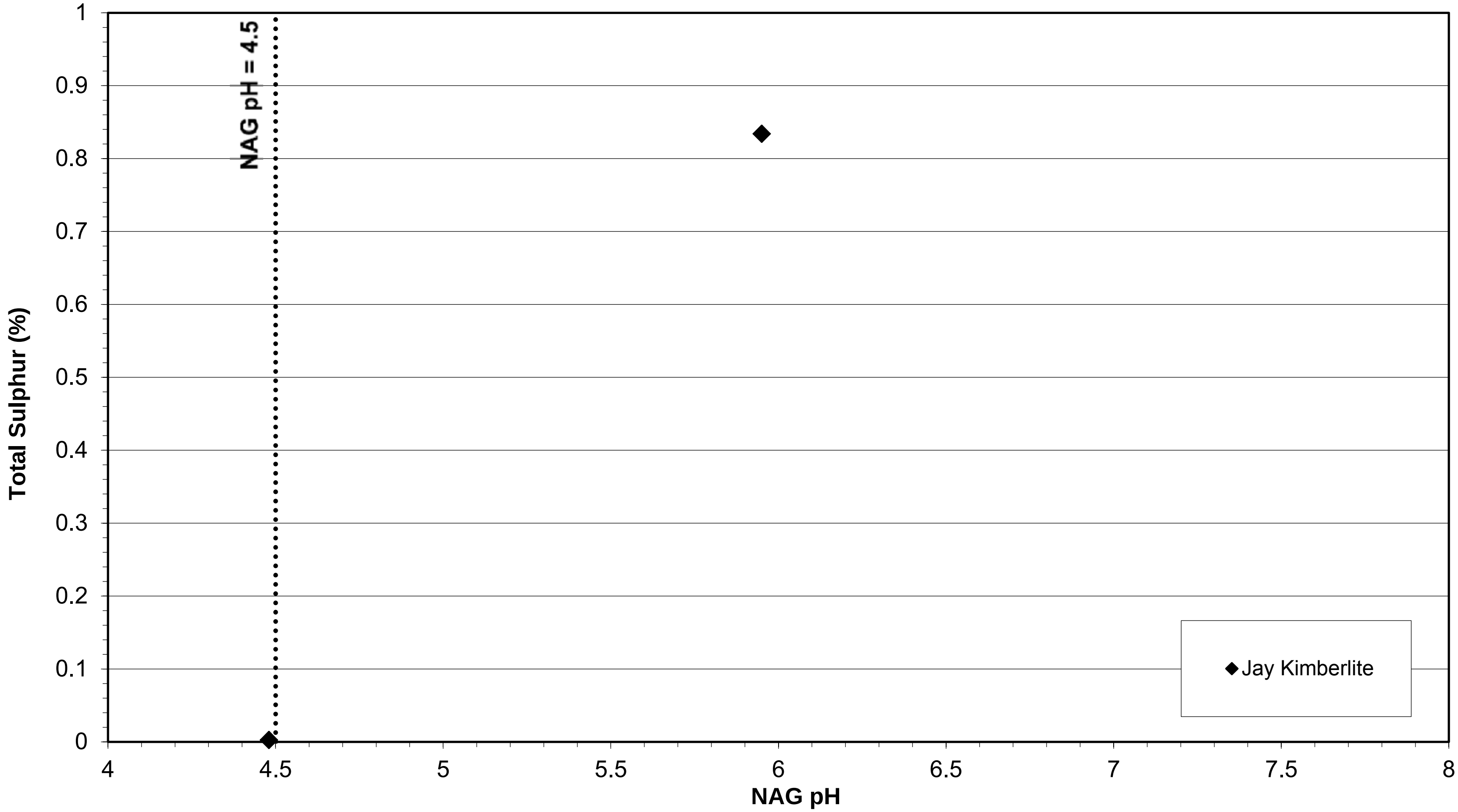
Kimberlite samples collected from the Jay pipe area generally had ABA characteristics within the range of the samples collected from the other pits for total sulphur (0.0025% and 0.83%) and acid potential (0.15 and 21 kg $CaCO_3$/t). One kimberlite sample collected from the Jay pipe had a lower neutralization potential (2.5 kg $CaCO_3$/t) than any kimberlite samples from the other locations, and the other sample had a neutralization potential within the range of the other locations (121 kg $CaCO_3$/t). Both samples had NP/AP ratios greater than 2 and are classified as non-PAG (Table 4.2-2, Figure 4.2-19).

The NAG results for the Jay pipe kimberlite samples are summarized in Table 4.2-1. The NAG pH values of the two kimberlite samples were 4.5 and 6.0. The NAG pH values are shown relative to total sulphur (Figure 4.2-20) and the NP/AP ratio (Figure 4.2-21). The NAG pH value of 4.5 is considered suspect based on the overall geochemical characteristics of kimberlite as determined from the Ekati database, and both samples are classified as non-PAG.

The proportion of samples with concentrations of metals in the solid phase exceeding five times crustal abundance (Price 1997) is presented in Table 4.2-5. Generally, Jay pipe kimberlite samples had lower concentrations of several solid phase metals identified as elevated in kimberlite samples from the other pits, including arsenic, barium, mercury, magnesium, nickel, antimony, strontium, and tungsten. Similar to kimberlite collected from the other pits, kimberlite from the Jay pipe reported elevated silver, bismuth, chromium, molybdenum, magnesium, nickel, and thorium in the solid phase.

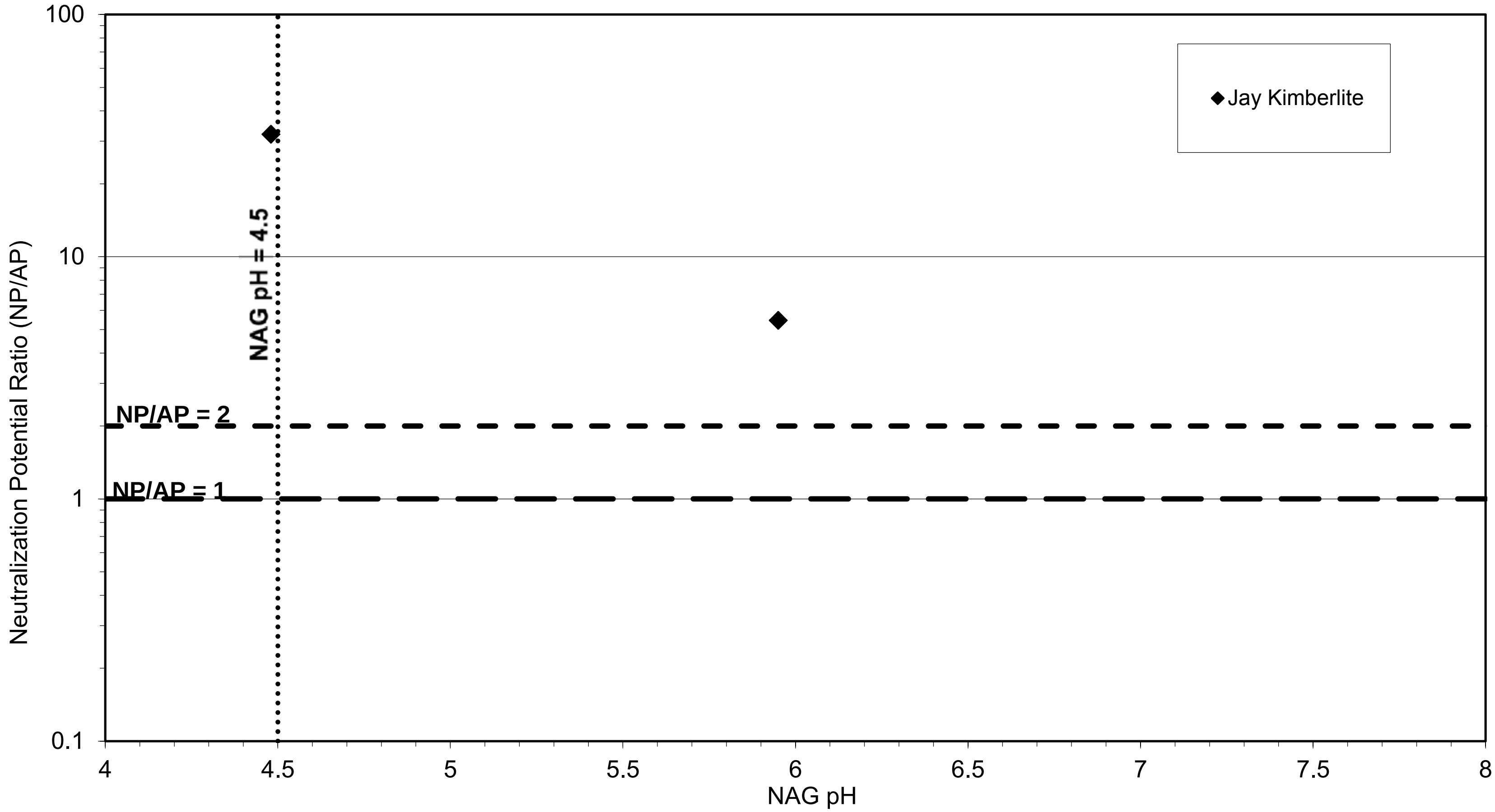
The geochemical dataset includes one kimberlite sample from the Jay pipe that were submitted for short-term leach testing. The leach test results were compared to the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) to qualitatively identify parameters that may require further consideration in the context of the Project waste and water management plans. The results of short-term leach tests typically do not directly represent the expected effluent chemistry of the test material under ambient conditions.

Figure 4.2-20 Net Acid Generation pH vs. Total Sulphur in Processed Kimberlite Samples



Note: All values below detection were assigned a value of half their respective detection limit.
NAG = net acid generation;% = percent.

Figure 4.2-21 Net Acid Generation pH vs. Neutralization Potential Ratio in Processed Kimberlite Samples



Notes: Acid potential was calculated using total sulphur values.
All values below detection were assigned a value of half their respective detection limit.
NP = neutralization potential; AP = acid potential; NAG = net acid generation.

The SFE results are presented in Table 4.2-6. Parameters that occurred at concentrations in excess of the reference guidelines included the following:

- cadmium concentration of 0.0001 mg/L, greater than the CCME guideline of 0.00009 mg/L;
- copper concentration of 0.003 mg/L, greater than the CCME guideline of 0.002 mg/L;
- molybdenum concentration of 0.41 mg/L, greater than the CCME guideline of 0.073 mg/L;
- nickel concentration of 0.12 mg/L, greater than the CCME guideline of 0.025 mg/L;
- selenium concentration of 0.01 mg/L, greater than the CCME guideline of 0.001 mg/L; and,
- silver concentration of 0.003 mg/L, greater than the CCME guideline of 0.0001 mg/L.

All parameter concentrations were below the SSWQOs for the Ekati Mine in the kimberlite SFE leachate, with the exception of sulphate. The concentration of sulphate in the kimberlite SFE leachate was 600 mg/L, greater than both the short- and long-term SSWQOs for sulphate concentrations (138 and 487 mg/L, respectively) at hardness concentrations exceeding 160 mg/L $CaCO_3$.

The results of NAG leachate analysis are presented in Table 4.2-7. Parameters that occurred at concentrations in excess of the reference guidelines included the following:

- pH value of 6.3, below the CCME guideline of 6.5;
- aluminum concentration of 0.03 mg/L, greater than the CCME guideline of 0.1 mg/L;
- arsenic concentration of 0.02 mg/L, greater than the CCME guideline of 0.005 mg/L;
- cadmium concentration of 0.0005 mg/L, greater than the CCME guideline of 0.00009 mg/L;
- copper concentration of 0.003 mg/L, greater than the CCME guideline of 0.002 mg/L;
- nickel concentration of 0.38 mg/L, greater than the CCME guideline of 0.025 mg/L;
- selenium concentration of 0.02 mg/L, greater than the CCME guideline of 0.001 mg/L; and,
- silver concentration of 0.00011 mg/L, greater than the CCME guideline of 0.0001 mg/L.

The concentration of sulphate in the kimberlite NAG leachate was 201 mg/L, greater than the short-term SSWQO for sulphate concentrations (138 mg/L) at hardness concentrations exceeding 160 mg/L $CaCO_3$. Additionally, the concentration of vanadium in the kimberlite NAG leachate was 0.08 mg/L, greater than the long-term SSWQO for vanadium of 0.03 mg/L.

Phosphorous concentrations were elevated in NAG leachate samples owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test. Therefore, the phosphorous results in the NAG leachates do not represent the concentrations of phosphorous that would be released by the complete oxidation of kimberlite samples.

4.2.5.3 Coarse Processed Kimberlite

A total of 189 coarse PK were analyzed as part of the geochemical dataset. The ABA results for coarse PK are summarized in Table 4.2-1. Key findings include the following:

- Coarse PK had near-neutral to alkaline paste pH values ranging from 6.5 to 9.8.
- Total sulphur concentrations ranged from 0.04% to 0.61% by weight, with a median concentration of 0.28% by weight.
- Sulphur is primarily in the form of sulphide in the coarse PK (Figure 4.2-17).
- The AP of the coarse PK samples ranged from 1.3 to 19 kg $CaCO_3$/tonne.
- The NP of the coarse PK samples ranged from 75 to 264 kg $CaCO_3$/tonne, and the CaNP ranged from 20 to 96 kg $CaCO_3$/tonne. Coarse PK samples reported a large variation in the NP to CaNP ratio (Figure 4.2-18). The NP was four times greater than CaNP, on average.
- The NP/AP ratio of coarse PK samples is presented in Figure 4.2-19. All coarse PK samples had NP/AP ratios greater than 2, and are classified as non-PAG (Table 4.2-2).

A total of 184 coarse PK samples were analyzed for bulk metal composition (Table 4.2-4). Parameters that occurred at elevated concentrations relative to crustal abundance in more than 10% of the coarse PK samples included bismuth, chromium, mercury, magnesium, nickel, antimony, and strontium (Table 4.2-5).

The geochemical dataset includes two coarse PK samples that were submitted for short-term leach testing (Table 4.2-8). Parameters that occurred at concentrations greater than the CCME guidelines included:

- pH values were 4.3 in both samples, below the CCME guideline of 6.5.
- Copper concentrations were 0.003 mg/L in both samples, greater than the CCME guideline of 0.002 mg/L.
- Nickel concentrations were 0.01 and 0.03 mg/L, with one sample exceeding the CCME guideline of 0.025 mg/L.

Additionally, sulphate concentrations were greater than the short- and long-term SSWQOs for the Ekati Mine in both samples.

Based on the results of ABA testing and bulk metal composition, the solid phase composition of the coarse PK is similar to the composition of kimberlite at the Project. The coarse PK produced from processing of Jay pipe kimberlite is anticipated to be similar to the coarse PK produced from the other Ekati pits.

Table 4.2-8 Shake Flask Extraction Leach Test Results for Coarse Processed Kimberlite From the Ekati Mine

Sample	pH	EC	Eh	Sulphate	Acidity to pH 4.5	Acidity to pH 8.3	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cu	Fe
Unit	**unit**	**(µS/cm)**	**(mv)**	**(mg/L)**	**(mg $CaCO_3$/L)**	**(mg $CaCO_3$/L)**	**mg/L**	**ppm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**ppm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**ppm**
CCME Guideline[(a)]	**6.5 to 9.0**	**---**	**---**	**---**	**---**	**---**	**---**	**0.005[(b)]**	**0.005**	**1.5[(c)]**	**---**	**---**	**---**	**---**	**0.00009[(d)]**	**---**	**---**	**---**	**0.002[(e)]**	**0.3**
TP SRK-09 0.2-0.22m	**4.34**	1,055	364	570	2	14	<0.005	0.0004	<0.03	<0.02	0.03	<0.002	<0.02	0.03	<0.002	<0.03	<0.005	<0.02	**0.003**	0.00006
TP SRK-09 0.4-0.45m	**4.27**	854	383	450	2	17	<0.005	0.0005	<0.03	<0.02	0.04	<0.002	<0.02	0.03	<0.002	<0.03	0.007	<0.02	**0.003**	0.00006

Sample	K	Li	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Se	Si	Te	Ti	Tl	U	V	W	Zn
Unit	**ppm**	**ppm**	**ppm**	**ppm**	**mg/L**	**ppm**	**mg/L**	**ppm**	**mg/L**	**ppm**	**mg/L**	**mg/L**	**ppm**	**mg/L**	**mg/L**	**mg/L**	**ppm**	**mg/L**	**mg/L**	**mg/L**
CCME Guideline[(a)]	**---**	**---**	**---**	**---**	**0.073**	**---**	**0.025[(f)]**	**0.004[(g)]**	**0.001[(h)]**	**---**	**---**	**0.001**	**---**	**---**	**---**	**0.0008**	**0.015[(i)]**	**---**	**---**	**0.03**
TP SRK-09 0.2-0.22m	0.04	<0.00005	0.08	0.00008	<0.005	0.007	0.01	0.0001	<0.01	0.16	<0.01	<0.02	0.003	<0.01	<0.01	<0.01	<0.00005	<0.01	<0.01	0.02
TP SRK-09 0.4-0.45m	0.03	<0.00005	0.06	0.0002	0.006	0.006	**0.03**	0.0001	<0.01	0.13	<0.01	<0.02	0.005	<0.01	<0.01	<0.01	<0.00005	<0.01	<0.01	0.01

Note:

0.01 Indicates parameter concentration is greater than CCME guidelines.

a) CCME (2014).

b) Aluminum guideline = 0.005 mg/L for pH <6.5 and 0.01 mg/L for pH ≥ 6.5.

c) Boron guideline = 29 mg/L long term and 1.5 mg/L short term.

d) Cadmium guideline = 0.001 mg/L short term and hardness dependent and 0.00009 mg/L long term and hardness dependent.

e) Copper guideline is hardness dependent and is 0.002 mg/L when hardness is unknown.

f) Nickel guideline is hardness dependent and is 0.025 mg/L when hardness is unknown.

g) Phosphorus guideline is dependent on nature of waterbody, and is 0.004 mg/L at its lowest for ultra-oligotrophic bodies.

h) Lead guideline is hardness dependent and is 0.001 mg/L when hardness is unknown.

i) Uranium guideline = 0.03 mg/L long term and 0.015 mg/L short term.

Ag = silver; Al = aluminum; As = arsenic; B = boron; Ba = barium; Be = beryllium; Bi =bismuth; Ca = calcium; Cd = cadmium; Ce = cerium; Co = cobalt; Cr = chromium; Cu = copper; Fe = iron; K = potassium; Li = lithium; Mg = magnesium; Mn = manganese; Mo = molybdenum; Na = sodium; Ni = nickel; P = phosphorus ; Pb = lead; S = sulphur; Sb = antimony; Se = selenium; Si = silicon; Te = tellurium; Ti = titanium; Tl =thallium; U = uranium ;V = vanadium ; W = tungsten; Zn = zinc; EC = electrical conductivity; Eh = redox; µS/cm = microsiemens per centimetre; mv = millivolts; mg/L = milligrams per litre; mg $CaCO_3$/L = milligrams calcium carbonate per litre; ppm = parts per million; --- = no guidelines, < = less than; ≥ = greater than or equal to.

4.2.5.4 Fine Processed Kimberlite

A total of 39 fine PK samples were analyzed as part of the geochemical dataset. The ABA results for the fine PK samples are summarized in Table 4.2-1. The key findings were as follows:

- Fine PK had near-neutral paste pH values ranging from 7.9 to 8.5.
- Total sulphur concentrations ranged from 0.10% to 0.60% by weight, with a median concentration of 0.29% by weight.
- The AP ranged from 1.3 to 18 kg $CaCO_3$/tonne.
- The NP was measured in two fine PK samples, which had values of 251 and 320 kg $CaCO_3$/t, respectively. The CaNP ranged from 31 to 79 kg $CaCO_3$/tonne. Both samples for which NP was determined had NP/AP ratios greater than 2.

A total of 39 fine PK samples were analyzed for bulk metal composition (Table 4.2-4). Elements reported at elevated concentrations relative to crustal abundance in more than 10% of the overburden samples included bismuth, chromium, magnesium, nickel, antimony, and tungsten (Table 4.2-5).

Based on the results of ABA testing and bulk metal composition, the solid phase composition of the fine PK is similar to the composition of kimberlite at the Project. The fine PK produced from processing of Jay pipe kimberlite is anticipated to be similar to the fine PK produced from the other Ekati pits.

4.3 Kinetic Geochemical Tests

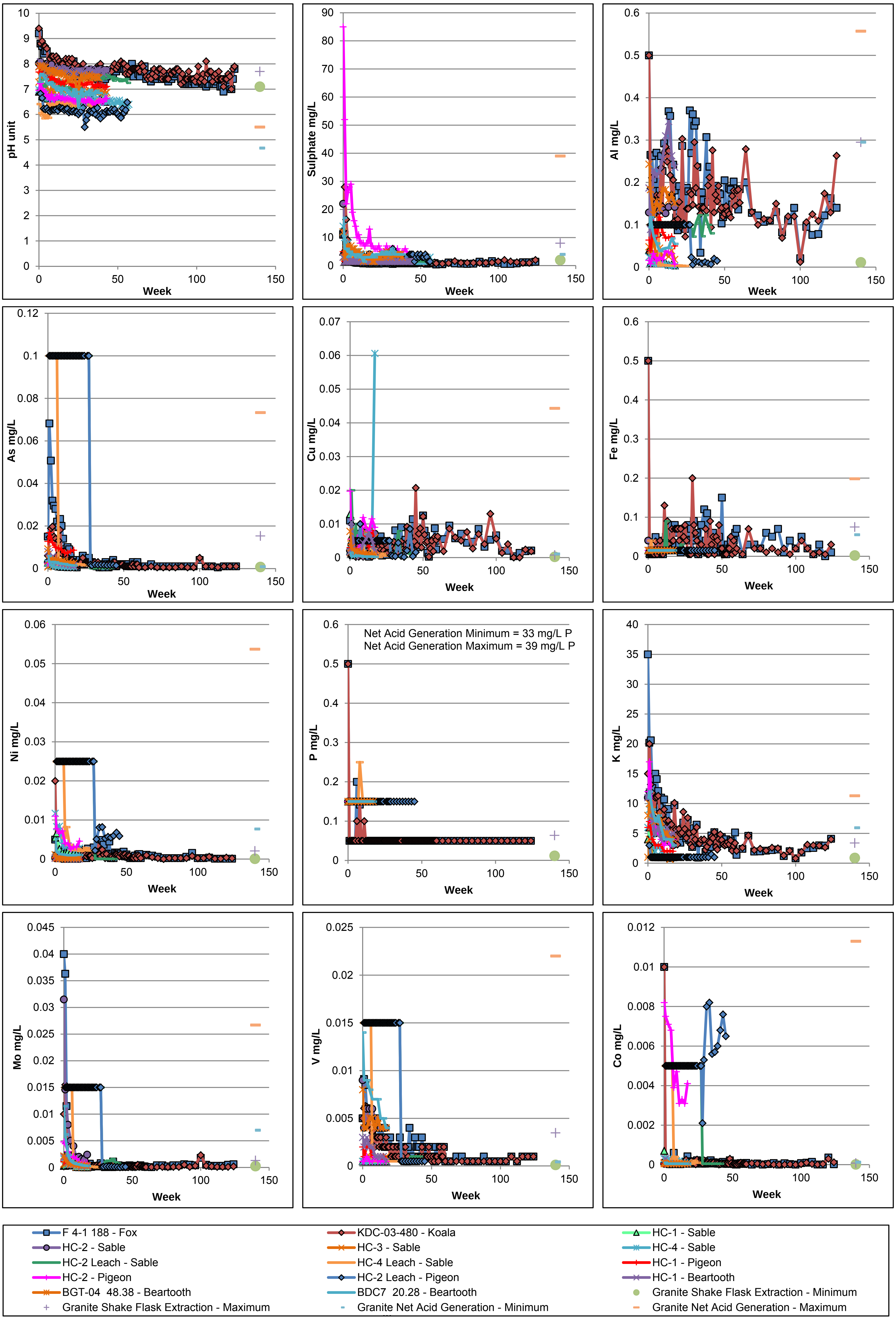
The detailed HCT results in the Ekati Mine geochemical dataset are presented in the Humidity Cell Testing Results (Appendix F). Concentration trend plots for the HCT results, grouped according to rock type, are presented in the Humidity Cell Testing Figures (Appendix G). The discussion in this section focuses on several key parameters. Key parameters include those that are used to evaluate concentration trends related to the acid generation potential of a material, parameters that had increasing concentration trends over time, and parameters that can be used as proxies for several parameters of a similar geochemical nature. The key parameters presented in Figures 4.3-1 through 4.3-4 include pH, sulphate, aluminum, arsenic, copper, iron, nickel, phosphorus, and cobalt. Concentrations of the key parameters are discussed in the context of the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014).

4.3.1 Granite

Sixteen granite samples were submitted for kinetic testing, including one from the Fox Pit (F 4-1 188), one sample from the Koala Pit (KDC-03-480), six samples from the Sable Pit (HC-1, HC-2, HC-3, HC-4, HC-2 Leach, and HC-4 Leach), three samples from the Pigeon Pit (HC-1, HC-2, and HC-2 Leach), and three samples from the Beartooth Pit (HC-1, BGT-04 48.38, and BDC7 20.28). The HCT duration ranged from 17 to 124 weeks.

Concentration trends for key parameters are presented in Figure 4.3-1. Certain parameters had high detection limits (an order of magnitude higher than most other results) in the first 10 to 20 weeks of testing. These results are not included. The NAG and SFE results for Jay pipe granite samples are compared to the granite HCT results in Figure 4.3-1 and Appendix F.

Figure 4.3-1 Key Parameter Concentrations From Humidity Cell Testing of Granite Samples From the Ekati Mine



mg/L = milligrams per litre; Al = aluminium; As = arsenic; Cu = copper; Fe = iron; Ni = nickel; P = phosphorous; K = potassium; Mo = molybdenum; V = vanadium; Co = cobalt.

The HCT results for granite are summarized as follows:

- pH values ranged from 5.5 to 9.2 and were generally stable throughout testing after an initial decrease during the first weeks of testing (also referred to as the first flush). Most samples had steady-state pH values between 6 and 8. Samples that underwent an initial carbonic leach (HC-2 leach – Pigeon and HC-4 leach Sable) had the lowest pH values in the dataset. Carbonic leach sample HC-2 leach – Sable maintained neutral pH conditions throughout the test.
- Sulphate concentrations stabilized to less than 10 mg/L in all granite HCTs after the initial flushing of the cell. One granite sample from the Pigeon Pit had a sulphate concentration greater than the long-term SSWQOs for sulphate at the Ekati Mine (35 and 63 mg/L depending on hardness) in the initial week of testing (85 mg/L).
- Aluminum concentrations ranged from 0.003 to 0.5 mg/L. Granite samples collected from the Fox and Koala pits generally reported higher aluminum concentrations than those observed in leachates from the Sable, Pigeon, and Beartooth HCTs. The HCT leachates from the Sable, Pigeon, and Beartooth areas had steady-state aluminum concentrations below 0.05 mg/L. Most HCT leachates had aluminum concentrations greater than the CCME guideline of 0.1 mg/L.
- Arsenic concentrations ranged from less than 0.0001 to 0.07 mg/L. Arsenic concentrations were highest in the HCTs from the Fox and Koala pits and one sample from the Pigeon area. Generally, arsenic concentrations decreased and stabilized after the first 20 weeks of sampling. Arsenic concentrations were greater than the CCME guideline of 0.005 mg/L during the first 20 weeks of sampling in leachates from the Fox Pit and Koala Pit samples and one sample from the Pigeon Pit.
- Copper concentrations ranged from less than 0.0005 to 0.06 mg/L. Copper concentrations were generally less than 0.01 mg/L. Copper concentrations were greater than the CCME guideline for copper of 0.002 mg/L throughout most of the duration of the HCTs.
- Iron concentrations ranged from 0.005 to 0.5 mg/L. Iron concentrations were below the CCME guideline of 0.3 mg/L, with the exception of the week 0 leachate sample from the Koala and Fox pit granites.
- Nickel concentrations ranged from below 0.0001 to 0.025 mg/L. Nickel concentrations were below the CCME guideline of 0.025 mg/L throughout testing.
- Phosphorus concentrations ranged from less than 0.1 to 0.5 mg/L, and were generally below the detection limits (0.30 and 0.10 mg/L) after the initial flushing of the cells.
- Potassium concentrations ranged from 1.0 to 35 mg/L, and were below the SSWQOs for potassium, at the Ekati Mine (41 mg/L long term and 112 mg/L short term) throughout testing of all samples.
- Molybdenum concentrations ranged from 0.00005 to 0.04 mg/L, and were below both the CCME guideline (0.073 mg/L) and the SSWQOs for molybdenum at the Ekati Mine (19 mg/L long term and 223 mg/L short term) throughout testing of all samples.
- Vanadium concentrations ranged from 0.0005 to 0.015 mg/L, and were below the SSWQOs for vanadium at the Ekati Mine (0.30 mg/L short term and 0.03 mg/L long term) throughout testing of all samples.

- Cobalt concentrations ranged from below 0.00001 to 0.03 mg/L. Generally, cobalt concentrations were below or near the detection limit throughout testing. However, one granite HCT from the Pigeon Pit reported increasing cobalt concentrations over time. This sample had a pH of approximately 6, which was lower than all other granite samples in the HCT dataset.

Other parameters reporting concentrations greater than the CCME guidelines at several points throughout testing included cadmium, lead, and selenium in leachates from the Fox and Koala granites, and several other samples during the first flush. Mercury concentrations were greater than the CCME guideline throughout testing for many of the granite samples. Zinc concentrations were greater than the CCME guideline in the first flush of the Pigeon Pit and Sable area granite.

The short-term leach testing results of granite samples from the Jay pipe were qualitatively compared to the HCT results of granite samples from the Ekati Mine to confirm its metal leaching potential. This comparison is summarized as follows:

- The Jay pipe SFE results were generally within the range observed in the Ekati kinetic tests for key parameters (i.e., aluminum, arsenic, cadmium, cobalt, iron, lead, mercury, nickel, phosphorous, selenium, sulphate, and zinc). The pH values observed in SFE leach testing (7.1 to 7.7) also were within the range observed in kinetic testing of granite samples.
- The minimum concentrations of all key parameters observed in Jay pipe NAG leachates were within the range observed in granite kinetic tests; however, maximum concentrations of aluminum, arsenic, copper, iron, nickel, and cobalt in NAG leachates were higher than those observed in most HCT leachates. The NAG leach testing pH values of Jay pipe granites (4.7 to 5.5) were below those observed in kinetic testing.
- Jay pipe granite sample NAG leachates reported higher phosphorous concentrations than were observed in all HCT leachate samples due to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test. Therefore, the phosphorous results in the NAG leachates do not represent the concentrations of phosphorous that would be released by the complete oxidation of granite samples.

Select ABA results (total sulphur, NP, and NP/AP ratio), and sulphide and NP depletion rates calculated based on the HCT results, are summarized in Table 4.3-1. Carbonic leach HCT samples are not included. The long-term acid generation potential of the granite samples, based on the interpretation of the HCT results, is summarized as follows:

- Five of the 11 granite samples were also classified as non-PAG based on the NP/AP ratio and the results of sulphide and NP depletion calculations. The results of HCT indicated that sulphur would be depleted before NP, limiting the long-term potential for acid generation. Neutral pH values were measured through the duration of the kinetic tests.
- Three samples were classified as non-PAG based on NP/AP ratio, but were classified as PAG based on depletion calculations. These samples included one granite sample from the Sable area, one from the Fox Pit, and one from the Koala Pit. In these samples, NP was predicted to be completely depleted before sulphur. The total sulphur content of these samples ranged from 0.04% to 0.12%

by weight, and kinetic testing leachate pH values were generally stable and greater than 7 throughout testing for all samples. Sulphate concentrations were stable at steady-state conditions and below 3 mg/L for all samples, and alkalinity concentrations were generally stable or increasing over time. It is expected that these materials could only produce nominal quantities of ARD, owing to their low sulphur concentration.

- Two samples collected from the Beartooth Pit were not analyzed for NP and, therefore, could not be classified based on static testing or depletion calculations. These samples had 0.19% and 0.12% sulphide-sulphur by weight, and reported stable and near-neutral pH values at steady state in kinetic testing.
- One sample collected from the Sable Pit was classified as PAG based on depletion calculations and static ABA testing. The sample consisted of a mixture of biotite schist and granite. The sample reported decreasing pH values to 6.4 over time.

Table 4.3-1 Summary of Depletion Calculation Results of Granite Samples From the Ekati Mine

Lab ID	Lithology	NP/AP (kg/t as $CaCO_3$)	HCT Duration (week)	Acidity Generated During HCT?	Initial HCT pH	Steady State HCT pH	Final HCT pH	Total Sulphur				Initial NP (kg/t as $CaCO_3$)	NP (Empirical)			Acidic or Non-acidic Conditions?[b]
								Initial (wt% as S)	Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)		Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)	NP (Empirical)
HC-1 – Sable	two-mica granite/pegmatite	6.4	43	no	6.9	6.6	6.5	0.005	80	0.15	5.2	1.0	95	0.96	19	non-acid
HC-2 – Sable	two-mica granite/pegmatite	3.4	43	no	8.0	7.8	7.8	0.12	98	0.15	151	12.8	96	8	28	acid
HC-3 – Sable	biotite granite/schist	32	43	no	7.3	6.9	6.9	0.005	83	0.15	5.3	5.0	98	1.5	62	non-acid
HC-4 – Sable	biotite granite/schist	1.1	57	no	7.0	6.4	6.4	0.080	98	0.20	75	2.9	96	0.8	65	acid
HC-1 – Pigeon	biotite granite	35	43	no	7.7	7.1	7.1	0.005	81	0.15	5.2	5.4	96	2.2	46	non-acid
HC-2 – Pigeon	biotite granite	2.0	43	no	7.0	6.6	6.6	0.050	83	0.46	17.3	3.1	90	1.9	29	non-acid
HC-1 – Beartooth	biotite granite	27	43	no	7.9	7.7	7.8	0.010	92	0.15	12	8.3	95	6.6	23	non-acid
BGT-04 48.38 – Beartooth	biotite granite	n/a[a]	38	no	7.9	7.5	7.5	0.19	99	0.38	95	n/a[a]	n/a[a]	4.4	n/a[a]	n/a[a]
BDC7 20.28 – Beartooth	biotite granite	n/a[a]	38	no	7.3	6.8	6.9	0.12	98	0.40	56	n/a[a]	n/a[a]	1.6	n/a[a]	n/a[a]
F 4-1 188 – Fox	granite	8.8	111	no	9.2	7.2	7.8	0.040	94	0.21	35	11.0	88	9	20	acid
KDC-03-480 – Koala	granite	3.0	111	no	9.4	7.4	7.9	0.070	95	0.19	65	6.6	76	10	9.6	acid

a) Neutralization potential was not calculated and, therefore, these calculations cannot be completed.

b) Acid: Time to sulphide depletion >Time to NP depletion; Non-Acid: Time to sulphide depletion <Time to NP depletion.

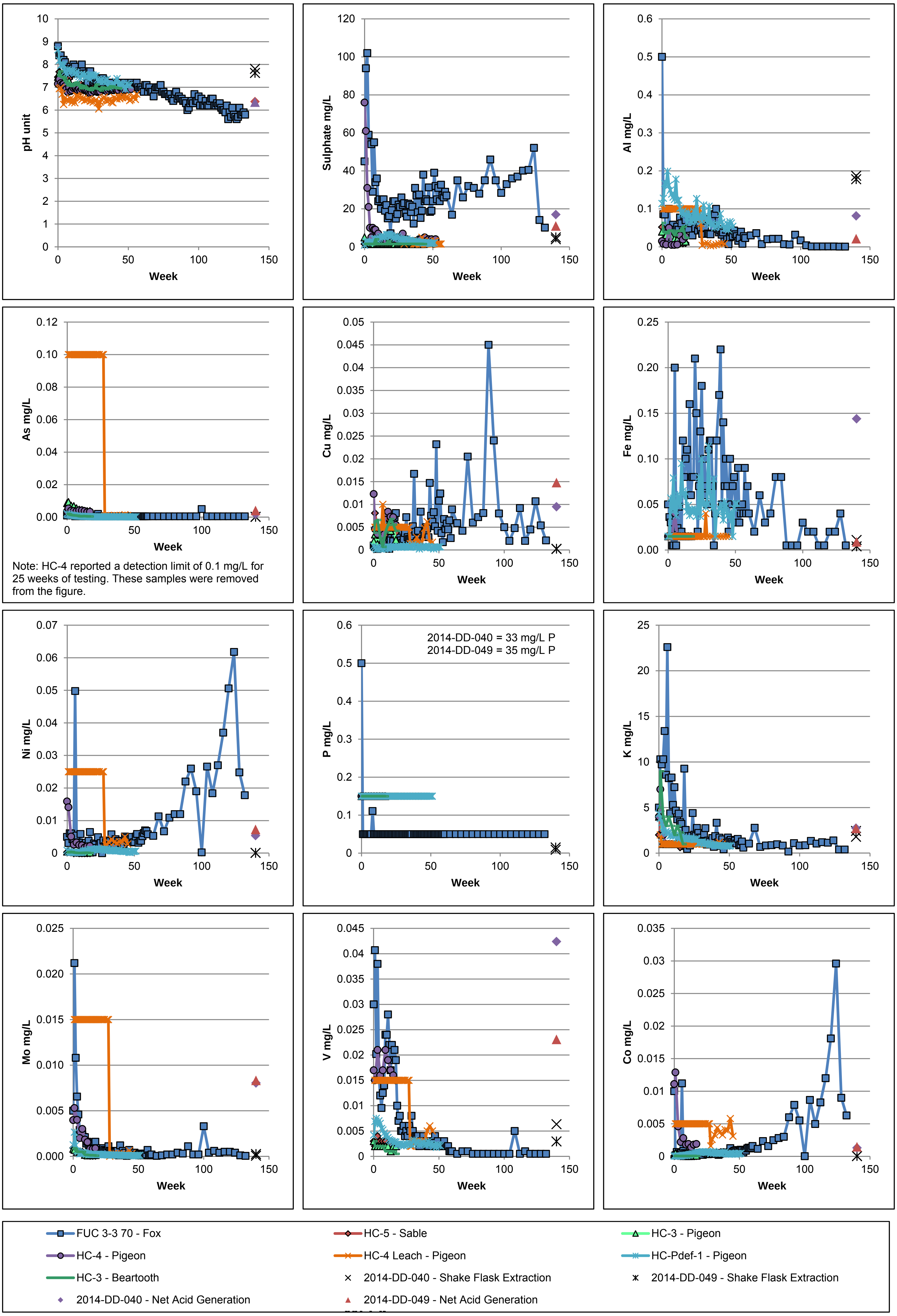
ID = identification; NP = neutralization potential; AP = acid potential; kg/t = kilograms per tonne; $CaCO_3$ = calcium carbonate; HCT = humidity cell test; wt% = weight percent; S = sulphur; % = percent; mg/kg = milligrams per kilogram; n/a = not available; >= greater than; <= less than.

4.3.2 Diabase

Seven diabase samples were submitted for kinetic testing, including one sample from the Fox Pit (FUC 3-370), one sample from the Sable Pit (HC-5), four samples from the Pigeon Pit (HC-3, HC-4, HC-4 Leach [carbonic leach sample], and HC-Pdef-1) and one sample from the Beartooth Pit (HC-3). Test length ranged from 17 to 133 weeks.

Concentration trends of key parameters are presented in Figure 4.3-2. Concentrations of parameters with high detection limits (an order of magnitude higher than most other results) are not included. Sample HC-4 Leach, which underwent a carbonic leach to remove neutralizing minerals before HCT, is presented in comparison to the other diabase HCT samples; however, the results are not discussed. The NAG and SFE results of Jay pipe diabase samples are compared to the diabase HCT results in Figure 4.3-2 and Appendix F.

Figure 4.3-2 Key Parameter Concentrations From Humidity Cell Testing of Diabase Samples From the Ekati Mine



mg/L = milligrams per litre; Al = aluminium; As = arsenic; Cu = copper; Fe = iron; Ni = nickel; P = phosphorous; K = potassium; Mo = molybdenum; V = vanadium; Co = cobalt.

The HCT results for diabase are summarized as follows:

- pH values ranged from 5.6 to 8.7 and were generally stable throughout testing after an initial decrease during the first weeks of HCT. Most samples had steady-state pH values between 6 and 8. One exception was the sample from the Fox Pit, which had a decreasing pH throughout testing.
- Sulphate concentrations stabilized at values less than 10 mg/L after the initial flushing of the cell, with the exception of the sample from the Fox Pit. The Fox Pit diabase HCT had increasing sulphate concentrations from 20 weeks to 120 weeks, corresponding with decreasing pH. The diabase sample from the Fox Pit had sulphate concentrations greater than the long-term SSWQOs for sulphate at the Ekati Mine (35 and 63 mg/L depending on hardness) at several points throughout testing.
- Aluminum concentrations ranged from 0.003 to 0.5 mg/L. All samples had steady-state aluminum concentrations below 0.05 mg/L. Most HCT leachates had aluminum concentrations greater than the CCME guideline of 0.01 mg/L.
- Arsenic concentrations ranged from less than 0.0001 to 0.07 mg/L. Generally, arsenic concentrations decreased and stabilized after the first 20 weeks of sampling. Arsenic concentrations were greater than the CCME guideline of 0.005 mg/L during the first 20 weeks of sampling in leachates from two diabase samples from the Pigeon area.
- Copper concentrations ranged from less than 0.0005 to 0.14 mg/L. Copper concentrations were greater than the CCME guideline for copper of 0.002 mg/L throughout most of the duration of the HCTs.
- Iron concentrations ranged from 0.005 to 0.5 mg/L. Iron concentrations were below the CCME guideline of 0.3 mg/L.
- Nickel concentrations ranged from below 0.0001 to 0.06 mg/L. Concentrations in all but the Fox diabase HCT leachates were below the CCME guideline of 0.025 mg/L throughout testing. The Fox diabase reported increasing nickel concentrations over time corresponding with a decrease in pH values below 7. The remaining samples generally reported stable nickel concentrations or nickel concentrations decreasing after the first flush.
- Phosphorus concentrations ranged from less than 0.1 to 0.5 mg/L, and were generally below the detection limits (0.30 and 0.10 mg/L) after the first flush.
- Potassium concentrations ranged from 1.0 to 23 mg/L, and were below the SSWQOs for potassium, at the Ekati Mine (41 mg/L long term and 112 mg/L short term) throughout testing of all samples.
- Molybdenum concentrations ranged from 0.00005 to 0.02 mg/L, and were below both the CCME guideline (0.073 mg/L) and the SSWQOs for molybdenum at the Ekati Mine (19 mg/L long term and 223 mg/L short term) throughout testing of all samples.
- Vanadium concentrations ranged from 0.0005 to 0.04 mg/L, and were greater than the long-term SSWQO for vanadium at the Ekati Mine (0.03 mg/L long term) in the first flush of a diabase from the Fox Pit.

- Cobalt concentrations ranged from below 0.00001 to 0.03 mg/L. Generally, cobalt concentrations were below the detection limit or stable and low throughout testing. However, the Fox Pit diabase reported increasing cobalt concentrations over time as pH values decreased below 6.

Other parameters reporting concentrations greater than the CCME guidelines at several points throughout testing included cadmium, lead, and selenium in leachates from the Fox diabase and several other samples during the first flush. Mercury concentrations were greater than the CCME guideline throughout testing for many of the diabase samples. Zinc concentrations were greater than the CCME guideline in the first flush of the Pigeon and Sable area diabase samples, and increased to above the guideline over time in the leachates from the Fox Pit diabase sample. The increase in zinc corresponded with a decrease in pH below 6.

The results of short-term leach testing of diabase samples from the Jay pipe were qualitatively compared to Ekati Mine diabase kinetic test results to confirm its metal leaching potential:

- The pH values in the first flush of testing were similar to the pH values observed in the SFE leach test Jay pipe diabase samples (7.6 to 7.8), and the steady-state pH values were similar to the net acid generation leach test Jay pipe diabase samples (6.4).
- The results of short-term leach testing of the Jay pipe diabase samples were generally within the range observed in the Ekati diabase kinetic tests for key parameters, including aluminum, arsenic, cadmium, cobalt, iron, lead, nickel, mercury, sulphate, selenium and zinc.
- Concentrations of key parameters measured in NAG leachates were generally higher than those measured in the SFE leachates. The NAG leachate concentrations were similar to kinetic test leachates from one Fox Pit and one Pigeon Pit sample.

- The SFE leach test phosphorous results of Jay pipe diabase samples were lower than those observed in the diabase humidity cells. However, phosphorous concentrations were elevated in NAG leachate samples owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test.

The results of depletion calculations of diabase kinetic tests are shown in the Sulphide and Neutralization Potential Depletion Calculations (Appendix H) and summarized in Table 4.3-2. Five of the six diabase samples were classified as non-PAG based on ABA results and depletion calculations. These samples also had sulphide-sulphur concentrations below 0.1% by weight, stable and neutral pH values in humidity cells. One diabase sample from the Fox Pit was classified as PAG because the time to depletion of sulphide minerals was greater than the time to depletion for NP. This sample had decreasing pH values in humidity cell testing, contained 0.43% sulphide-sulphur by weight, and was classified as PAG based on an NP/AP ratio of 0.04.

Table 4.3-2 Summary of Depletion Calculation Results of Diabase Samples From the Ekati Mine

Lab ID	Lithology	NP/AP (kg/t as $CaCO_3$)	HCT Duration (week)	Acidity Generated During HCT?	Initial HCT pH	Steady State HCT pH	Final HCT pH	Total Sulphur				Initial NP (kg/t as $CaCO_3$)	NP (Empirical)			Acidic or Non-acidic Conditions?[a]
								Initial (wt% as S)	Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)		Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)	NP (Empirical)
HC-5 – Sable	diabase	28.8	43	no	7.45	6.94	6.97	0.010	93	0.15	12	9.0	99	1.7	101	non-acid
HC-3 – Pigeon	diabase	33.9	43	no	7.46	6.94	6.97	0.010	91	0.15	12	10.6	99	1.7	117	non-acid
HC-4 - Pigeon	diabase	5	52	no	7.2	7.0	6.9	0.060	88	0.31	33	8.6	97	2.1	75	non-acid
HC-PDef-1 – Pigeon	diabase	9.6	51	no	8.7	7.1	7.1	0.050	94	0.33	27	15.0	98	1.7	170	non-acid
HC-3 – Beartooth	diabase	55	43	no	7.5	7.0	7.0	0.005	85	0.15	5.4	8.6	98	2.0	81	non-acid
FUC 3-3 70 – Fox	diabase	0.04	133	no	8.80	5.87	5.80	0.43	84	2.1	33	0.5	0	6	0	acid

a) Acid: Time to sulphide depletion >Time to NP depletion; Non-acid: Time to sulphide depletion <Time to NP depletion.

ID = identification; NP = neutralization potential; AP = acid potential; kg/t = kilograms per tonne; $CaCO_3$ = calcium carbonate; HCT = humidity cell test; wt% = weight percent; S = sulphur; % = percent; mg/kg = milligrams per kilogram; > = greater than; < = less than.

4.3.3 Metasediment

Thirteen metasediment samples were submitted for kinetic testing, including three samples from the Misery Pit (MCH3 220-258, MDC-4 31.5, and MDC-4 59.04), eight samples from the Pigeon area (94-727-32, HC-Pdef-3, HC-Pdef-4, HC-Pdef-5, HC-Pdef-10, HC-Pdef-29, HC-Pdef-30, and HC-Pdef-16), and two samples from the Beartooth Pit (HC-2 and BDC5 41.75). The duration of HCT ranged from 38 to 124 weeks. Samples HC-Pdef-29 and HC-Pdef-30 (Pigeon area) consist of mixed granite and metasediment; the samples contain 30% and 70% metasediment, respectively.

Concentration trends for key parameters in the metasediment samples are presented in Figure 4.3-3. The NAG and SFE results of Jay pipe metasediment samples are compared to the metasediment HCT results in Figure 4.3-3 and Appendix F. The HCT results for metasediment are summarized as follows:

- pH values ranged from 3.5 to 9.4 and generally decreased to the end of testing, or decreased then stabilized. The metasediment samples collected from the Beartooth Pit reported near-neutral to alkaline pH values throughout testing. The two mixed granite/metasediment samples from the Pigeon area reported pH values stabilizing to near-neutral values. All other metasediment HCTs reported pH values decreasing to below 6 in the long term.
- Sulphate concentration trends ranged from 1.5 to 178 mg/L with the exception of one sample from the Misery Pit at week 1 of testing (329 mg/L), and were greater than the long-term SSWQOs for sulphate at the Ekati Mine (35 and 63 mg/L depending on hardness) in several samples throughout testing. Three metasediment samples from the Pigeon area reported increasing sulphate concentration trends over time. Samples from the Misery Pit generally reported an increase in sulphate concentrations after 30 weeks, followed by a decrease to the end of testing. Metasediment samples from the Beartooth Pit generally reported stable and low sulphate concentrations relative to the samples from the other pits.
- Aluminum concentrations ranged from below 0.005 to 6.6 mg/L and exceeded the CCME guideline of 0.01 mg/L throughout most of the testing for all samples. There was no consistent trend in aluminum concentrations over time for all samples. Several HCTs from the Pigeon area, one HCT from the Beartooth Pit, and one sample from the Misery Pit reported increasing aluminum concentrations over time. One HCT from the Beartooth Pit had low aluminum concentrations relative to the other metasediment HCTs. The highest aluminum concentrations were detected in a HCT leachate from the Misery Pit at 36 weeks, followed by a decrease to the end of testing.
- Arsenic concentrations ranged from less than 0.0001 to 0.04 mg/L. Generally, arsenic concentrations stabilized after the first 20 weeks of sampling, with the exception of increasing arsenic concentrations observed in one metasediment sample from the Pigeon area. Arsenic concentrations were greater than the CCME guideline of 0.005 mg/L during the first 20 weeks of sampling in leachates from one HCT from the Beartooth Pit, two from the Pigeon area, and one from the Misery Pit. One Misery Pit sample reported arsenic concentrations greater than the CCME guideline throughout the duration of testing.

- Copper concentrations ranged from 0.0002 to 0.83 mg/L. Copper concentrations were generally less than 0.06 mg/L with the exception of two samples from the Misery Pit and one from the Pigeon area. Copper concentrations were generally greater than the CCME guideline for copper of 0.002 mg/L in most samples. Copper concentrations increased over time as HCT pH values decreased.
- Iron concentrations ranged from 0.0001 to 18 mg/L. Iron concentrations reported similar trends to copper concentrations. Iron concentrations were generally greater than the CCME guideline of 0.3 mg/L, with the exception of one sample from the Misery Pit, which reported a decrease in iron concentrations to below the guideline after week 40.
- Nickel concentrations ranged from below 0.0001 to 4.6 mg/L, exceeding the CCME guideline for nickel of 0.025 mg/L throughout testing for most samples with the exception of two Beartooth Pit HCTs and three Pigeon area HCTs. Nickel concentrations generally reported similar trends to copper concentrations.
- Phosphorus concentrations ranged from 0.0002 to 1.4 mg/L, and were generally below the detection limits (0.30 and 0.10 mg/L) with the exception of several peaks reported in leachates from one Misery Pit sample.
- Potassium concentrations ranged from 1.0 to 36 mg/L, and were below the SSWQOs for potassium, at the Ekati Mine (41 mg/L long term and 112 mg/L short term) throughout testing of all samples.
- Molybdenum concentrations ranged from 0.00005 to 0.01 mg/L, and were below both the CCME guideline (0.073 mg/L) and the SSWQOs for molybdenum at the Ekati Mine (19 mg/L long term and 223 mg/L short term) throughout testing of all samples.
- Vanadium concentrations ranged from 0.0005 to 0.01 mg/L, and were below the SSWQOs for vanadium at the Ekati Mine (0.30 mg/L short term and 0.03 mg/L long term) throughout testing of all samples.
- Cobalt concentrations ranged from below 0.0002 to 0.59 mg/L. Several samples reported increasing cobalt concentrations over time, including three samples collected from the Pigeon area and one from the Misery Pit. These samples reported pH values continuing to decrease into the end of testing. The remaining samples generally reported a decrease in cobalt concentration after 30 weeks of testing.

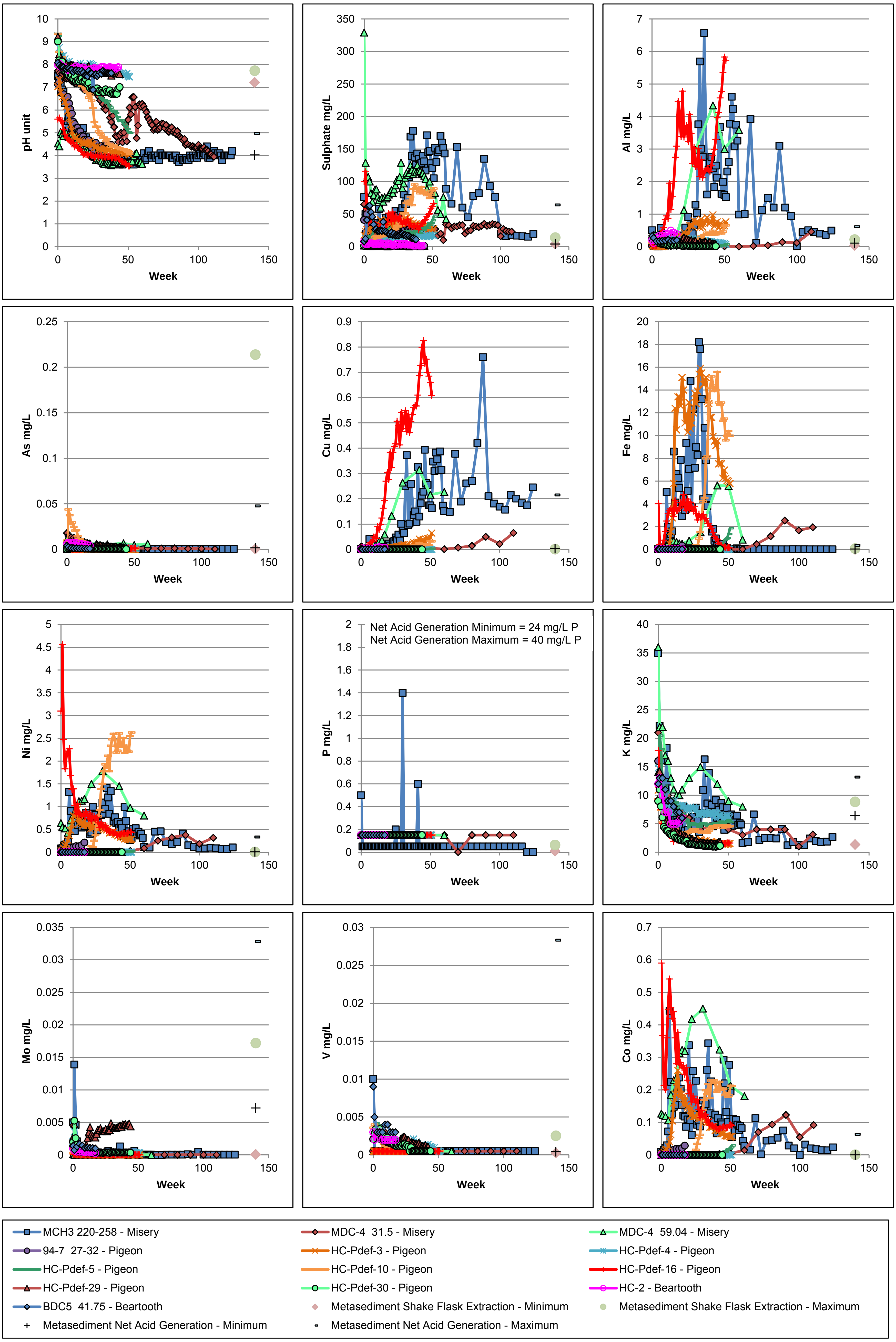
Other parameters reporting concentrations greater than the CCME guidelines in several samples throughout testing included mercury, cadmium, lead, selenium, and zinc.

The results of short-term leach testing of metasediment samples from the Jay pipe were qualitatively compared to Ekati Mine metasediment HCT results to confirm its metal leaching potential:

- The results of short-term leach testing of the Jay pipe metasediment samples were generally within the range observed in the Ekati metasediment kinetic tests for the key parameters (i.e., aluminum, arsenic, cadmium, cobalt, iron, lead, nickel, mercury, sulphate, selenium, and zinc).

- The maximum arsenic concentrations observed in both methods of short-term leach testing of Jay pipe metasediments were higher than arsenic concentrations observed throughout kinetic testing of metasediment samples. Minimum values were within the range observed in kinetic testing.
- The pH values in the first flush of kinetic testing were similar to the pH values observed in the Jay pipe SFE leachates (7.2 to 7.7), and the Pigeon and Misery steady-state pH values were similar to the NAG leach test Jay pipe metasediment samples (4.0 to 5.0).
- Phosphorous concentrations were elevated in NAG leachate samples owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test.

Figure 4.3-3 Key Parameter Concentrations From Humidity Cell Testing of Metasediment Samples From the Ekati Mine



mg/L = milligrams per litre; Al = aluminium; As = arsenic; Cu = copper; Fe = iron; Ni = nickel; P = phosphorous; K = potassium; Mo = molybdenum; V = vanadium; Co = cobalt.

Select ABA results (total sulphur, NP, and NP/AP ratio), and sulphide and NP depletion rates calculated based on the HCT results, are summarized in Table 4.3-3. The long-term acid generation potential of metasediment samples, based on the interpretation of the ABA and HCT results, is summarized as follows:

- Six of the 10 metasediment samples, including four from the Pigeon area and two from the Misery Pit, were classified as having uncertain acid generation potential based on NP/AP ratio. The HCT results indicated that sulphur would be depleted before NP, limiting the long-term potential for acid generation. However, decreasing pH values were observed through the duration of kinetic tests for all six samples.
- Two metasediment samples from the Pigeon Pit and area were classified as non-PAG based on the NP/AP ratio. The HCT results indicated that sulphur would be depleted before NP, limiting the long-term potential for acid generation. Neutral and declining pH values were measured through the duration of the kinetic tests for the two samples, respectively.
- One metasediment sample from the Beartooth Pit could not be classified based on static or kinetic calculations because NP was not measured. Neutral pH values were measured through the duration of kinetic tests of this sample.
- One metasediment sample from the Beartooth Pit was classified as non-PAG based on the NP/AP ratio. However, the HCT results indicated sulphur would remain after the depletion of NP, suggesting an ARD potential. Neutral pH values were measured throughout kinetic testing. The sulphide-sulphur content of this sample was 0.10% by weight.

Table 4.3-3 Summary of Depletion Calculation Results of Metasediment Samples From the Ekati Mine

Lab ID	Lithology	NP/AP (kg/t as $CaCO_3$)	HCT Duration (week)	Acidity Generated During HCT?	Initial HCT pH	Steady State HCT pH	Final HCT pH	Total Sulphur				Initial NP (kg/t as $CaCO_3$)	NP (Empirical)			Acidic or Non-acidic Conditions?[b]
								Initial (wt% as S)	Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)		Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)	NP (Empirical)
HC-31 - Pigeon	biotite schist	1.3	38	yes	7.14	5.06	4.47	0.19	93	2.3	15	7.0	96	2.3	55	non-acid
MDC-4 31.5 – Misery	schist	1.4	111	yes	7.72	4.04	3.95	0.18	83	2.3	13	8.0	89	3.9	35	non-acid
MDC-4 59.04 – Misery	schist	1.0	60	yes	4.53	3.75	3.62	0.34	81	5.9	9.0	11	87	6	32	non-acid
HC-PDef-3 – Pigeon	metasediment	1.7	51	yes	7.03	4.09	4.04	0.21	87	4.4	8.0	11	98	1.9	110	non-acid
HC-PDef-4 – Pigeon	metasediment	4.3	51	no	9.26	7.52	7.46	0.14	91	2.8	8.7	19	95	13	28	non-acid
HC-PDef-5 – Pigeon	metasediment	1.5	51	yes	9.25	5.14	5.00	0.43	95	6.4	12	20	96	17	22	non-acid
HC-PDef-10 – Pigeon	metasediment	2.6	51	yes	9.35	4.19	4.07	0.27	85	13.7	3.2	22	96	25	16	non-acid
HC-PDef-16 – Pigeon	metasediment	1.7	51	yes	5.60	3.61	3.54	0.17	78	9.6	2.7	9.0	97	4.6	37	non-acid
HC-Pdef-29 – Pigeon	mixed metasediment and granite	16	44	no	9.2	7.6	7.6	0.020	97	0.12	30	10.0	96	4.6	40	non-acid
HC-Pdef-30 – Pigeon	mixed metasediment and granite	8.0	44	no	9.0	6.8	7.0	0.040	98	0.16	48	10.0	99	0.3	612	non-acid
HC-2 – Beartooth	biotite schist	2.0	43	no	7.99	7.82	7.88	0.10	98	0.18	105	5.6	90	9	10.7	acid
BDC5 41.75 – Beartooth	biotite schist	n/a[a]	38	no	8.08	7.71	7.62	0.30	97	1.3	44	n/a[a]	n/a[a]	8	n/a[a]	n/a[a]

a) Neutralization potential was not calculated and, therefore, these calculations cannot be competed.

b) Acid: Time to sulphide depletion >Time to NP depletion; Non-acid: Time to sulphide depletion <Time to NP depletion.

ID = identification; NP = neutralization potential; AP = acid potential; kg/t = kilograms per tonne; $CaCO_3$ = calcium carbonate; HCT = humidity cell test; wt% = weight percent; S = sulphur; % = percent; mg/kg = milligrams per kilogram; n/a = not available; > = greater than; < = less than.

4.3.4 Kimberlite

4.3.4.1 Kimberlite

Nine kimberlite samples were submitted for kinetic testing, including one sample from the Fox Pit (F1-1216), two samples from the Misery Pit (M19-100M and M19-106M), two samples from the Sable area (HC-6 and HC-7), two samples from the Pigeon Pit (HC-5 and HC-6), and two samples from the Beartooth Pit (HC-4 and HC-5). Test length ranged from 41 to 130 weeks. Key parameters for these HCTs are shown in Figure 4.3-4. The SFE and NAG results of one Jay pipe kimberlite sample are compared to kimberlite HCT results in Figure 4.3-3 and Appendix F. The HCT results for kimberlite are summarized as follows:

- pH values were near-neutral to alkaline and ranged from 7.5 to 9.6. The pH values were generally stable over time in all samples.
- Sulphate concentrations decreased after the first flush in all samples, and stabilized to below 100 mg/L. Sulphate concentrations were greater than the long-term SSWQOs for sulphate at the Ekati Mine (35 and 63 mg/L depending on hardness) in several samples throughout testing, and the short-term SSWQOs for sulphate (138 and 487 mg/L depending on hardness) in the first flush of most kimberlite samples.
- Aluminum concentrations ranged from below 0.0005 to 0.50 mg/L and exceeded the CCME guideline of 0.01 mg/L throughout most of testing for the samples collected from the Fox and Misery pits. There was generally no trend in aluminum concentrations over time consistent for all samples. Most samples reported stable aluminum concentrations; however, the Fox Pit kimberlite sample reported increasing aluminum concentrations from week 70 to the end of testing at week 130.
- Arsenic concentrations typically ranged from 0.0002 to 0.02 mg/L, while one kimberlite HCT collected from the Pigeon area had arsenic concentrations that ranged from 0.02 to 0.04 mg/L. Kimberlite HCTs from the Fox and Misery pits reported increasing arsenic concentrations after week 100 of testing. Arsenic concentrations were generally greater than the CCME guideline of 0.005 mg/L throughout testing for many of the kimberlite HCTs.
- Copper concentrations ranged from 0.0003 to 0.04 mg/L and were less than 0.03 mg/L in all but two leachate samples from the Fox and Misery pits. Copper concentrations were greater than the CCME guideline of 0.002 mg/L in most samples throughout testing.
- Iron concentrations ranged from 0.0002 to 0.59 mg/L, with the exception of two peaks reported in the leachates from a kimberlite from the Misery Pit (1.9 mg/L) and the Fox Pit (1.5 mg/L). Iron concentrations were greater than the CCME guideline of 0.3 mg/L between weeks 10 and 35 in leachates from the Fox Pit kimberlite.
- Nickel concentrations ranged from 0.0002 to 0.12 mg/L, exceeding the CCME guideline for nickel of 0.025 mg/L in the first flush for most cells, and into week 30 for the Fox Pit kimberlite HCT. Nickel concentrations generally decreased and stabilized after the first flush.

- Potassium concentrations ranged from 1.0 to 310 mg/L, and were greater than one or both of the SSWQOs for potassium at the Ekati Mine (41 mg/L long term and 112 mg/L short term) during the first flush for most samples. Concentrations generally stabilized below 30 mg/L at steady-state conditions.
- Molybdenum concentrations ranged from 0.00005 to 1.6 mg/L, and were below both the SSWQOs for molybdenum at the Ekati Mine (19 mg/L long term and 223 mg/L short term) throughout testing of all samples. Molybdenum concentrations were greater than the CCME guideline of 0.073 mg/L in the first flush of testing of two kimberlite samples from the Misery Pit and one sample from the Pigeon Pit.
- Vanadium concentrations ranged from 0.0005 to 0.18 mg/L, and were greater than the long term SSWQO for vanadium at the Ekati Mine (0.03 mg/L) during the first flush of several samples.
- Phosphorus concentrations ranged from less than 0.10 to 0.70 mg/L, and generally stabilized to below the detection limit (0.10 mg/L) after the first 10 weeks of testing.
- Cobalt concentrations ranged from below 0.0001 to 0.002 mg/L, though detection limits as high as 0.01 mg/L were reported for more than one sample. Generally, cobalt concentrations were stable after 20 weeks of testing.

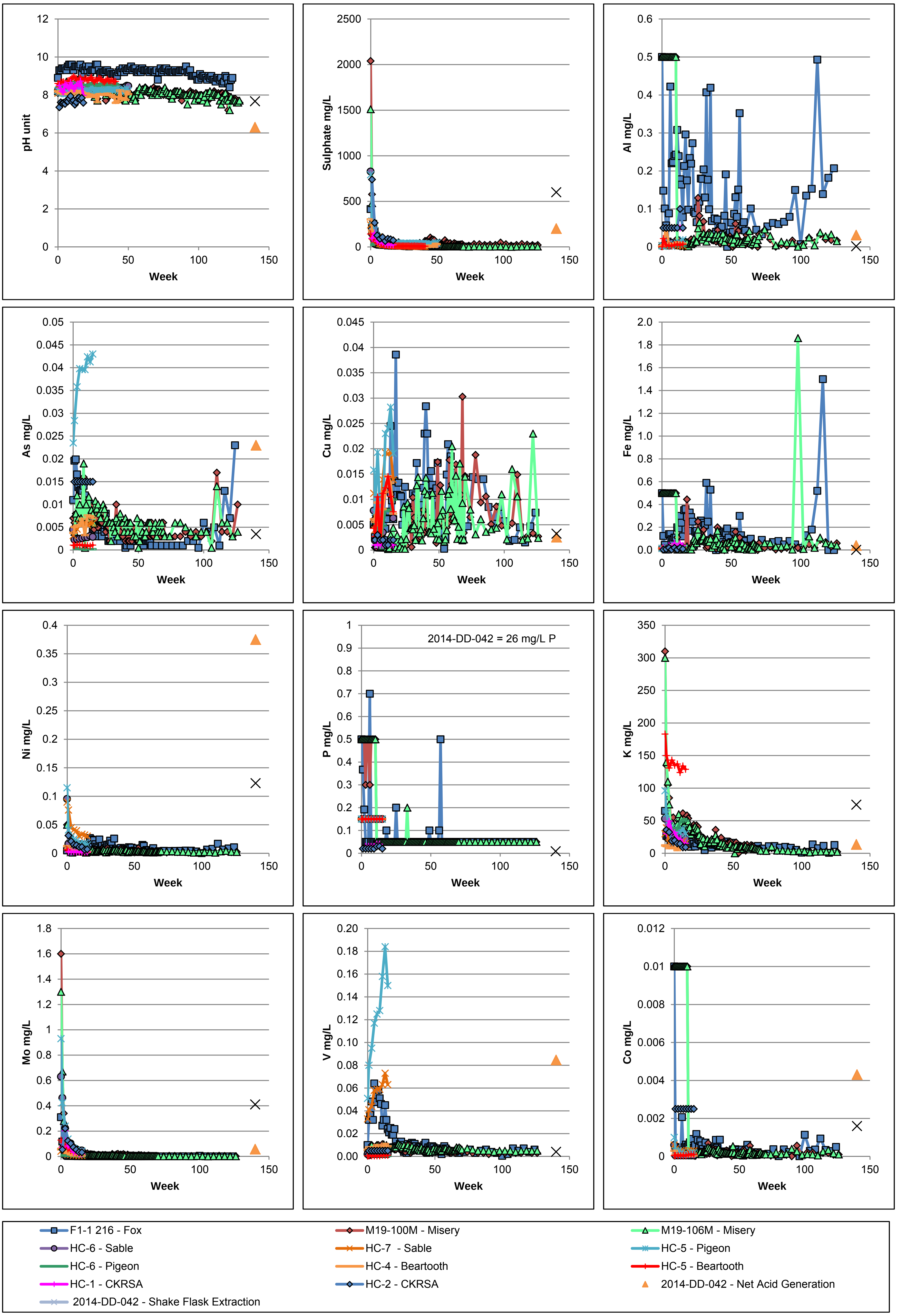
Other parameters that were greater than the CCME guidelines near the beginning of testing, but generally stabilized below or near the CCME guidelines over time, included cadmium, mercury, lead (in samples from the Fox and Misery pits), selenium, and zinc.

The results of short-term leach testing of the Jay pipe kimberlite sample are generally within the range observed in the Ekati kimberlite kinetic tests for key parameters, including aluminum, arsenic, cadmium, iron, lead, mercury, selenium, sulphate, and zinc. Cobalt and nickel concentrations were generally higher in short-term leach testing than those observed in kinetic testing of kimberlite samples. The NAG leachate results were higher than the SFE results in most cases. The SFE leach test pH value of the Jay pipe kimberlite sample (7.7) is similar to the range observed in the kimberlite HCTs. The NAG pH value (6.3) is lower than was observed in any kimberlite humidity cell. The SFE test result for phosphorus for the Jay pipe kimberlite sample was within the range observed in the kimberlite humidity cells.

Phosphorous concentrations were elevated in the NAG leachate sample owing to the presence of phosphorous in the hydrogen peroxide solution used to complete the NAG test.

The results of depletion calculations of kimberlite kinetic tests are shown in Appendix H and summarized in Table 4.3-4. All nine kimberlite samples were classified as non-PAG based on ABA results and depletion calculations. These samples also had stable and neutral pH values in the humidity cells.

Figure 4.3-4 Key Parameter Concentrations From Humidity Cell Testing of Kimberlite and Processed Kimberlite Samples From the Ekati Mine



mg/L = milligrams per litre; Al = aluminum; As = arsenic; Cu = copper; Fe = iron; Ni = nickel; P = phosphorous; K = potassium; Mo = molybdenum; V = vanadium; Co = cobalt.

Table 4.3-4 Summary of Depletion Calculation Results of Kimberlite and Processed Kimberlite Samples From the Ekati Mine

Lab ID	Lithology	NP/AP (kg/t as $CaCO_3$)	HCT Duration (week)	Acidity Generated During HCT?	Initial HCT pH	Steady State HCT pH	Final HCT pH	Total Sulphur				Initial NP (kg/t as $CaCO_3$)	NP (Empirical)			Acidic or Non-acidic Conditions?[b]
								Initial (wt% as S)	Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)		Remaining (%)	Depletion Rate (mg/kg/week)	Time to Depletion (year)	NP (Empirical)
HC-6 – Sable	sulphur-rich kimberlite phase	14.3	50	no	8.24	8.42	8.47	0.32	83	1.6	32	142.5	97	42	64	non-acid
HC-7 – Sable	typical kimberlite phase	44.8	41	no	8.10	8.32	8.35	0.11	80	0.8	22.1	154.1	99	28	104	non-acid
HC-5 – Pigeon	sulphur-rich kimberlite phase	16.0	50	no	8.24	8.24	8.22	0.27	75	3.6	10.8	135	97	38	67	non-acid
HC-6 – Pigeon	typical kimberlite phase	317.0	41	no	8.46	8.55	8.56	0.02	64	0.6	4.1	198	99	54	70	non-acid
HC-4 – Beartooth	sulphur-rich kimberlite phase	9.0	50	no	8.19	7.91	8.05	0.46	94	1.5	54	130	98	19	131	non-acid
HC-5 – Beartooth	typical kimberlite phase	20.4	41	no	8.61	8.73	8.72	0.25	94	0.8	55	160	98	51	58	non-acid
F1-1 216 – Fox	kimberlite	265.1	124	no	8.90	8.67	8.90	0.04	0.0	0.5	0.0	331	n/a[a]	n/a[a]	n/a[a]	n/a[a]
M19-100M – Misery	kimberlite	7.3	129	no	8.10	7.69	7.60	0.75	85	3.4	35	172.0	96	31	104	non-acid
M19-106M – Misery	kimberlite	10.4	130	no	8.20	7.66	7.70	0.59	90	0.8	133	191.0	97	18	198	non-acid
HC 1 – CKRSA	coarse processed kimberlite	20.0	17	no	8.50	8.36	7.98	0.39	94	4.1	17.4	244.0	n/a[a]	n/a[a]	n/a[a]	n/a[a]
HC 2 – CKRSA	coarse processed kimberlite	13.5	17	no	7.35	7.762	7.59	0.45	78	13	5.0	190.0	n/a[a]	n/a[a]	n/a[a]	n/a[a]

a) Neutralization potential was not calculated and, therefore, these calculations cannot be competed.

b) Acid: Time to sulphide depletion >Time to NP depletion; Non-acid: Time to sulphide depletion <Time to NP depletion.

ID = identification; NP = neutralization potential; AP = acid potential; kg/t = kilograms per tonne; $CaCO_3$ = calcium carbonate; HCT = humidity cell test; wt% = weight percent; S = sulphur; % = percent; mg/kg = milligrams per kilogram; n/a = not available; > = greater than; < = less than.

4.3.4.2 Coarse Processed Kimberlite

Two coarse PK samples were submitted for HCTs (CKRSA HC1 and CKRSA HC2) and tested for 18 weeks. Key parameters for these HCTs are shown in Figure 4.3-4. The results are summarized as follows:

- pH values were near-neutral to alkaline and ranged from 7.4 to 8.7. The pH values were generally stable over time in both samples.
- Sulphate concentrations decreased after the first flush in both samples, and stabilized to below 80 mg/L.
- Aluminum concentrations were below the detection limit of 0.05 mg/L in all but one leachate sample. One leachate sample collected at week 13 of testing in sample CKRSA HC2 reported 0.1 mg/L, exceeding the CCME guideline of 0.01 mg/L.
- Arsenic concentrations were below the detection limit of 0.03 mg/L in both samples throughout testing.
- Copper concentrations ranged from less than 0.002 to 0.003 mg/L, exceeding the CCME guideline for copper of 0.002 mg/L in the first flush.
- Iron concentrations were generally stable throughout testing and ranged from less than 0.01 to 0.06 mg/L.
- Nickel concentrations ranged from less than 0.005 to 0.03 mg/L, exceeding the CCME guideline for nickel of 0.025 mg/L in the first flush.
- Phosphorus concentrations ranged from 0.02 to 0.04 mg/L, and were generally stable throughout testing.
- Cobalt concentrations were below the detection limit of 0.005 mg/L throughout testing.

One other parameter with concentrations greater than its CCME guideline during the first flush of testing, but were then lower and stable over time, was molybdenum,

The results of depletion calculations of coarse PK kinetic tests are shown in Appendix H and summarized in Table 4.3-4. Both coarse PK samples were classified as non-PAG based on ABA and HCT results. These samples also had stable and neutral pH values in the humidity cells. This is as expected given the results for kimberlite rock (Section 4.3.4.1), which is not geochemically altered through the process that produces PK.

5 SUMMARY

A geochemical dataset was compiled using existing data from the Ekati Mine, which were collected between 1995 and 2014. The geochemical dataset was used to develop an understanding of the ARD and ML potential of overburden, granite, diabase, metasedimentary rock, and kimberlite that will be mined at the Jay pipe. The analytical results from supplemental samples collected from the Jay pipe in 2014 were used to evaluate and confirm the ARD and ML characteristics of material that will be mined from the Jay pipe, relative to the regional dataset.

A statistical evaluation of solid-phase chemical compositions of waste rock and kimberlite samples was performed to determine if the solid-phase composition of each rock type was similar at each area of the Ekati Mine. The conclusion of the statistical evaluation was that there was a statistically identifiable variation in solid-phase composition of the rock types by area. However, a detailed review of the results of geochemical characterization of waste rock revealed that the ARD/ML characteristics of waste rock were similar between the various pits and areas at the Ekati Mine. Therefore, based on the Ekati Mine geochemical dataset, general conclusions regarding the ARD/ML potential of granite, metasediments, diabase, and kimberlite, respectively, were developed.

Overburden, granite, and diabase have a low acid generation potential. Most samples had NP/AP ratios greater than 2, and were classified as non-PAG according to the guidelines in MEND (2009). Kinetic testing of granite and diabase confirmed that these materials are generally non-PAG, and further identified that granite and diabase may have the potential for leaching several metals in neutral conditions. Concentrations of certain metals were elevated relative to the CCME guidelines for the protection of aquatic life, including aluminum and copper. Occasional occurrences of elevated concentrations of arsenic, cobalt, and nickel concentrations were also measured in certain granite and diabase kinetic test leachates. Leachate concentrations of vanadium and sulphate were elevated with respect to the SSWQOs. Concentrations of these parameters were generally within the range observed in seepage from the existing WRSAs at the Ekati Mine.

Jay pipe overburden samples were not collected as part of the Geochemistry Baseline Report. However, it is anticipated that the geochemical characteristics of overburden at the Jay pipe are similar to those in the Ekati database given the ubiquitous occurrence of glacial till in the area.

Granite and diabase samples collected from the Jay pipe generally reported similar ABA results as the samples collected from the other pits. These lithologies are classified as non-PAG based on ABA and NAG testing. Short-term leachates (shake flask extraction [SFE]) of the Jay pipe granite and diabase samples had near-neutral pH values, with several samples reporting aluminum and arsenic concentrations greater than the CCME guidelines. All metal concentrations in SFE leachates were below the SSWQOs in Jay pipe granite and diabase samples. The SFE leachate metal concentrations were within the range of those reported in kinetic testing of Ekati Mine granite and diabase. Metals that occurred at elevated concentrations relative to the CCME guidelines in NAG leachates included aluminum, arsenic, copper, lead, nickel, selenium, silver, and zinc. Vanadium and sulphate concentrations were elevated with respect to the SSWQOs in NAG leachates of one sample of granite and one sample of diabase. The results of NAG testing conservatively represent the metals that could be released to leachate after complete oxidation of a sample.

Metasedimentary rock has a higher potential for acid generation than overburden, granite, diabase, and kimberlite. Metasedimentary rock is capable of leaching several parameters in neutral and acidic conditions, including sulphate, aluminum, arsenic, cadmium, copper, iron, lead, mercury, nickel, selenium, and zinc. The Ekati Mine test data, including that for the Jay Project, consistently shows that only a portion of the metasediment samples are classified as PAG. Approximately 12% of the samples were classified as PAG, with an NP/AP ratio less than 1; 39% of the samples had an uncertain acid generation potential, with an NP/AP ratio between 1 and 2. However, for practical reasons, the Waste Rock and Ore Storage Management Plan for the Ekati Mine classifies and manages all metasedimentary rock as PAG. The acid generation potential of PAG materials is mitigated operationally by encapsulation of metasedimentary rock in the core of WRSAs.

Metasedimentary samples from the Jay pipe generally reported similar ABA results to the samples collected from the other pits. Approximately 42% of the Jay pipe metasediment samples were classified as PAG, and 38% of the samples had an uncertain acid generation potential. The SFE leachates of the Jay pipe metasediment samples had near-neutral pH values, with several samples reporting aluminum, arsenic, fluoride, and selenium concentrations greater than the CCME guidelines. The SFE leachate metal concentrations were within the range of those reported in kinetic testing of Ekati Mine metasediment, with the exception of arsenic, which was higher in short-term leachates than most kinetic test leachates. The NAG leachates contained elevated concentrations of aluminum, arsenic, cadmium, copper, nickel, selenium, silver, and zinc relative to the CCME guidelines. All metasediment leachate concentrations were below the SSWQOs for the Ekati Mine.

Kimberlite and PK are non-PAG, owing to the abundance of carbonate minerals in these materials. Kimberlite samples from the Jay pipe generally reported similar ABA results to the samples collected from the other pit sampling areas, and both samples were classified as non-PAG. Kimberlite and PK leached elevated concentrations of certain metals relative to the CCME guidelines, including aluminum, arsenic, copper, nickel, and iron. The SFE leachates of the Jay pipe kimberlite sample had a near-neutral pH value, with concentrations of cadmium, copper, molybdenum, nickel, selenium, and silver greater than the CCME guidelines, as well as sulphate concentrations greater than the SSWQO for the Ekati Mine. Several parameters were elevated in kimberlite and PK kinetic leachates relative to the SSWQOs for the Ekati Mine, including vanadium, molybdenum, potassium, and sulphate. The SFE leachate metal concentrations were within the range of those reported in kinetic testing of Ekati Mine kimberlite, though cobalt and nickel concentrations were generally higher in the Jay pipe samples. The NAG leachates contained elevated concentrations of aluminum, arsenic, cadmium, copper, nickel, selenium, and silver relative to the CCME guidelines, and sulphate and vanadium concentrations greater than the SSWQOs for the Ekati Mine.

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7 GLOSSARY

Term	Definition
Acid base accounting	A whole rock analysis whereby acid potential and neutralizing potential are compared to determine a balance.
Acid potential	The ability of a rock or geologic material to produce acid leachates, estimated as the amount of sulphuric acid that could be generated by the amount of sulphur present in a sample.
Acid rock drainage	Acidic pH rock drainage due to the oxidation of sulphide minerals that includes natural acidic drainage from rock not related to mining activity; an acidic pH is defined as a value less than 6.0.
Acidity	Amount of both weak and strong acids expressed as milliequivalents of a strong base necessary to neutralize those acids.
Alkalinity	A measure of water's capacity to neutralize acid. It indicates the presence of carbonates, bicarbonates and hydroxides, and less significantly, borates, silicates, phosphates and organic substances. Alkalinity is expressed as an equivalent of calcium carbonate. Its composition is affected by pH, mineral composition, temperature, and ionic strength. However, alkalinity is normally interpreted as a function of carbonates, bicarbonates and hydroxides. The sum of these three components is called total alkalinity.
Ambient conditions	The conditions surrounding a person or sampling location.
Arctic tundra	Arctic tundra occurs in the far Northern Hemisphere, north of the taiga belt. The word "tundra" usually refers only to the areas where the subsoil is permafrost, or permanently frozen soil.
Baseline	Background or reference; conditions before Project development.
Baseline study area	The project area that forms the basis of the geochemical assessment, which includes the Project and the Ekati Mine.
Bedrock	The solid rock (harder than 3 on Moh's scale of hardness) underlying soils and the regolith in depths ranging from zero (where exposed to erosion) to several hundred metres.
Biotite	Common phyllosilicate mineral within the mica group, with the approximate chemical formula $K(Mg,Fe)_3AlSi_3O_{10}(F,OH)_2$.
Breccia	A fragmental rock whose fragments are angular.
Calcite	A mineral composed of calcium, carbon, and oxygen. Calcite used in this assessment is from the carbonate class of minerals, and has the chemical formula $CaCO_3$.
Chlorite	Phyllosilicate mineral commonly found in igneous rocks as an alteration product of mafic minerals such as pyroxene, amphibole, and biotite.
Conductivity	A measure of the capacity of water to conduct an electrical current. It is the reciprocal of resistance. This measurement provides an estimate of the total concentration of dissolved ions in the water.
Contact water	Water that may contact materials disturbed as part of construction or mining activities.
Diabase	A dark coloured, fine- to medium-grained igneous intrusive rock.
Diatreme	A diatreme is a breccia filled volcanic pipe that was formed by a gaseous explosion. Kimberlite volcanic pipes associated with diamond occurrences are usually considered to be volatile charged piercement structures or diatreme volcanic features from the lower crust or upper mantle.
Dolomite	A carbonate mineral composed of calcium magnesium carbonate $CaMg(CO_3)_2$.
Dyke	Sheet of rock that formed in a crack in a pre-existing rock body.
Feldspar	Group of rock-forming tectosilicate minerals that make up as much as 60% of the Earth's crust. Feldspars crystallize from magma as veins in both intrusive and extrusive igneous rocks and are also present in many types of metamorphic rock.
Footprint	The proposed development area that directly affects the soil and vegetation components of the landscape.
Geochemistry	The chemistry of the composition and alterations of solid matter such as sediments or soil.
Geology	The study of the Earth's crust, its structure, the chemical composition and the physical properties of its components.
Glacial Till	Unsorted and unstratified glacial drift (generally unconsolidated) deposited directly by a glacier without subsequent reworking by water from the glacier. Consisting of a heterogeneous mixture of clay, silt, sand, gravel and boulders (i.e., drift) varying widely in size and shape.

Term	Definition
Granite	A coarsely crystalline igneous intrusive rock composed of quartz, potassium feldspar, mica, or hornblende.
Granitoid	Rocks with a composition the same as, or similar to granite.
Granodiorite	A group of coarse-grained plutonic rocks intermediate in composition between quartz diorite and quartz monzonite.
Hardness	A characteristic of water caused by the presence of positively charged ions (cations) such as calcium, magnesium, iron, and manganese. This parameter is measured in mg/L of calcium carbonate.
Hornblende	Complex inosilicate series of minerals (ferrohornblende to magnesiohornblende). It is not a recognized mineral in its own right, but the name is used as a general or field term, to refer to a dark amphibole.
Humidity Cell	A type of kinetic test in which a small sample (approximately 1 kg) is placed in an enclosed chamber in a laboratory, alternating cycles of moist and dry air is constantly pumped through the chamber, and once a week the sample is rinsed with water; chemical analysis of rinse water yields concentrations of elements and other parameters used to calculate reaction rates.
Hypabyssal	Applied to medium-grained, intrusive igneous rocks that have crystallized at shallow depth below the Earth’s surface.
Intrusive rock	Also called plutonic rock, is an igneous rock formed from magma forced into older rocks at depths within the Earth’s crust, which then slowly solidifies below the Earth’s surface, though it may later be exposed by erosion.
Kimberlite	Igneous rocks that originate deep in the mantle, and intrude the Earth’s crust. These rocks typically form narrow pipe-like deposits that sometimes contain diamonds.
Kimberlite pipe	Vertical structures on which kimberlites occur in the Earth’s crust.
Kinetic Test	A long-term, repetitive leach test designed to evaluate changes in leachate composition over time.
Lithology	The character of a rock described in terms of its structure, colour, mineral composition, grain size, and arrangement of its visible features that in the aggregate impart individuality to the rock.
Mafic	A term to describe minerals that contain iron and magnesium.
Mafic dyke swarm	Large geological structure consisting of a major group of parallel, linear, or radially oriented dykes intruded within continental crust.
Mean	Arithmetic average value in a distribution.
Metal leaching	Removal of metals by dissolution, desorption, or other chemical reaction from a solid matrix by passing liquids through the material.
Metasediments	Sedimentary rocks that have been modified by metamorphic processes.
Migmatite	Rock that is a mixture of metamorphic rock and igneous rock. It is created when a metamorphic rock such as gneiss partially melts, and then that melt recrystallizes into an igneous rock, creating a mixture of the unmelted metamorphic part with the recrystallized igneous part.
Mudstone	Fine-grained sedimentary rock whose original constituents were clays or muds. Grain size is up to 0.0625 millimetres (0.0025 inches) with individual grains too small to be distinguished without a microscope. With increased pressure over time the platey clay minerals may become aligned, with the appearance of fissility or parallel layering.
Neoarchean	Geologic era within the Archaean spanning the period of time from 2,800 to 2,500 million years ago.
Neutralizing potential	The amount of alkaline or basic material in rock or soil materials that is estimated by acid reaction followed by titration to determine the capability of neutralizing acid from exchangeable acidity or pyrite oxidation.
Oligotrophic	Designation for peatlands that are poor to extremely poor in nutrients and with low biological activity.
Ore	The naturally occurring material from which a mineral or minerals of economic value can be extracted.
Overburden	Materials of any nature, consolidated or unconsolidated, that overlie a deposit of useful materials. In the present situation, overburden refers to the soil and rock strata that overlie kimberlite deposits.
Oxidation	A chemical process involving a reaction(s) that produces an increase in the oxidation state of elements such as iron and sulfur.
Oxidation Reduction Potential	The electric potential to transfer electrons from one compound or element (the oxidant) to another compound or element (the reductant); used as a qualitative measure of the state of oxidation.

Term	Definition
Paste pH	A method of measuring the contribution of readily dissolvable acid-generating and acid-neutralizing minerals in a sample.
Pegmatite	An exceptionally coarse-grained igneous rock, with interlocking crystals, usually found as irregular dykes, lenses, or veins, especially at the margins of batholiths.
Pelite	Old and currently not widely used field geological term for a clayey fine-grained clastic sediment or sedimentary rock, i.e., mud or a mudstone. It is equivalent to the Latin-derived term lutite.
Permafrost	Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years. Permafrost is defined on the basis of temperature. It is not necessarily frozen, because the freezing point of the included water may be depressed several degrees below 0°C; moisture in the form of water or ice may or may not be present.
pH	The degree of acidity (or alkalinity) of soil or solution. The pH scale is generally presented from 1 (most acidic) to 14 (most alkaline). A difference of one pH unit represents a ten-fold change in hydrogen ion concentration.
Plagioclase	Important series of tectosilicate minerals within the feldspar family. Rather than referring to a particular mineral with a specific chemical composition, plagioclase is a solid solution series, more properly known as the plagioclase feldspar series (from the Greek "oblique fracture," in reference to its two cleavage angles).
Processed kimberlite	The residual material left behind when the processing of kimberlite has been completed to extract the diamonds.
Psammite	Metamorphosed sedimentary rock with a dominantly sandstone protolith.
Pyroxene	Group of important rock-forming inosilicate minerals found in many igneous and metamorphic rocks. They share a common structure consisting of single chains of silicatetrahedra and they crystallize in the monoclinic and orthorhombic systems.
Quartz	The second most abundant mineral in the Earth’s continental crust, after feldspar. It is made up of a continuous framework of SiO_4 silicon–oxygen tetrahedra, with each oxygen being shared between two tetrahedra, giving an overall formula SiO_2.
Redox	Shorthand for reduction-oxidation. Describes all chemical reactions in which atoms have their oxidation number (oxidation state) changed, most commonly through the transfer of electrons.
Rutile	Mineral composed primarily of titanium dioxide, TiO_2. Rutile is a common accessory mineral in high-temperature and high-pressure metamorphic rocks and in igneous rocks.
Seepage	Slow water movement in subsurface. Flow of water from man-made retaining structures. A spot or zone, where water exits the ground, often forming the source of a small spring.
Slave Structural Province	Archean granite-greenstone terrane covering 190,000 km^2 in the Northwest Territories of Canada.
Solid phase	Referring to the solid state of a material.
Static test	A one-time geochemical test.
Sulphate	A measure of the oxidized species of sulphur, which typically exists as SO_4^{2-}.
Sulphide	A measure of the reduced species of sulphur, or S_{2-}.
Terrane	Shorthand for tectonostratigraphic terrane, which is a fragment of crust.
Till	An unsorted glacial sediment. Glacial drift is a general term for the coarsely graded and extremely heterogeneous sediments of glacial origin. Glacial till is that part of glacial drift which was deposited directly by the glacier. It may vary from clays to mixtures of clay, sand, gravel, and boulders.
Tonalite	Igneous, plutonic (intrusive) rock, of felsic composition, with phaneritic texture. Feldspar is present as plagioclase (typically oligoclase or andesine) with 10% or less alkali feldspar. Quartz is present as more than 20% of the rock. Amphiboles and pyroxenes are common accessory minerals.
Total dissolved solids	The total concentration of all dissolved compounds solids found in a water sample.
Total Kjeldahl Nitrogen	The sum of all organic nitrogen, ammonia (NH_3), and ammonium (NH_4).
Total suspended solids	The amount of suspended substances in a water sample. Solids, found in wastewater or in a stream, which can be removed by filtration. The origin of suspended matter may be artificial or anthropogenic wastes or natural sources such as silt.

Term	Definition
Tourmaline	Crystal boron silicate mineral compounded with elements such as aluminum, iron, magnesium, sodium, lithium, or potassium.
Tundra	A vast, mostly flat, treeless arctic region of Europe, Asia, and North America in which the subsoil is permanently frozen. The dominant vegetation is low-growing stunted shrubs, mosses, lichens.
Volcaniclastic	Clastic rock chiefly composed of volcanic materials.
Waste Rock	Rock moved and discarded to access the resources being mined.
Waste Rock Storage Area	Engineered landforms in which waste rock from mining activities is stored.
Waterbody	An area of water such as a river, stream, lake, or sea.
Watershed	The area drained by a river or stream.
Zircon	Mineral belonging to the group of nesosilicates. Its chemical name is zirconium silicate and its corresponding chemical formula is $ZrSiO_4$.