TRILOGY METALS INC.

NI 43-101 Technical Report

on the Bornite Project, Northwest Alaska, USA

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TRILOGY metals inc

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GLOSSARY

two dimensional	2D
three dimensional	3D
atomic absorption	AA
atomic absorption spectroscopy	AAS
Acme Analytical Laboratories Ltd.	Acme Labs
Alaska Department of Environmental Conservation	ADEC
Alaska Department of Fish and Game	ADF&G
Alaska Department of Natural Resources	ADNR
Alaska Department of Transportation	ADOT
Annual Hardrock Exploration Activity	AHEA
Alaska Industrial Development and Export Authority	AIDEA
aluminum	Al
Ambler Mining District Industrial Access Project	AMDIAP
audio-frequency magnetotelluric	AMT
Alaska Native Claims Settlement Act	ANCSA
Alaska Native Regional Corporations	ANCSA Corporations
Andover Mining Corp.	Andover
area of interest	AOI
Bear Creek Mining Corporation	BCMC
Bruce M. Davis	BMD
carbon	C
calcium	Ca
Canadian Institute of Mining, Metallurgy, and Petroleum	CIM
cobalt	Co
Trilogy Metals Inc.	the Company
chromium	Cr

complex resistivity induced polarization	CRIP
controlled-source audio-frequency magnetotelluric	CSAMT
copper	Cu
digital elevation model	DEM
drill hole	DH
deep penetrating geochemistry	DPG
digital terrain model	DTM
exploratory data analysis	EDA
Environmental Impact Statement	EIS
electromagnetic	EM
Environmental Protection Agency	EPA
Fellow of the Australasian Institute of Mining and Metallurgy	FAusIMM
iron	Fe
Fugro Airborne Surveys	Fugro
grams per cubic centimetre	g/cc
GeoSpark Consulting Inc.	GeoSpark
Geostatistical Software Library	GSLib
inductively coupled plasma	ICP
inductively coupled plasma-atomic emission spectroscopy	ICP-AES
inductively coupled plasma-mass spectrometry	ICP-MS
inverse distance squared	ID^2
induced polarization	IP
International Organization for Standardization	ISO
potassium	K
kilowatt	kW
Kennecott Exploration Company and Kennecott Arctic Company	Kennecott
Kennecott Research Centre	KRC
liquefied natural gas	LNG
million years	Ma
Mine Development Associates	MDA
magnesium	Mg
sodium	Na
North American Datum	NAD
Exploration Agreement and Option to Lease	NANA Agreement
National Environmental Policy Act	NEPA
nickel	Ni
National Instrument 43-101	NI 43-101
Northern Land Use Research Inc.	NLUR Inc.

nearest neighbour	NN
naturally occurring asbestos	NOA
NovaGold Resources Inc.	NovaGold
natural source audio-magnetotelluric	NSAMT
net smelter return	NSR
Northwest Arctic Borough	NWAB
oxygen	O
ordinary kriging	OK
lead	Pb
Professional Geoscientist	P.Geo
polarized light microscopy	PLM
parts per million	ppm
Bornite Property	the Property
quality assurance/quality control	QA/QC
qualified person	QP
rhenium–osmium	Re-Os
rock quality designation	RQD
sulphur	S
specific gravity	SG
SIM Geological Inc.	SGI
Dead Creek	Shungnak
single point	SP
Teck Resources Ltd.	Teck
Trilogy Metals Inc.	Trilogy Metals
uranium	U
Upper Kobuk Mineral Projects	UKMP
US Army Corps of Engineers	USACE
US Geological Survey	USGS
Universal Transverse Mercator	UTM
vanadium	V
volcanogenic massive sulphide	VMS
versatile time domain electromagnetic	VTEM
WH Pacific, Inc.	WHPacific
Zonge International Inc.	Zonge

1 SUMMARY

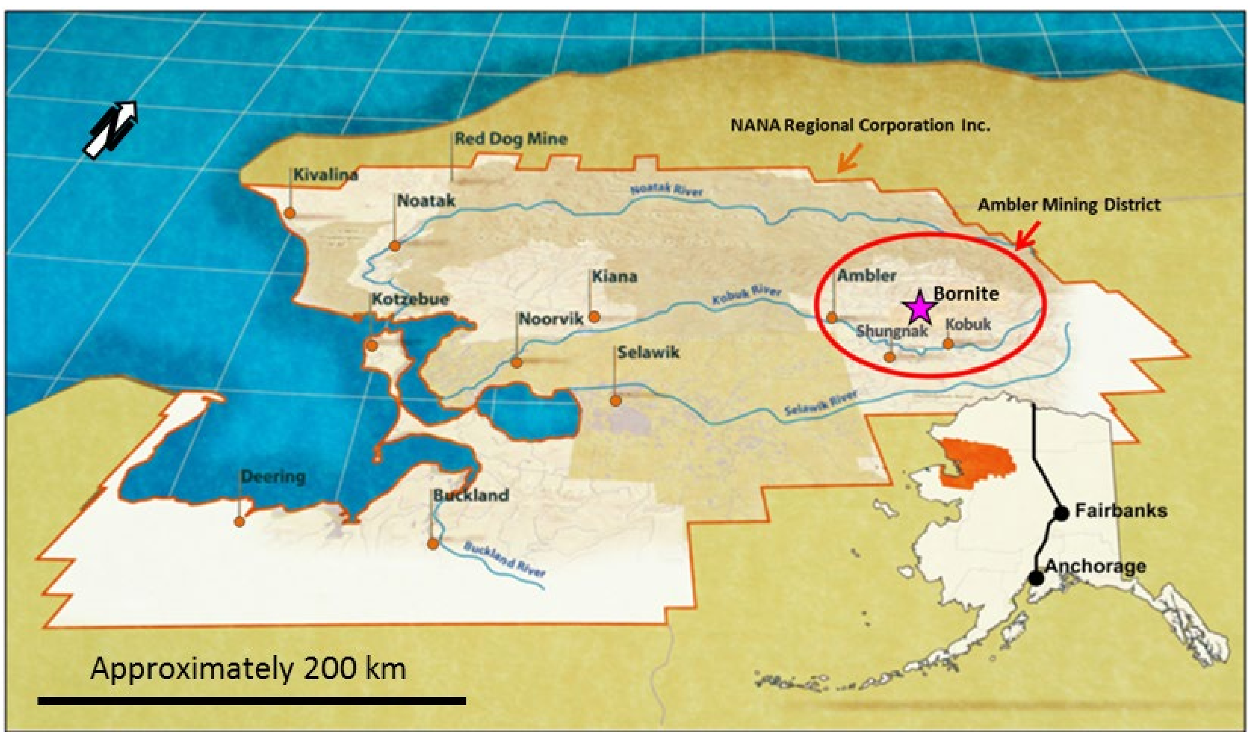
1.1 INTRODUCTION

Trilogy Metals Inc. (Trilogy Metals) retained Robert Sim of SIM Geological Inc. (SGI) and Bruce M. Davis (BMD), to prepare an updated mineral resource estimate for the Bornite Project and disclose it in a technical report prepared in accordance with National Instrument 43-101 and Form 43-101F1 (collectively "NI 43-101"). The Bornite Property (the Property) is part of the Upper Kobuk Mineral Projects (UKMP) mineral tenure package, which includes the Bornite deposit, as well as numerous additional mineral showings/deposits. The Property is located in the Ambler Mining District of the southern Brooks Range, in the Northwest Arctic Borough (NWAB) of Alaska. The Property is located 248 km east of the town of Kotzebue, 19 km north of the village of Kobuk, and 275 km west of the Dalton Highway, an all-weather state-maintained highway. Figure 1-1 shows the location of the Property.

This technical report replaces and supersedes the previous technical report for the Bornite Project which was filed on SEDAR on July 20, 2018 and had an effective date of June 5, 2018.

All amounts are in US dollars unless otherwise stated.

FIGURE 1-1: PROPERTY LOCATION MAP



1.2 PROPERTY DESCRIPTION AND LOCATION

The Bornite Project is located in the Ambler Mining District of the southern Brooks Range, in the NWAB of Alaska. The Property is geographically isolated with no current road access or nearby power infrastructure. The Property is located 248 km east of the town of Kotzebue, 19 km north of the village of Kobuk, and 275 km west of the Dalton Highway, an all-weather state-maintained highway.

The Property is part of the UKMP mineral tenure package, which includes the Bornite Deposit, as well as numerous additional mineral showings/deposits (see Figure 4-1). In October 2011, Trilogy Metals entered into an exploration agreement with NANA Regional Corporation, Inc. (NANA), the owner of the Property, for the development of the parties' collective resource interests in the Ambler Mining District. The agreement consolidated certain land holdings of the parties into a land package that currently totals approximately 181,387 ha.

On February 11, 2020, Trilogy Metals transferred the UKMP to a 50/50 joint venture named Ambler Metals LLC (Ambler Metals). With NANA's approval, Trilogy Metals also contributed, along with the UKMP, its rights under the NANA Agreement to Ambler Metals while its joint venture partner, South32 Limited, contributed $145 million dedicated to advancing the projects.

1.3 GEOLOGY AND MINERALIZATION

Mineralization in the UKMP area is characterized by two mineralized belts: the Devonian Ambler Schist Belt and the Devonian Bornite carbonate sequence. The Ambler Schist Belt is host to a series of volcanogenic massive sulphide (VMS) deposits related to metamorphosed and strongly deformed bimodal Devonian volcanic and sedimentary rocks. A series of notable VMS deposits, including the Arctic, Dead Creek (Shungnak), Sunshine, Horse Creek, Sun, and Smucker deposits, occur in this belt. At Bornite, the focus of this NI 43-101 technical report, mineralization is hosted in less deformed Devonian clastic and carbonate sedimentary rocks lying immediately south of the Ambler Schist Belt across the Ambler Lowlands. Widespread hydrothermal dolomitization is characteristic of the belt and locally hosts the associated copper and cobalt mineralization.

Bornite has characteristics similar to a series of districts and deposits including the Mt Isa district in Australia, the Tynagh deposit in Ireland, the Kipushi deposit in the Congo, and the Tsumeb deposit in Namibia. All of these deposits show: syngenetic to early epigenetic characteristics; emplacement in carbonate stratigraphy; and early pyrite-dolomite alteration followed by copper dominant sulphide mineralization. All occur in intra-continental to continental margin settings undergoing extensional tectonics and bimodal volcanism. Basin-margin faults seem to play an important role in localizing mineralizing fluids.

Copper mineralization at Bornite is comprised of chalcopyrite, bornite, and chalcocite as stringers, veinlets, and breccia fillings distributed in stacked, roughly stratiform zones exploiting favourable stratigraphy. Stringer and massive pyrite and locally significant sphalerite occur above and around the copper zones, while locally massive pyrite and sparse pyrrhotite occur in association with siderite alteration below and adjacent to copper mineralization.

Cobalt mineralization at Bornite is comprised of cobaltiferous pyrite within and enveloping the copper mineralized zones and carrollite and cobaltite directly associated with copper bearing minerals.

1.4 EXPLORATION

Regional exploration began in the area in the early 1900s, and outcropping copper mineralization related to the Bornite deposit was discovered in 1947. Since then, the Property has been explored using integrated programs, including geologic mapping; soil, stream, and rock chip geochemistry; geophysics; underground shaft sinking and drifting; and diamond and reverse circulation drilling. Trilogy Metals geologists continue to use these integrated approaches to explore for other Bornite-style mineral systems on the Property.

1.5 METALLURGICAL TESTING

Metallurgical test work to date indicates that the Bornite Project can be treated using standard grinding and flotation methods to produce copper concentrates with good results being obtained. Copper recoveries range from 89 to 90 percent resulting in copper concentrate grades in the range of 26 to 28 percent copper.

Cobalt occurs at grades that are of potential interest to the project economics. Very preliminary analysis of flotation products in test work indicates that the majority (~80%) of the available cobalt reports to the flotation tailings. This cobalt occurs within cobaltiferous pyrite.

Additional metallurgical test work is recommended.

1.6 MINERAL RESOURCE ESTIMATE

The mineral resource estimate has been prepared by Robert Sim, P.Geo. and Bruce M. Davis, FAusIMM, both "Independent Qualified Persons" as defined in section 1.5 of NI 43-101.

This report contains estimates of copper and cobalt in mineral resources that are considered amenable to a combination of open pit and underground extraction methods. Open pit mineral resources are contained within a pit shell that was generated with the assistance of AGP Mining Consultants Inc. and are based on a 0.5% copper cut-off grade and the underground mineral resource is material below the pit shell calculated at a higher cut-off grade of 1.5% copper. Note that although the data supports estimates of copper resources in both the Indicated and Inferred categories, the volume and distribution of available cobalt sample data is considered insufficient to support the estimate of cobalt resources in the Indicated category and, as a result, all of the estimated cobalt resource remains in the Inferred category. It is assumed that extraction from the Bornite deposit is based on the copper content in the rocks and that cobalt would be a secondary contributor to the potential economic viability of the deposit. As a result, both copper and cobalt mineral resource estimates are defined based on a copper cut-off grade threshold.

Estimates of the copper and cobalt mineral resources are presented in Tables 1.1 and 1.2. The underground mineral resources for the South Reef and Ruby Zone are presented separately in Tables 1.1 and 1.2 to show the differences in average copper and cobalt grades in these two deposit areas.

TABLE 1.1: ESTIMATE OF COPPER MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type/Area	Cut-off (Cu %)	Tonnes (million)	Average Grade Cu (%)	Contained Metal Cu (Mlbs)
Indicated	In-Pit(1)	0.5	41.7	1.04	955
Inferred	In-Pit(1)	0.5	93.9	0.98	2,034
	Below-Pit South Reef	1.5	35.3	3.39	2,639
	Below-Pit Ruby Zone	1.5	15.0	1.98	653
	Total Inferred		144.1	1.68	5,326

1) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3/tonne, milling costs of US$11/tonne, G&A cost of US$5/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees. Underground mining cost US$65/t.
2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

TABLE 1.2: ESTIMATE OF COBALT MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type/Area	Cut-off (Cu %)	Tonnes (million)	Average Grade Co (%)	Contained Metal Co (Mlbs)
Inferred	In-Pit(1)	0.5	135.6	0.017	51
	Below-Pit South Reef	1.5	35.3	0.039	30
	Below-Pit Ruby Zone	1.5	15.0	0.021	7
	Total Inferred		185.8	0.021	88

1) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3/tonne, milling costs of US$11/tonne, G&A cost of US$5/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees. Underground mining cost US$65/t.
2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.
4) Due to limited sample data, none of the cobalt mineral resource meets the confidence level for Indicated-class mineral resources. All cobalt mineral resources are considered to be in the Inferred category.

1.7 INTERPRETATIONS AND CONCLUSIONS

The level of understanding of the geologic controls that influence the distribution of copper mineralization at the Bornite Deposit is relatively good. The drilling, sampling and validation practices used by Trilogy Metals during the various campaigns have been conducted in a professional manner and adhere to accepted industry standards. The confidence in older, historical, drilling conducted by Kennecott has been demonstrated through a series of validation checks and, overall, the underlying database is considered sufficient for the estimation of Indicated and Inferred mineral resources.

SGI and BMD have prepared an updated mineral resource estimate and supporting Technical Report in accordance with NI 43-101. The deposit remains "open" to potential expansion near-surface toward the south, and at depth toward the north, northeast and east.

Metallurgical test work to date is very limited but suggests that potentially marketable concentrates can be produced using standard grinding and flotation methods.

Based on the information to date, the Bornite Project hosts a relatively large copper resource with associated cobalt that is potentially amenable to a combination of open pit and underground extraction methods. It is recommended that Trilogy Metals continue to advance the Project through continued exploration, metallurgical studies, preliminary engineering studies, and environmental baseline analyses, and it should consider the generation of a preliminary economic analysis in the near future.

1.8 RECOMMENDATIONS

The author's recommendations for this project are summarized in Table 1.3.

There is no specific order to these recommendations, and none are dependent on the success or completion of any of the others in order to proceed.

TABLE 1.3: RECOMMENDATIONS FOR THE BORNITE PROJECT

Recommended Program	Description	Estimated Budget
Baseline Studies	Maintain environmental baseline studies and permitting activities	50,000
Acid Base Accounting Study	Implement an initial acid base accounting waste-rock study	50,000
Exploration	Continue exploration in the vicinity of Bornite looking for satellite deposits through an integrated program, including geologic mapping, relogging of existing drill holes, lithogeochemistry and geophysical surveys.	250,000
Metallurgical Testing	Conduct additional metallurgical testing, including the collection of bulk samples for grinding and flotation tests as well as a suite of samples that test the variability of mineralization throughput the Bornite deposit. This proposal includes drilling of 3 holes in the open pit area of the Ruby Zone and 3 holes into the South Reef area to obtain fresh sample material for testing. Metallurgical testing will evaluate optimal processes for recovering copper and cobalt. Studies will also look at grinding, concentrating, filtering and possible options for tailings management. Includes 4,000 m drilling @ $300/m = $1,200,000 plus $300,000 for metallurgical testing.	1,500,000
Hydrogeological and Geotechnical Testing	Initiate hydrogeological and geotechnical programs to better understand the groundwater regime and the stability characteristics of the rocks at Bornite.	500,000
Preliminary Economic Assessment	Proceed with a preliminary economic assessment of the Bornite project.	500,000
Total		**$2,850,000**

2 INTRODUCTION

2.1 TERMS OF REFERENCE

Trilogy Metals Inc. (Trilogy Metals), a company involved in the exploration and development of projects in the Upper Kobuk Mineral Projects (UKMP) in Alaska's Ambler Mining District, retained SIM Geological Inc. (SGI) and Bruce M. Davis (BMD) to prepare an updated mineral resource estimate for the Bornite Project and disclose it in a technical report prepared in accordance with National Instrument 43-101 and Form 43-101F1 (collectively NI 43-101).

This report replaces and supersedes the previous mineral resource estimate for the Bornite Project in its entirety. The previous mineral resource estimate was filed on SEDAR on July 20, 2018 and had an effective date of June 5, 2018.

The effective date of the estimate of mineral resources contained in this report is December 31, 2021.

SGI is responsible for Sections 2 to 10 and Sections 14 to 26 of the current technical report. BMD is responsible for Sections 11 and 12 of the current technical report. SGI and BMD are responsible for portions of Sections 1, 25 and 26. Trilogy Metals engaged AGP Mining Consultants Inc. of Barrie, Ontario to assist in the generation of a resource limiting pit shell as described in Section 14 of this report. International Metallurgical and Environmental Inc., of Kamloops, BC provided a summary of Bornite metallurgical test work and is responsible for Section 13 of the current technical report. BMD and SGI used the information completed by these contributors to support information in this technical report.

2.2 UNITS OF MEASUREMENT

All units of measurement in this technical report are metric, unless otherwise stated. Specifically, imperial units are used in the section describing historical resource estimates and when reporting contained copper.

Currency is expressed in US dollars, unless otherwise stated.

2.3 QUALIFIED PERSONS

Robert Sim, P.Geo., the president of SIM Geological Inc., is the principal author of this Technical Report. Bruce Davis, FAusIMM and Jeffrey (Jeff) Austin, P.Eng., the president of International Metallurgical and Environmental Inc., are co-authors of this Technical Report. Robert Sim, Bruce Davis and Jeff Austin are qualified persons (QPs) as defined in NI 43-101, *Standards of Disclosure for Mineral Projects*, and in compliance with Form 43-101F1.

Neither Robert Sim, Bruce Davis, Jeff Austin, or any associates employed in the preparation of this report (Consultants), has any beneficial interest in Trilogy Metals. These Consultants are not insiders, associates, or affiliates of Trilogy Metals. The results of this Technical Report are not dependent on any prior agreements concerning the conclusions of this report, and there are no undisclosed understandings concerning future business dealings between Trilogy Metals and the Consultants. The Consultants are paid a fee for their work in accordance with normal professional consulting practices.

2.4 SITE VISITS

Bruce Davis conducted several site visits to the Bornite Project on July 26 to 27, 2011; September 25, 2012; August 10 to 12, 2015; and August 28 to 29, 2019. The site visits included a review of drilling procedures, site facilities, historical and recent drill core, logging procedures, data capture, and sample handling. During the 2015 and 2019 Bornite site visits, Mr. Davis undertook helicopter traverses along proposed access corridors and potential site layouts within the UKMP, as well as inspected mineralized outcrop within the historical Berg Pit.

Robert Sim conducted a site visit to the Bornite Project on September 20 to 22, 2018. He toured the deposit in a helicopter, observing a series of locations where previous drilling had occurred as well as the headframe and old mining equipment remaining from the period when Kennecott conducted an underground exploration program during the 1960s. The core handling procedures were reviewed with site geologists, including geotechnical and geological logging, magnetic susceptibility measurements, SG measurements and core sampling procedures, including the implementation of the QA/QC program. The drill core from a series of holes was reviewed, including several randomly selected intervals. The visual observations of rock-type designations reflect the logged information in the database and the volume and type of sulphide minerals present reflect the grades in the assay database. The QP concludes that the procedures followed by Trilogy Metals personnel during drilling programs adhere to standard industry practices.

Jeffrey Austin did not conduct a site visit.

2.5 INFORMATION SOURCES

Reports and documents listed in Section 27 were used to support the preparation of the technical report. Additional information was requested from Trilogy Metals personnel where required.

3 RELIANCE ON OTHER EXPERTS

SGI and BMD have relied entirely on discussions with, and information provided by, the management team at Trilogy Metals for matters relating to mineral tenure and mining rights permits, surface rights, agreements and encumbrances relevant to this report, including the Trilogy Metals and NANA Exploration Agreement and Option to Lease dated October 19, 2011 (the NANA Agreement). Discussions with members of Trilogy management include Richard Gosse, Vice President, Exploration (period 2021 through January 2022), Elaine M. Sanders, Chief Financial Officer and Corporate Secretary (period 2017 through January 2022), and Andy West, Exploration Manager, Ambler Metals (previous Exploration Manager for Trilogy Metals, period 2014 through January 2022).

SGI and BMD have not independently researched the property title or mineral rights for the Bornite Project and express no legal opinion as to the ownership status of the property. For disclosure relating to these matters, they have relied upon information provided by Trilogy Metals and its independent counsel in Anchorage, Alaska (Holmes Weddle & Barcott) in a letter from James N. Reeves "Re: Bornite Property Status Report" dated April 5, 2018 that states that they examined the records of the Office of the District Recorder for the Kotzebue District and concluded that the title to all of the Bornite Property is vested in NANA Regional Corporation, Inc. and is subject to an unrecorded option to lease held by NovaCopper US Inc. as described in Sections 4.2 and 4.3.

SGI and BMD believe the data and information provided by Trilogy Metals are essentially complete and correct to the best of their knowledge and that no information was intentionally withheld that would affect the conclusions made herein.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 LOCATION

The Property is part of the UKMP mineral tenure package, which includes the Bornite deposit as well as numerous additional mineral showings/deposits (Figures 4-1 and 4-2). The Property is located in the Ambler Mining District of the southern Brooks Range in the Northwest Arctic Borough (NWAB) of the State of Alaska, USA. The Property is located in Ambler River A-2 quadrangle, Kateel River Meridian T 19N, R 9E, sections 4, 5, 8 and 9.

The Bornite Project is located 248 km east of the town of Kotzebue, 19 km north of the village of Kobuk, 275 km west of the Dalton Highway (an all-weather state maintained public road) at geographic coordinates N67.07° latitude and W156.94° longitude [Universal Transverse Mercator (UTM) North American Datum (NAD) 83, Zone 4W coordinates 7440449N, 589811E].

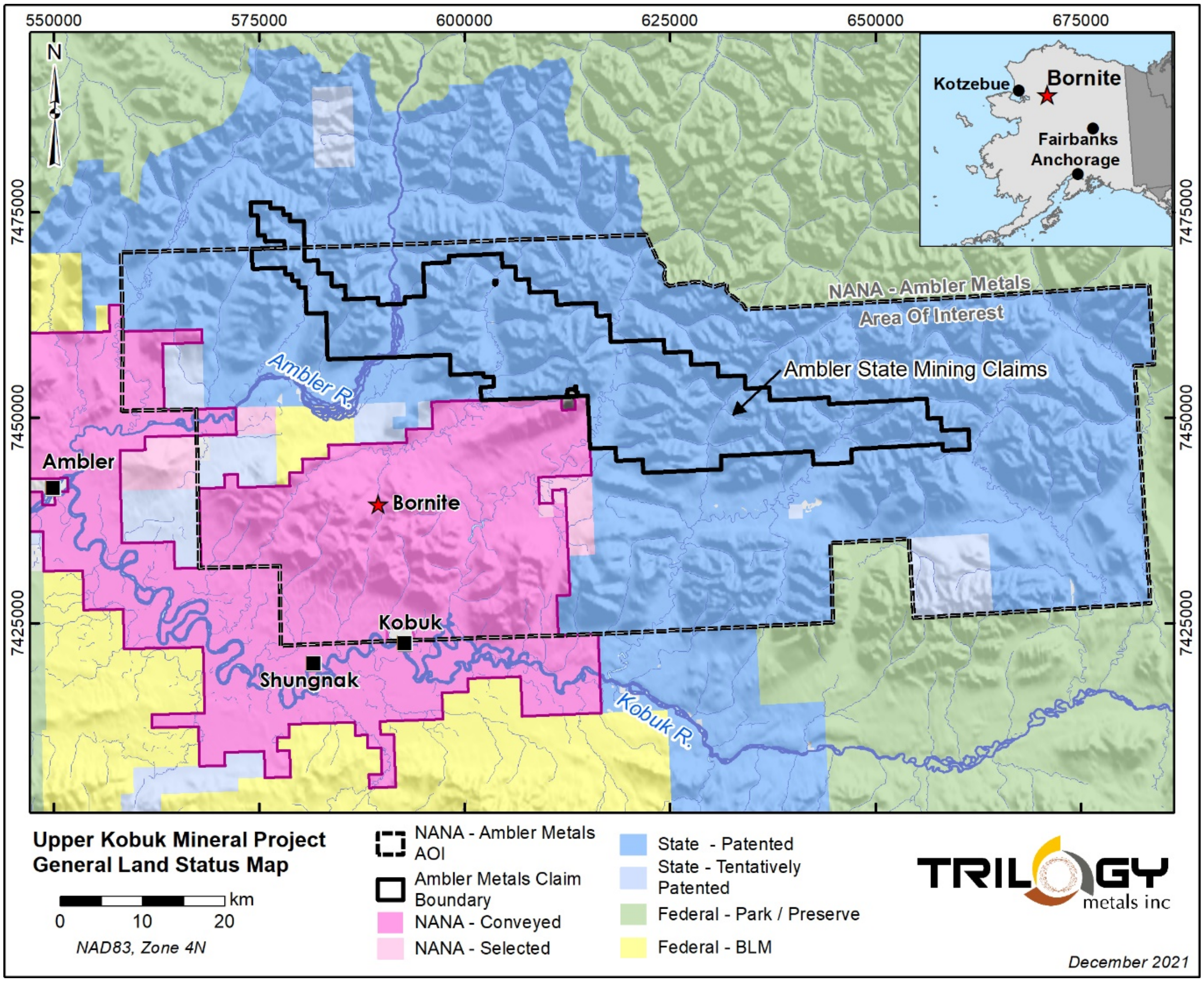
4.2 MINERAL TENURE

The UKMP lands consist of NANA-owned patented lands, NANA-selected ANCSA lands, State of Alaska mining claims, and patented land owned by Trilogy Metals through its subsidiaries. The total land tenure package consists of 181,387 ha: 179,056 ha are within the Area of Interest (AOI) covered by the NANA Agreement, and 20 contiguous State of Alaska mining claims totalling 2,331 ha are outside of the AOI. A breakdown of the UKMP lands is provided in Table 4.1.

TABLE 4.1: SUMMARY OF UKMP LANDS STATUS

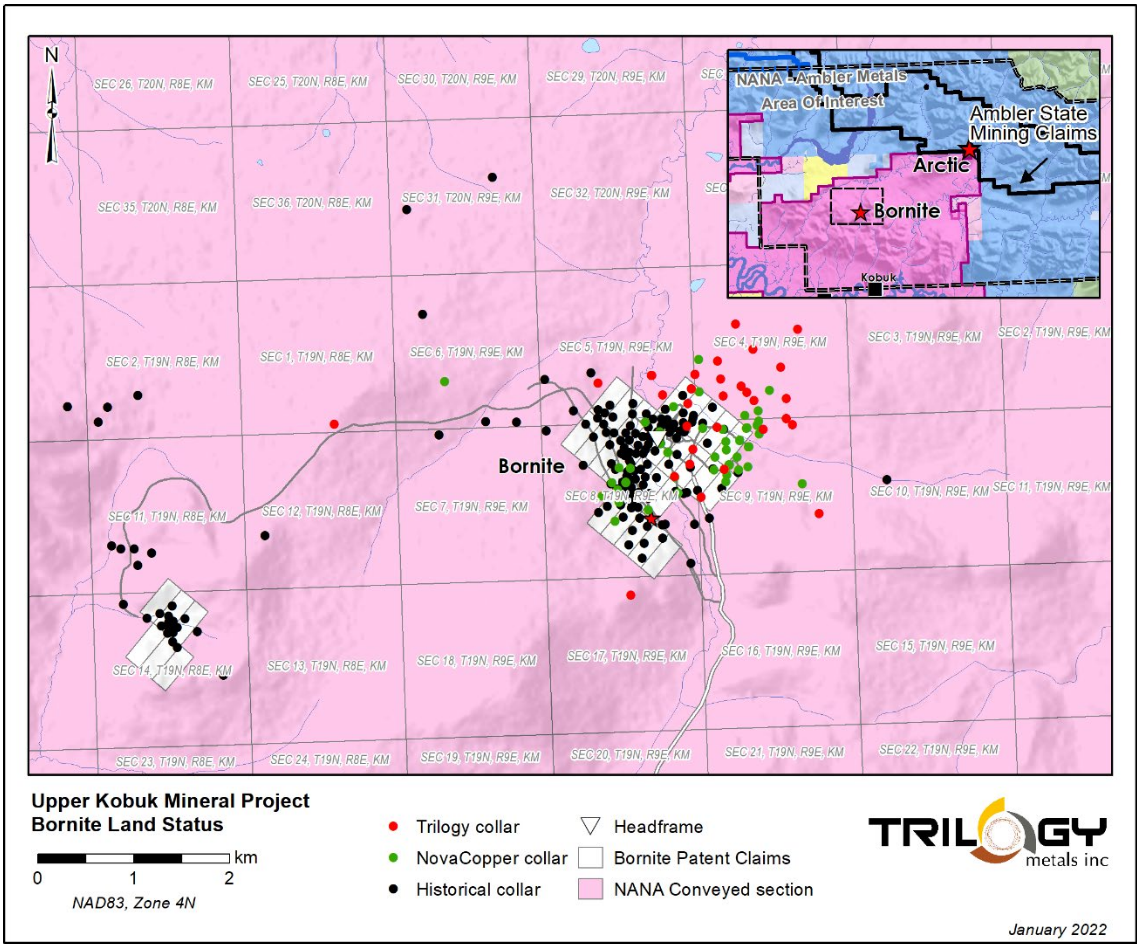
Owner	Number	Type	Acres	Hectares
Ambler Metals	1968	State Claims (inside AOI)	201,397	81,463
Ambler Metals	20	State Claims (outside AOI)	5,760	2,331
Ambler Metals	18 (2 USMS Patents)	Patented	272	110
Ambler Metals Total			207,429	83,904
NANA (ANCSA)	N/A	Selected/Patented	240,369	97,274
NANA (Bornite)	25 (2 USMS Patents)	Patented	517	209
NANA Total			240,886	97,483
Grand Total			448,315	181,387

FIGURE 4-1: UPPER KOBUK MINERAL PROJECTS LANDS



(Source: Trilogy Metals, 2021)

FIGURE 4-2: MINERAL TENURE PLAN



(Source: Trilogy Metals, 2022)

4.3 ROYALTIES, AGREEMENTS AND ENCUMBRANCES

4.3.1 KENNECOTT AGREEMENTS

On March 22, 2004, Alaska Gold Company (Alaska Gold), a wholly owned subsidiary of NovaGold Resources Inc. (NovaGold), completed an *Exploration and Option to Earn an Interest Agreement* with Kennecott Exploration Company and Kennecott Arctic Company (collectively, Kennecott) on the Ambler land holdings.

On December 18, 2009, a *Purchase and Termination Agreement* was entered into between Alaska Gold and Kennecott whereby NovaGold agreed to pay Kennecott a total purchase price of $29 million for a 100% interest in the Ambler land holdings, which included the Arctic Project, to be paid as: $5 million by issuing 931,098 NovaGold shares, and two installments of $12 million each, due 12 months and 24 months from the closing date of January 7, 2010.

The NovaGold shares were issued in January 2010, the first $12 million payment was made on January 7, 2011, and the second $12 million payment was made in advance on August 5, 2011; this terminated the March 22, 2004 exploration agreement between NovaGold and Kennecott. Under the *Purchase and Termination Agreement*, the seller retained a 1% net smelter return (NSR) royalty that is purchasable at any time by the landowner for a one-time payment of $10 million.

In 2011, NovaGold incorporated the Trilogy Metals entities and transferred its Ambler land holdings, including the Arctic Project, from Alaska Gold to Trilogy Metals. In April 2012, NovaGold completed a spin-out of NovaCopper, with the Ambler lands, to the NovaGold shareholders and made NovaCopper an independent publicly listed company, listed on the TSX and NYSE-MKT exchanges. NovaCopper Inc. subsequently underwent a name change to Trilogy Metals Inc. in 2016.

On February 11, 2020, Trilogy Metals transferred the UKMP to a 50/50 joint venture named Ambler Metals LLC (Ambler Metals). With NANA's approval, Trilogy Metals also contributed, along with the UKMP, its rights under the NANA Agreement to Ambler Metals while its joint venture partner, South32 Limited, contributed $145 million dedicated to advancing the projects.

4.3.2 NANA Agreement

In 1971, the US Congress passed the Alaska Native Claims Settlement Act (ANCSA) which settled land and financial claims made by the Alaska Natives and provided for the establishment of 13 regional corporations to administer those claims. These 13 corporations are known as the Alaska Native Regional Corporations (ANCSA Corporations). One of these 13 regional corporations is NANA Regional Corporation, Inc. ANCSA Lands controlled by NANA bound the southern border of the Property claim block. National Park lands are within 25 km of the northern Property border. The Bornite deposit is located entirely on lands owned by NANA.

On October 19, 2011, Trilogy Metals and NANA Regional Corporation, Inc. entered into the "NANA Agreement" for the cooperative development of their respective resource interests in the Ambler Mining District. The NANA Agreement consolidates Trilogy Metals' and NANA's land holdings into an approximately 142,831 ha land package and provides a framework for the exploration and development of the area. The NANA Agreement provides that NANA will grant Trilogy Metals the nonexclusive right to enter onto, and the exclusive right to explore, the Bornite Lands and the ANCSA Lands (each as defined in the NANA Agreement) and in connection therewith, to construct and utilize temporary access roads, camps, airstrips and other incidental works. The NANA Agreement has a term of 20 years, with an option in favour of Trilogy Metals to extend the term for an additional 10 years. The NANA Agreement may be terminated by mutual agreement of the parties or by NANA if Trilogy Metals does not meet certain expenditure requirements on NANA's lands.

On February 11, 2020, Trilogy Metals transferred the UKMP to a 50/50 joint venture named Ambler Metals LLC (Ambler Metals). With NANA's approval, Trilogy Metals also contributed, along with the UKMP, its rights under the NANA Agreement to Ambler Metals while its joint venture partner, South32 Limited contributed $145 million dedicated to advancing the projects.

The NANA Agreement outlines a partnership agreement for the development the UKMP. If, following receipt of a feasibility study and the release for public comment of a related draft environmental impact statement, Ambler Metals decides to proceed with construction of a mine on the lands subject to the NANA Agreement, Ambler Metals will notify NANA in writing and NANA will have 120 days to elect to either (a) exercise a non-transferrable back-in-right to acquire between 16% and 25% (as specified by NANA) of that specific project; or (b) not exercise its back-in-right, and instead receive a net proceeds royalty equal to 15% of the net proceeds realized by Ambler Metals from such project. The cost to exercise such back-in-right is equal to the percentage interest in the Project multiplied by the difference between (i) all costs incurred by Ambler Metals or its affiliates on the Project, including historical costs incurred prior to the date of the NANA Agreement together with interest on the historical costs; and (ii) $40 million (subject to exceptions). This amount will be payable by NANA to Ambler Metals in cash at the time the parties enter into a joint venture agreement and in no event will the amount be less than zero.

In the event that NANA elects to exercise its back-in-right, the parties will, as soon as reasonably practicable, form a joint venture with NANA electing to participate between 16% to 25%, and Ambler Metals will own the balance of interest in the joint venture. Upon formation of the joint venture, the joint venture will assume all of the obligations of Ambler Metals and be entitled to all the benefits of Ambler Metals under the NANA Agreement in connection with the mine to be developed and the related lands. A party's failure to pay its proportionate share of costs in connection with the joint venture will result in dilution of its interest. Each party will have a right of first refusal over any proposed transfer of the other party's interest in the joint venture other than to an affiliate or for the purposes of granting security. A transfer by either party of a net smelter royalty return on the project or any net proceeds royalty interest in a project other than for financing purposes will also be subject to a first right of refusal.

In connection with possible development on the Bornite Lands or ANCSA Lands, Ambler Metals and NANA will execute a mining lease to allow Ambler Metals or the joint venture to construct and operate a mine on the Bornite Lands or ANCSA Lands (the Mining Lease). These leases will provide NANA a 2% NSR royalty as to production from the Bornite Lands and a 2.5% NSR royalty as to production from the ANCSA Lands.

If Ambler Metals decides to proceed with construction of a mine on its own lands subject to the NANA Agreement, NANA will enter into a surface-use agreement with Ambler Metals which will afford Ambler Metals access to the project along routes approved by NANA (the Surface Use Agreement). In consideration for the grant of such surface use rights, Ambler Metals will grant

NANA a 1% NSR royalty on production and an annual payment of $755 per acre (as adjusted for inflation each year beginning with the second anniversary of the effective date of the NANA Agreement and for each of the first 400 acres (and $100 for each additional acre) of the lands owned by NANA and used for access which are disturbed and not reclaimed.

4.4 ENVIRONMENTAL LIABILITIES

Under the NANA Agreement, NANA is required to complete a baseline environmental report following the cleanup of the former mining camp on the Bornite Lands; this work must be completed to Alaska Department of Environmental Conservation standards. Cleanup includes the removal and disposal, as required by law, of all hazardous substances present on the Bornite Lands. NANA has indemnified and will hold Trilogy Metals harmless for any loss, cost, expense, or damage suffered or incurred attributable to the environmental condition of the Bornite Lands at the date of the baseline report which relate to any activities prior to the date of the agreement.

In addition, there are no indications of any known environmental impairment or enforcement actions associated with NovaGold's activities to date. As a result, NovaGold, now Trilogy Metals, has not incurred outstanding environmental liabilities in conjunction with its entry into the NANA Agreement.

4.5 PERMITS

Multiple permits are required during the exploration phase of the Property. Permits are issued from Federal, State, and Regional agencies, including: the Environmental Protection Agency (EPA), US Army Corps of Engineers (USACE), Alaska Department of Environmental Conservation (ADEC), Alaska Department of Fish and Game (ADF&G), Alaska Department of Natural Resources (ADNR), and NWAB. The State of Alaska permit for exploration on the Property, known as the Annual Hardrock Exploration Activity (AHEA) Permit, is obtained and renewed every five years through the ADNR – Division of Mining, Land and Water. Trilogy Metals held an AHEA exploration permit in good standing with the Alaska DNR and has done so each year since 2004 under Alaska Gold. The Property is within the NWAB therefore requiring a Title 9 Miscellaneous Land Use permit for mineral exploration, fuel storage, gravel extraction, and the operation of a landfill. The Bornite Camp, Bornite Landfill, and Dahl Creek Camp are permitted by the ADEC. After the formation of the joint venture, Ambler Metals has renewed the necessary permits for exploration and related camp operations.

As the Bornite Project progresses, additional permits for environmental baseline and detailed engineering studies will be necessary at Federal, State, and Regional levels. A detailed outline of permitting requirements is discussed in Section 20.0.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE & PHYSIOGRAPHY

5.1 ACCESSIBILITY

5.1.1 AIR

Primary access to the Property is by air, using both fixed-wing aircraft and helicopters.

There are four well maintained, approximately 1,500 m long gravel airstrips located near the Property, capable of accommodating charter, fixed-wing aircraft. These airstrips are located 40 km west at Ambler, 23 km southwest at Shungnak, 19 km south at Kobuk, and 15 km south at Dahl Creek. There is daily commercial air service from Kotzebue to the village of Kobuk, the closest community to the Property. During the summer months, the Dahl Creek airstrip is suitable for larger aircraft, such as C-130 and DC-6.

There is also a 700 m airstrip located at the Bornite Camp. The airstrip at Bornite is suited to smaller aircraft, which support the Bornite Camp with personnel and supplies.

5.1.2 WATER

There is no direct water access to the Property. During spring runoff, river access is possible by barge from Kotzebue Sound to Ambler, Shungnak, and Kobuk via the Kobuk River.

5.1.3 ROAD

A two-lane, two-wheel drive gravel road links the Bornite Project's main camp to the 1,525 m Dahl Creek airstrip and village of Kobuk.

5.2 CLIMATE

The climate in the region is typical of a sub-arctic environment. Exploration is generally conducted from late May until late September. Weather conditions on the Property can vary significantly from year to year and can change suddenly. During the summer exploration season, average maximum temperatures range from 10°C to 20°C, while average lows range from -2°C to 7°C (Alaska Climate Summaries: Kobuk 1971 to 2000). By early October, unpredictable weather limits safe helicopter travel to the Property. During winter months, the Property can be accessed by snow machine, track vehicle, or fixed-wing aircraft. Winter temperatures are routinely below -25°C and can exceed -50°C. Annual precipitation in the region averages 395 mm with the most rainfall occurring from June through September, and the most snowfall occurring from November through January.

5.3 LOCAL RESOURCES

The Property is approximately 248 km east of the town of Kotzebue (on the edge of Kotzebue Sound), 19 km north of the village of Kobuk, 275 km west of the Dalton Highway, and 485 km northwest of Fairbanks. Kobuk (population 191; 2020 US Census) is a potential workforce source for the Bornite Project and is the location of one of the airstrips near the Property. Several other villages are also near the Property, including Shungnak located 23 km to the southwest (population of 272; 2020 US Census) and Ambler, 40 km to the west (population 274; 2020 US Census). Kotzebue (population of 3,102; 2020 US Census) is the largest population centre in the Northwest Arctic Borough. Kotzebue is a potential source of limited mining-related supplies and labourers and is the nearest centre serviced by regularly scheduled, large, commercial aircraft (via Nome or Anchorage). In addition, there are seven other villages in the region that will be potential sources of some of the workforce for the Property. Fairbanks (population 32,515; 2020 US Census) has a long mining history and can provide most mining-related supplies and support that cannot be sourced closer to the Property.

Drilling and mapping programs are seasonal and have been supported out of the main Bornite Camp. The main Bornite Camp facilities are located on Ruby Creek on the northern edge of the Cosmos Hills. The camp provides office space and accommodations for the geologists, drillers, pilots, and support staff. There were four, two-person cabins installed by NANA prior to Trilogy Metals' tenure.

The 85-person capacity Bornite Camp consists of 35 structures most of which are metal-framed, insulated tents that house multi-occupancy sleeping accommodations, kitchen facilities, dining facilities, medical services, showers, washrooms, laundry, administrative offices, and a recreation tent. Early 1960s-era legacy structures constructed by Kennecott to support Bornite Shaft sinking are used for equipment maintenance, storage, and sleeping cabins.

Core is logged in two, metal-clad buildings: one from the early 1970s and one 30 m x 9 m structure that was built in 2011.

Electricity is generated at site by one 275 kW primary and one 300 kW backup diesel-powered generator.

Potable water is sourced from a permitted well. Solid waste disposal is accomplished by a combination of diesel-fired incineration and permitted landfill placement. The primary camp's domestic wastewater is treated in a packaged bioreactor-style treatment plant before it is discharged. Wastewater from a small portion of the camp is treated in a conventional septic system.

5.4 INFRASTRUCTURE

Proposed infrastructure is discussed in more detail in Section 18.0. Currently, the Bornite Project does not have access to Alaska power and transportation infrastructure.

On July 23, 2020, the United States Bureau of Land Management issued the Joint Record of Decision (JROD) for the Ambler Access Project that authorizes a right-of-way across federally managed lands to the Alaska Industrial Development and Export Authority (AIDEA). The northern or “A” route, which is under consideration for a 211-mile long (340 km) controlled industrial access road in the southern Brooks Range foothills to the Ambler Mining District, was selected as part of the decision. Along with the JROD, a Section 404 Permit, which is governed by the Clean Water Act (CWA), was issued by the USACE to AIDEA.

On January 6, 2021, AIDEA signed agreements for Right-of-Ways for the Ambler Access Project with the United States Bureau of Land Management and the National Park Service. The agreements grant a 50-year right-of-way on federally owned and managed land by the federal agencies for the future development of the Ambler Access Project.

Subsequently, in February 2021 Ambler Metals LLC (Ambler Metals), the joint venture operating company equally owned by Trilogy Metals and South32 Limited (ASX, LSE, JSE: S32; ADR: SOUHY) (South32), entered into an Ambler Access Development Agreement with AIDEA.

The Ambler Access Development Agreement defines how AIDEA and Ambler Metals will work cooperatively together on the pre-development work for the Ambler Access Project to address funding and oversight of the project’s feasibility and permitting activities until the parties reach a decision on the construction of the project. The cost of the pre-development work and activities will be paid 50% by AIDEA and 50% by Ambler Metals based on an annually agreed upon program and budget.

Under the Ambler Access Development Agreement, Ambler Metals and AIDEA agree to contribute up to $35 million each for pre-development costs of the Ambler Access Project through December 31, 2024. This proposed Development Agreement follows up on and is consistent with both the Interim Funding Agreement agreed to by AIDEA and Ambler Metals for pre-development work done on the project in 2020 and with the Memorandum of Understanding (MOU) between the parties signed on July 3, 2020.

5.5 PHYSIOGRAPHY

The Bornite Project is located on Ruby Creek on the northern edge of the Cosmos Hills. The Cosmos Hills are part of the southern flank of the Brooks Range in Northwest Alaska. Topography in the area is moderately rugged. Maximum relief in the Cosmos Hills is approximately 1,000 masl with an average of 600 masl. Talus covers the upper portions of the hills; glacial and fluvial sediments occupy valleys.

The Kobuk Valley is located at the transition between boreal forest and Arctic tundra. Spruce, birch, and poplar are found in portions of the valley, with a ground cover of lichens (reindeer moss). Willow and alder thickets and isolated cottonwoods follow drainages, and alpine tundra is found at higher elevations. Tussock tundra and low, heath-type vegetation covers most of the valley floor. Patches of permafrost exist on the Property.

Permafrost is a layer of soil at variable depths beneath the surface where the temperature has been below freezing continuously from a few to several thousand years (Climate of Alaska, 2007). Permafrost exists where summer heating fails to penetrate to the base of the layer of frozen ground and occurs in most of the northern third of Alaska as well as in discontinuous or isolated patches in the central portion of the state.

Wildlife in the Property area is typical of Arctic and Subarctic fauna (Kobuk Valley National Park, 2007). Larger animals include caribou, moose, Dall sheep, bears (grizzly and black), wolves, wolverines, coyotes, and foxes. Fish species include salmon, sheefish, arctic char, and arctic grayling. The Kobuk River, which briefly enters the UKMP on its southwest corner, is a significant salmon spawning river. The caribou on the Property belong to the Western Arctic herd that migrates twice a year: south in August from their summer range north of the Brooks Range, and north in March from their winter range along the Buckland River.

5.6 SUFFICIENCY OF SURFACE RIGHTS

The Company has sufficient surface rights for its planned mining operations, including sufficient land to construct various facilities, such as tailings storage areas and potential waste disposal areas, stockpile areas and processing plants.

6 HISTORY

Regional exploration began in the early 1900s when gold prospectors noted copper occurrences in the hills north of Kobuk, Alaska.

In 1947, local prospector Rhinehart "Rhiny" Berg, along with various partners traversing in the area, located outcropping mineralization along Ruby Creek (Bornite) on the north side of the Cosmos Hills. They subsequently staked claims over the Ruby Creek showings and constructed an airstrip for access. In 1957, Bear Creek Mining Company (BCMC), Kennecott's exploration subsidiary, optioned the property from Berg.

Exploration drilling in 1961 and 1962 culminated in the discovery of the "No.1 Ore Body" where drill hole RC-34 cut 20 m of 24% Cu (the "No.1 Ore Body" is a historical term used by BCMC that does not connote economic viability in the present context; it is convenient to continue to use the term to describe exploration work and historical mineral resource estimation in a specific area that was previously referred to as the Ruby Creek zone and is now referred to as simply the Ruby Zone). The discovery of the "No.1 Ore Body" led to the development of an exploration shaft in 1965 through 1966. The shaft, which reached a depth of 328 m, encountered a significant watercourse and was flooded near completion depth. The shaft was subsequently dewatered, and an exploration drift was developed to provide access for sampling and mapping, and to accommodate underground drilling to further delineate mineralization. A total of 59 underground holes were drilled before the shaft was allowed to re-flood.

The discovery of the Arctic Project in 1965 prompted a hiatus in exploration at Bornite, and only limited drilling occurred up until 1976.

6.1 GEOCHEMISTRY

In the late 1990s, Kennecott resumed its evaluation of the Bornite deposit and the mineralization in the Cosmos Hills with an intensive soil, stream, and rock chip geochemical sampling program using a 32-element ICP analyses. Grid soil sampling yielded 765 samples. Ridge and spur sampling resulted in an additional 850 soil samples in the following year. Skeletonized core samples (85 samples) from key historical drill holes were also analyzed using 32-element ICP analytical methods. Geochemical sampling identified multiple areas of elevated copper and zinc in the Bornite region (Kennecott Annual Ambler Project Reports, 1995–1997).

6.2 GEOPHYSICS

Kennecott completed numerous geophysical surveys as an integral part of exploration throughout its tenure on the property. Various reports, notes, figures, and data files stored in Kennecott's Salt Lake City exploration office indicated that geophysical work included, but was not limited to, the following:

- Airborne magnetic and electromagnetic (EM) surveys (fixed-wing INPUT) (1950s)
- Gravity, single point (SP), audio-frequency magnetotelluric (AMT), EM, borehole and surface IP/resistivity surveys (1960s)
- Gravity, airborne magnetic, and controlled-source audio-frequency magnetotelluric (CSAMT) surveys (1990s)

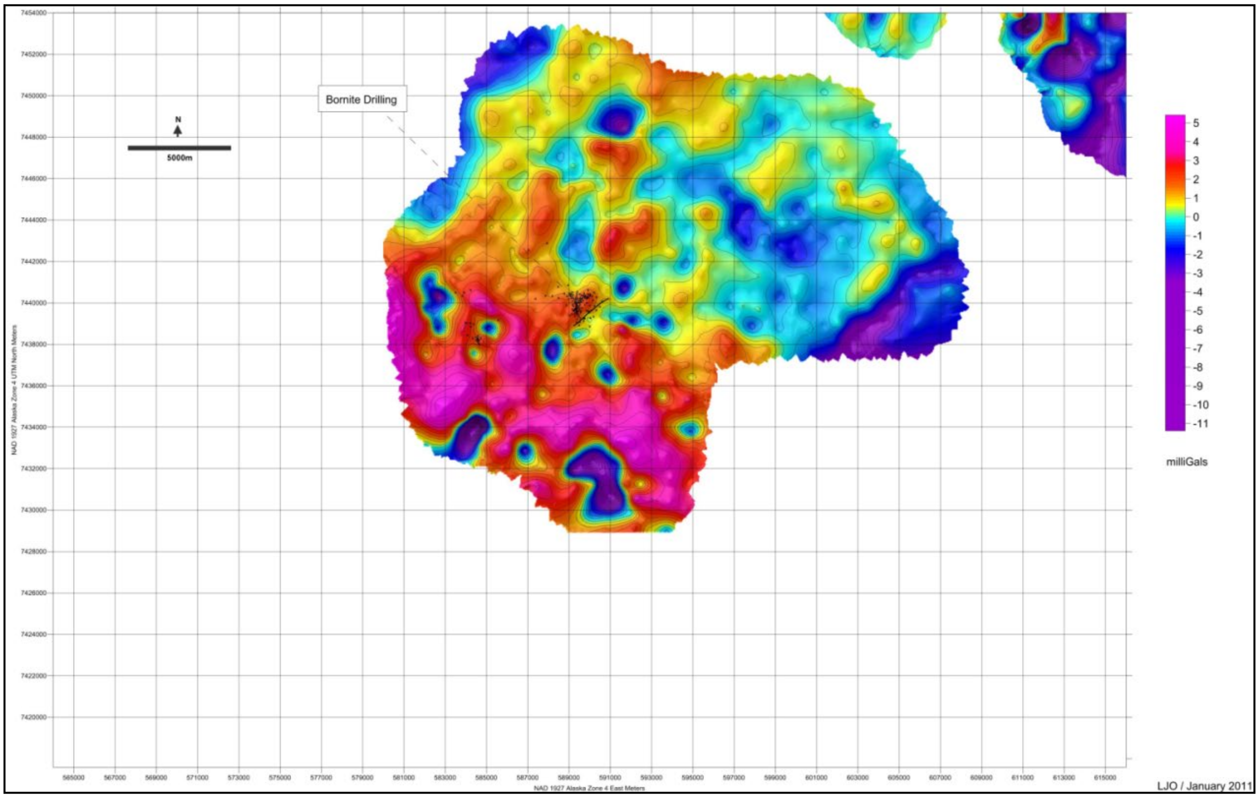
Trilogy Metals has minimal information or documentation associated with these geophysical surveys conducted prior to the 1990s. Where data are available in these earlier surveys, the lack of details in data acquisition, coordinate systems, and data reduction procedures limit their usefulness. The only complete geophysical report that is available concerns down-hole IP/resistivity results (Merkel, 1967).

Most notable is the 1996 Bouguer gravity survey from the Bornite deposit into the Ambler Lowlands. Figure 6-1 shows the terrain-corrected Bouguer residual gravity survey anomalies. The Bornite deposit itself is seen as a significant 3 milligal anomaly. Numerous 2 milligal to > 6 milligal anomalies occur under cover in the Ambler Lowlands and near the Aurora Mountain and Pardner Hill occurrences.

The wide range of geophysical techniques used in and around the deposit over a span of 40 years indicates the level of difficulty experienced by Kennecott/BCMC while trying to detect mineralization. When applying EM and IP/resistivity methods, the problem appears to be that deeper mineralization is often masked by the response of near-surface conductive rocks.

In addition to the geophysical surveys conducted by Kennecott, the Alaska Department of Natural Resources and Geometries completed an aeromagnetic survey of portions of the Ambler Mining District from 1974 to 1975 (Gilbert et al., 1977). Part of this survey is reproduced in Figure 9-3.

FIGURE 6-1: 1996 KENNECOTT RESIDUAL GRAVITY



(Source: Trilogy Metals, 2011)

6.3 DRILLING AND UNDERGROUND WORKINGS

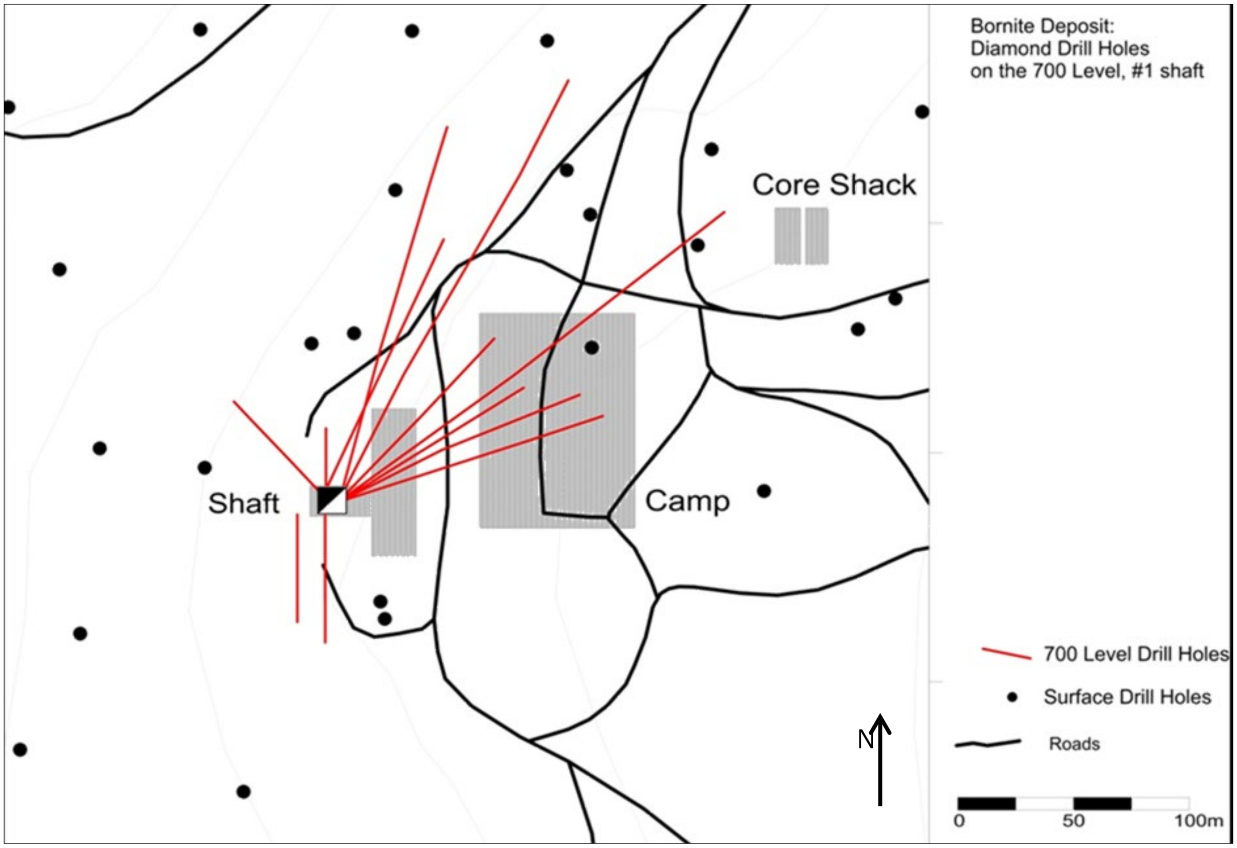
Between 1957 and 1997, Kennecott (BCMC) drilled 183 holes (including 51 underground holes) totalling 49,130 m. A complete and comprehensive discussion of all the drilling conducted at the Bornite deposit is contained in Section 10 of this report.

In October 1965, Kennecott began a shaft to further investigate the Ruby Zone Upper Reef “No.1 Ore Body” mineralization.

In 1966, the shaft reached the 297 m (975 ft) level. At this level, a 91 m crosscut was driven due north to the mineralized zone. The shaft was continued to 328 m (1,075 ft) deep to prepare a sump and loading pocket. On October 27, 1966, a small blast to excavate a bay at the bottom of the shaft opened a watercourse. The in-flood of water quickly exceeded the pump capacity and within 12 hours the 328 m shaft was flooded to within 13 m from the surface (Hawke, 1966). Prior to the shaft flooding, five diamond drill holes were completed from the 700-level shaft station and 21 drill holes from the 975-shaft station and crosscut.

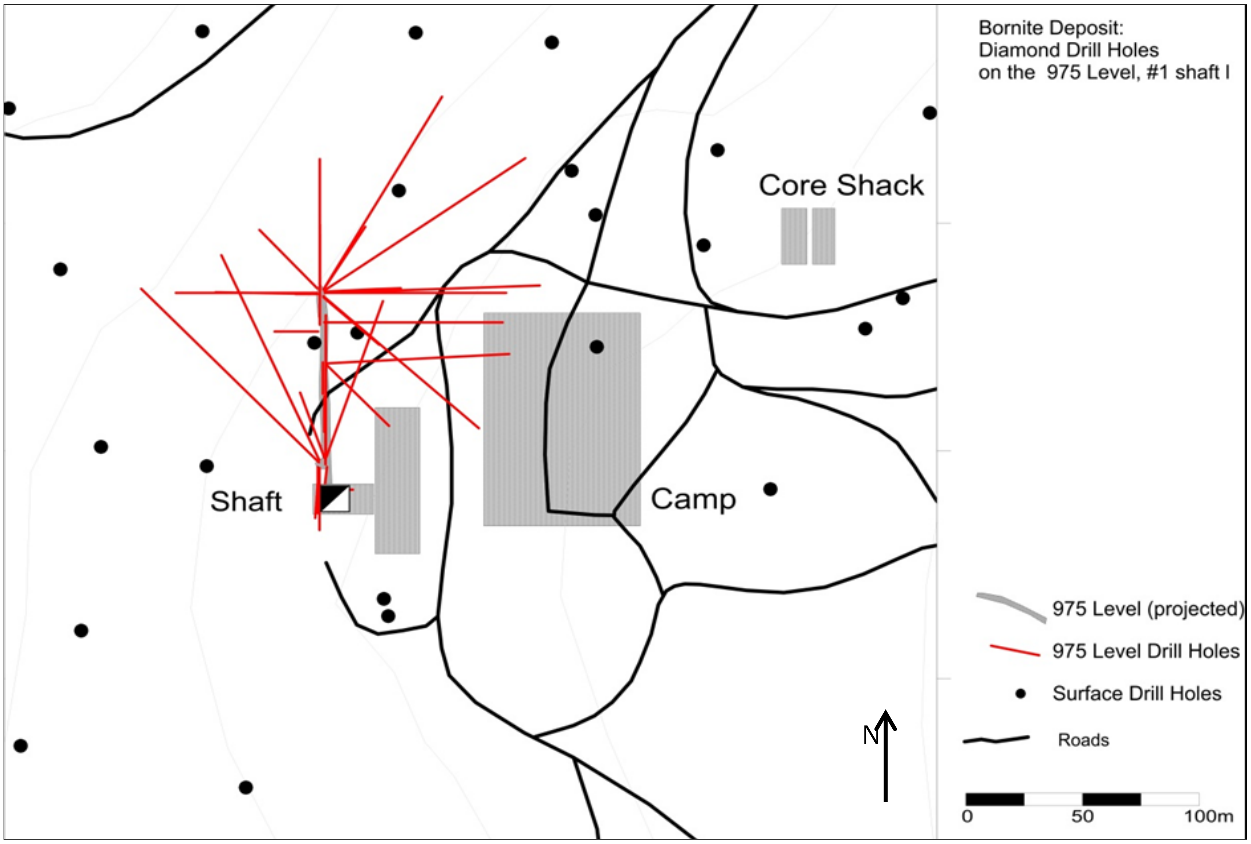
In 1967, the shaft bottom was partially sealed and then pumped out, and an additional 25 holes were drilled from the 700 level and the 975 level shaft stations. Figures 6-2 and 6-3 show underground diamond drilling from the 700 and 975 levels, respectively.

FIGURE 6-2: DIAMOND DRILLING FROM THE 700 LEVEL OF THE NO. 1 SHAFT



(Source: Trilogy Metals, 2017)

FIGURE 6-3: DIAMOND DRILLING FROM THE 975 LEVEL OF THE NO. 1 SHAFT



(Source: Trilogy Metals, 2017)

6.4 PETROLOGY, MINERALOGY, AND RESEARCH STUDIES

Several studies have been conducted to review the geology and geochemistry of the Bornite deposit. Most notable is Murray Hitzman's PhD dissertation at Stanford University (Hitzman, 1983) and Don Runnel's PhD dissertation at Harvard University (Runnels, 1963). Bernstein and Cox reported on mineralization of the "No. 1 Ore Body" in a 1986 paper in Economic Geology (Bernstein et al., 1986).

In addition to the historical work, Ty Conner at the Colorado School of Mines completed a Master's thesis which reported on the timing of alteration and mineralization at the Bornite deposit (Conner, 2015), and Zachary Mahaffey at University of Alaska Fairbanks completed a Master's thesis on the mineralogical associations and distribution of cobalt at the Bornite deposit (Mahaffey, 2021).

6.5 GEOTECHNICAL AND HYDROLOGICAL STUDIES

Kennecott conducted two technical reviews of the groundwater conditions (Vance, 1962) and a summary of the findings related to the flooding of the exploration shaft (Erskine, 1970).

6.6 METALLURGICAL STUDIES

In 1961, Kennecott collected 32 coarse reject samples from five drill holes to support preliminary metallurgical test work at Bornite. Samples targeted high-grade (> 10%) copper mineralization from the Upper Reef at the Ruby Zone (Lutz, 1961). An extensive discussion of the historical and current metallurgical studies is presented in Section 13 of this technical report.

6.7 HISTORICAL MINERAL RESOURCE ESTIMATES

All of the historical mineral resource estimates presented in Section 6.7 were completed prior to the implementation of NI 43-101. They do not conform to NI 43-101 reporting standards and should not be relied upon or interpreted as such. These historical resource estimates were stated in various company documents or reports which do not contain any details describing the methodology used and, as a result, a QP has not done sufficient work to consider the historical estimates as current mineral resources. They are presented here for information purposes only.

6.7.1 LUND (1961)

The earliest and most widely repeated resource number reported 91 million tons at 1.2% Cu in an unconstrained polygonal mineral resource estimate. At a constrained 1% Cu cut-off grade, 21.2 million tons of 3.04% Cu and at a 2.5% Cu cut-off, 5.2 million tons of 5.83% Cu were reported. The estimation is based on an 11.0 ft^3/ton tonnage factor for the Lower Reef or lower grade mineralization and a 10.0 ft^3/ton tonnage factor for the higher grade Upper Reef mineralization. It is not known if the tonnage factors were based on any direct specific gravity measurements of The Bornite drill core. Metals, such as silver and cobalt, were not considered in any of the historical estimations.

6.7.2 C.T. PENNEY (1968)

This estimate is restricted to the “No.1 Ore Body” in the Ruby Zone. The reported mineral resource is 180,000 to 200,000 tons at 8.4% Cu. There is no cut-off criteria included with this historical mineral resource estimate.

6.7.3 REED (1971)

This mineral resource estimate is (apparently) tabulated using an unknown grade times thickness (copper x thickness) cut-off criterion. It includes both Ruby Zone Upper Reef and Lower Reef mineralization with a reported total of 35.7M tons at 2.15% Cu.

6.7.4 SICHERMANN (1974)

This estimate used a polygonal methodology and is not considered entirely accurate as down-hole surveys were not available for all drill holes and mineralization lenses were observed to be erratic. A 10.5 ft^3/ton tonnage factor for >1% Cu mineralization and an 8.0 ft^3/ton tonnage factor for >4% Cu mineralization was applied. Two different mineral resource estimates were reported: 5 million tons (4.56 million tonnes) at 4% Cu and 40 million tons (36.2 million tonnes) at 2% Cu, respectively, without reporting cut-off grades.

6.7.5 KENNECOTT (1997)

In 1997, Macfarlane conducted a more rigorous mineral resource estimation of the Ruby Zone (Bornite) deposit. This estimation used Vulcan™ 3D modelling and mineral resource estimation software. A series of grade shells at 0.2%, 0.5% and 1.0% Cu were manually constructed on sections and imported into Vulcan. Within each shell, separate mineral resource calculations at 0.5%, 1.0%, 2%, and 4.0% Cu cut-off grades were made. The grade shells were constructed irrespective of various lithology or mineralization styles. Attempts to create meaningful semi-variograms for copper mineralization were reportedly unsuccessful. An inverse distance-squared weighting methodology was used to estimate the mineral resource. Results are shown in Table 6.1.

TABLE 6.1: BORNITE (RUBY ZONE) HISTORICAL RESOURCE (KENNECOTT, 1997)

Cut-off (% Cu)	0.2% Grade shell		0.5% Grade shell		1% Grade shell	
	Tonnage (M tonnes)	Grade (Cu %)	Tonnage (M tonnes)	Grade (Cu %)	Tonnage (M tonnes)	Grade (Cu %)
0.5	71.6	1.24	40.5	1.41	17.1	2.02
1.0	27.0	2.09	22.3	1.92	14.2	2.26
2.0	6.6	4.48	4.7	4.02	4.0	4.39
4.0	2.2	8.06	1.5	7.15	1.1	9.54

In an absence of actual measured densities, Kennecott used an approximation of the specific gravity based on the relationship of copper grade to specific gravity. No support for this approach was presented. Macfarlane noted: Using the method, tonnages for massive pyrite areas with low-grade copper were significantly underestimated.

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGY

The Bornite Project is located within the Arctic Alaska Terrane, a sequence of mostly Paleozoic continental margin rocks that make up the Brooks Range and North Slope of Alaska (Moore, 1992). It is within the Phyllite Belt geologic subdivision, which together with the higher metamorphic grade Schist Belt, stretches almost the entire length of the southern Brooks Range and is considered to represent the hinterland of the Jura-Cretaceous Brookian orogeny. The southern margin of the Phyllite Belt is marked by mélange and low-angle faults associated with the Kobuk River fault zone, while the northern boundary is thought to be gradational with the higher grade metamorphic rocks of the Schist Belt (Till et al., 2008).

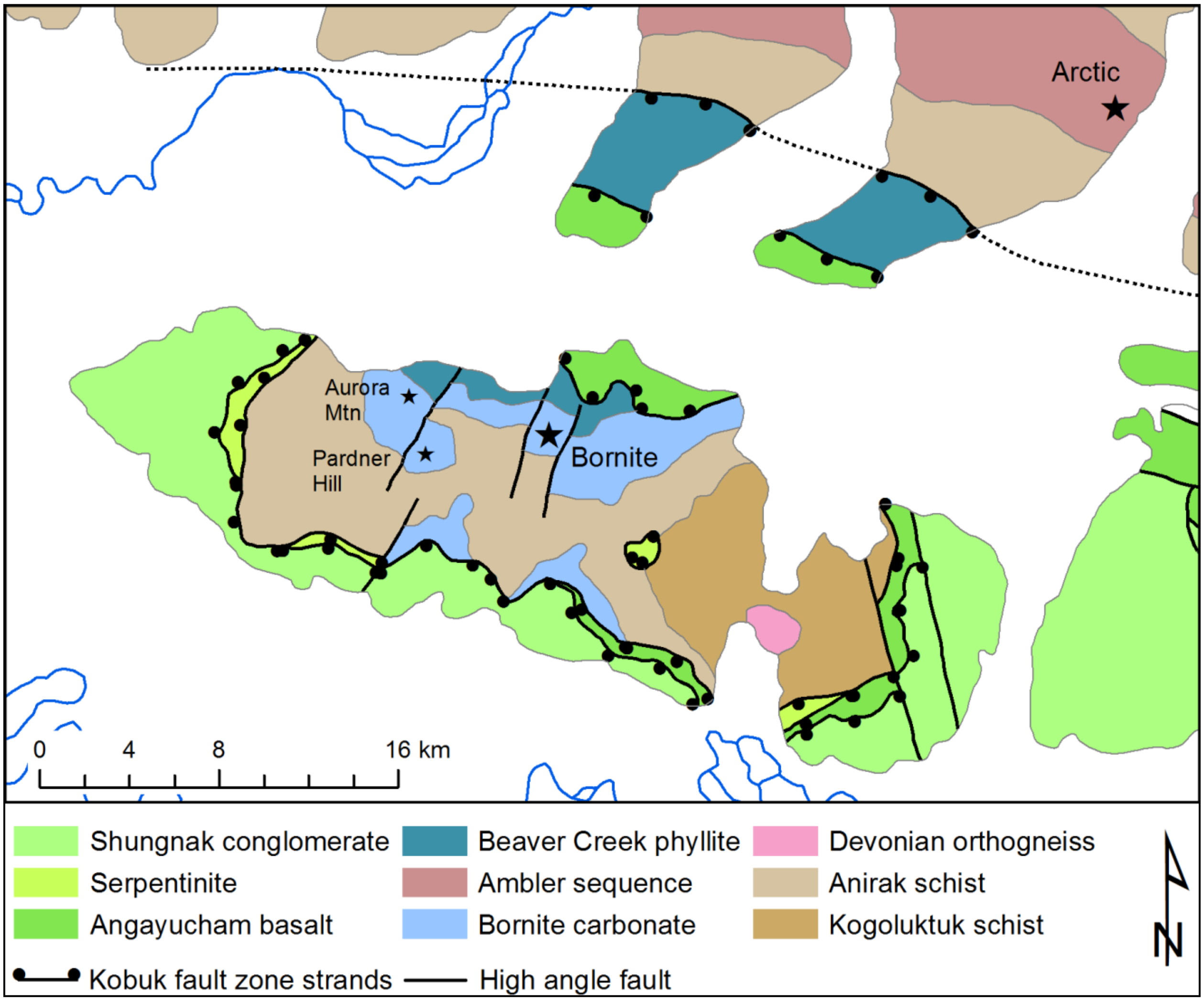
7.2 TECTONIC AND METAMORPHIC HISTORY

The tectonic setting of the project area during deposition of the host rocks (early Devonian) has been masked by subsequent Brookian deformation and remains difficult to reconstruct. Dillon et al. (1980) interpreted the existence of Devonian granites throughout the Brooks Range as supporting a volcanic arc environment, while Hitzman et al. (1986) pointed to bimodal volcanic rocks and abrupt lateral sedimentary facies transitions as supporting an extensional tectonic setting. Based on igneous geochemistry, Ratterman et al. (2006) suggest that the Ambler sequence volcanic rocks were emplaced in an extensional back-arc spreading environment; however, the original pre-deformation spatial relationship between the Bornite Project area and the Ambler sequence remains poorly understood.

The project area underwent regional deformation and metamorphism during the Middle Jurassic to Early Cretaceous Brookian orogeny. The collision of the Koyukuk Arc Terrane from present-day south caused north-directed imbrication and partial subduction of the Arctic Alaska passive margin sedimentary succession. Rocks in the Schist Belt were metamorphosed to blueschist facies. The Schist Belt and the Phyllite Belt were exhumed from greenschist facies conditions during an episode of rapid extension and erosion in the Late Cretaceous beginning around 103 Ma (Moore et al., 1994; Vogl et al., 2003). Mapping conducted in 2021 found kinematic indicators in the Cosmos Hills that suggest these rocks have experienced top-south deformation.

In the project area, the low-angle Kobuk fault zone juxtaposes the Cosmos Hills stratigraphy (Schist Belt and Phyllite Belt) against the overlying Angayucham Terrane, and another low-angle fault likely juxtaposes the Cosmos Hills against the Ambler sequence to the north (Figure 7-1). Bornite sequence carbonate rocks are also in low-angle fault contact with the structurally underlying Anirak schist and the overlying Beaver Creek phyllite.

FIGURE 7-1: GENERALIZED GEOLOGIC MAP OF THE COSMOS HILLS



(Source: Modified from Till et al., 2008 and Hitzman, 1986)

7.2.1 REGIONAL STRATIGRAPHY

The tectonostratigraphy of the district is characterized by pelitic, carbonate and local volcanic rocks metamorphosed to lower greenschist to epidote-amphibolite facies as shown in Figure 7-1 and summarized in Table 7.1.

TABLE 7.1: TECTONO-STRATIGRAPHIC UNITS OF THE COSMOS HILLS AREA

Unit (age)	Lithology	Metamorphic Grade	Approximate Thickness
Shungnak conglomerate (Cretaceous)	Pebble conglomerate, sandstone, siltstone, minor intermediate volcanics	Almost Unmetamorphosed	1,000 m
Angayucham terrane (Devonian-Mississippian) (allochthonous)	Pillow basalt, pillow breccia	Prehnite-Pumpellyite	>500 m
Beaver Creek phyllite (Devonian*)	Phyllite, quartzite, marble	Lower Greenschist	>2,000 m
Ambler sequence (Devonian*)	Metarhyolite, metabasite, tuffaceous metasediments, calcareous metasediments, pelitic schist	Blueschist to Greenschist	700–1,850 m
Bornite carbonate sequence (Lower Devonian to Upper Silurian*)	Marble, argillaceous marble, dolostone, phyllite, phyllitic marble	Lower Greenschist	200–1,000 m
Anirak schist (Devonian*)	Pelitic schist, quartzite, marble, minor metabasite	Greenschist	3,000 m
Kogoluktuk schist (Precambrian to Devonian*)	Pelitic schist, quartzite, metagabbro, minor marble	Epidote-Amphibolite	4,000 m

(Source: Modified from Hitzman et al., 1986, *Ages from Till et al. 2008)

7.2.2 IGNEOUS ROCKS

The intersection of the Cosmos Arch and the Kogoluktuk River drainage 14 km southeast of Bornite exposes a cataclastic orthogneiss of granitic composition that intrudes the Kogoluktuk Schist and has a uranium-lead (U-Pb) zircon age of 386 ± 3 Ma (Till et al., 2008, citing W.C. McClelland).

Higher in the tectono-stratigraphic section, the Kogoluktuk Schist is intruded by sub-horizontal sill-like bodies of metagabbro of unknown age. Other metamafic “greenstones” are interpreted to have originated as basaltic lava flows and/or tuffaceous volcaniclastic sedimentary rocks (Hitzman, 1986).

Although none occur in the Bornite resource area, discontinuous stratabound greenstone bodies occur in the Anirak schist and at the base of the Bornite carbonate succession, particularly west and southwest of Bornite, including at Aurora Mountain and near the base of the Beaver Creek phyllite west of Bornite (Hitzman et al., 1982). A gabbroic outcrop approximately 200 m wide is exposed 2 km east of Bornite that has been interpreted to be Cretaceous to Tertiary in age.

The most significant igneous rocks in the district are the bimodal volcanic rocks of the Ambler sequence that hosts VMS deposits and outcrop 20 km north of Bornite but are not observed in the Cosmos Hills (Table 7.1). These include sub-alkaline basaltic flows and sills with an un-depleted mantle geochemical signature. Sub-alkaline rhyolitic to andesitic tuffs and flows have geochemistry consistent with derivation from a source that includes melting continental crust. Geochemical data imply an origin in an extensional, back-arc basin setting (Ratterman et al., 2006). U-Pb zircon dating from Ambler sequence metarhyolites yields ages of 387–376 Ma (McClelland et al., 2006), which are syn- to early post-mineralization with respect to the Bornite (Ruby Zone) deposit.

7.2.3 Timing of Mineralization in the District

Sulphides (chalcopyrite, pyrite, and bornite) from Bornite (Ruby Zone) were dated by rhenium–osmium (Re-Os) techniques, yielding an age of 384 ± 4.2 Ma for main stage copper mineralization (Selby et al., 2009).

More recent work (Conner, 2015) suggests a post Jura-Cretaceous (i.e., Post-Brookian) age for mineralization based on 1) albite alteration associated with the mineralizing event cross-cuts the pronounced Jura-Cretaceous penetrative fabric at Bornite, and 2) the common presence of cymrite, a barium-rich blueschist-stable metamorphic mineral related to the Jura-Cretaceous deformation is common within all the various mineralized assemblages. The Re-Os ages appear to be contradictory to the Conner (2015) geologic observations, and it seems unlikely for Re-Os to retain a syn-sedimentary age in a metamorphosed and orogenically modified terrane. The question of whether or not sulphides at Bornite are deformed by, cross-cut, or lie in the plane of Brookian deformation still needs to be further investigated.

The syngenetic VMS deposits in the Ambler sequence are constrained by dating of related felsic volcanic rocks. Early post-mineral metarhyolite at the Arctic deposit yielded a mean U-Pb zircon age of 378 ± 2Ma. Uranium-lead zircon ages for metarhyolite at the Tom-Tom prospect, 11 km east of Arctic, and the Sun prospect, 60 km east of Arctic, are 381 ± 2 Ma and 386 ± 2 Ma, respectively (McClelland et al., 2006) suggesting that felsic magmatism migrated west over time.

7.3 Deposit Geology

The geology of the Bornite resource area is composed of alternating intervals of carbonate rocks (limestone and dolostone) and calcareous phyllite. Limestone transitions laterally into dolostone near zones of mineralization and is considered to be hydrothermally altered. Spatial relationships and petrographic work suggest that dolomitization is genetically related to early stages of the copper mineralizing system (Hitzman, 1986); however, recent re-logging has questioned this view.

Trilogy Metals geologists have been unable to identify any meta-igneous rocks in the resource area; all lithologies described are interpreted as meta-sedimentary in origin.

7.3.1 Lithology Units

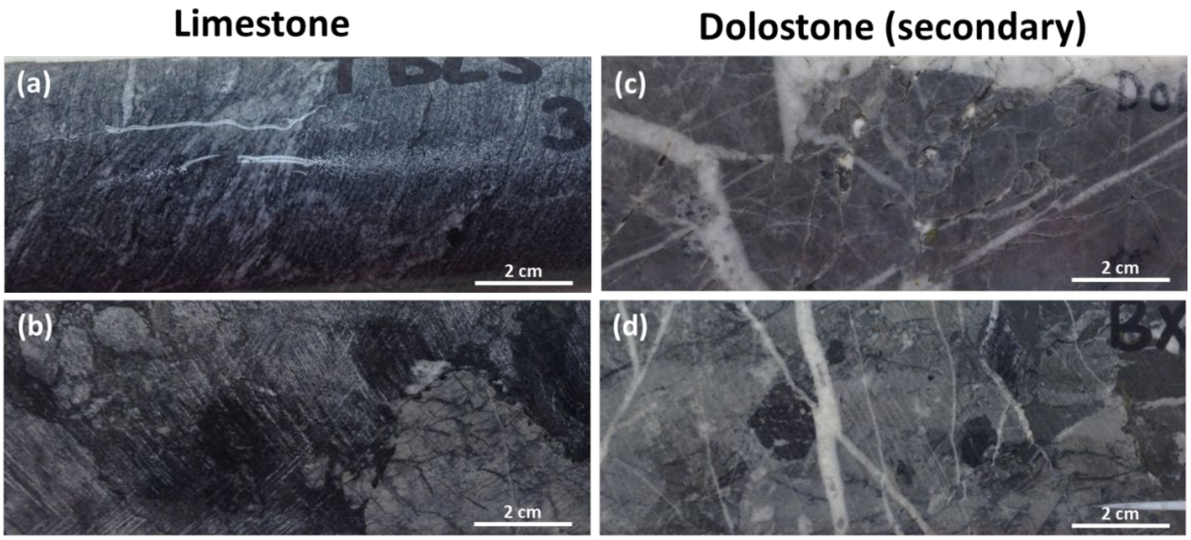
The current logging system for lithology derives from early BCMC core logs (1960). Original unit descriptions have not been found; however, the units were re-described during re-logging by NovaGold geologists in the summer of 2010. The scheme encompasses not only primary lithology, but also alteration, and compositional and textural variations. Resource-scale geologic interpretation and modelling is based on the hierarchical generalization shown in Table 7.2.

Figure 7-2 shows typical dolomitized sedimentary breccias of the Bornite carbonate sequence, which are the principal host of mineralization at Bornite. Figure 7-3 shows typical phyllites of the Bornite carbonate sequence.

Table 7.2: Lithology Units on the Bornite Property

	Lithology	Codes	Description
Carbonate	Limestone	BXLC, LS, TBLS	Carbonate sedimentary breccia consisting of 10% to 90% polylithic carbonate clasts supported in a calcareous matrix. Clast lithologies include limestone, dolostone, ferroan dolostone, and locally massive pyrite.
	Dolostone (secondary)	BXDC, DOL, ADP	Dolomitized carbonate sedimentary breccia consisting of abundant (±90%), polylithic clasts (0.5 to 50 cm in diameter). Host for mineralization at Bornite.
Phyllite	Carbonaceous Calcareous Phyllite	AP, ALP, APL, ALS, ALCB	Weakly to moderately carbonaceous calcareous phyllite defined by presence of a significant (5 to 95%) shale-rich component in the carbonate section. Phyllites commonly act as limits or delimit mineralized bodies.
	Bleached Calcareous Phyllite	TS, TLP, TPL, CHPL	Texturally similar to the carbonaceous calcareous phyllite described above and interpreted as altered equivalents. Commonly characterized by strong sericite component historically misidentified as talc.
Anirak Schist	Quartz Phyllite (Anirak Schist)	QPh	Moderately graphitic quartz-rich-phyllite, locally moderately calcareous.

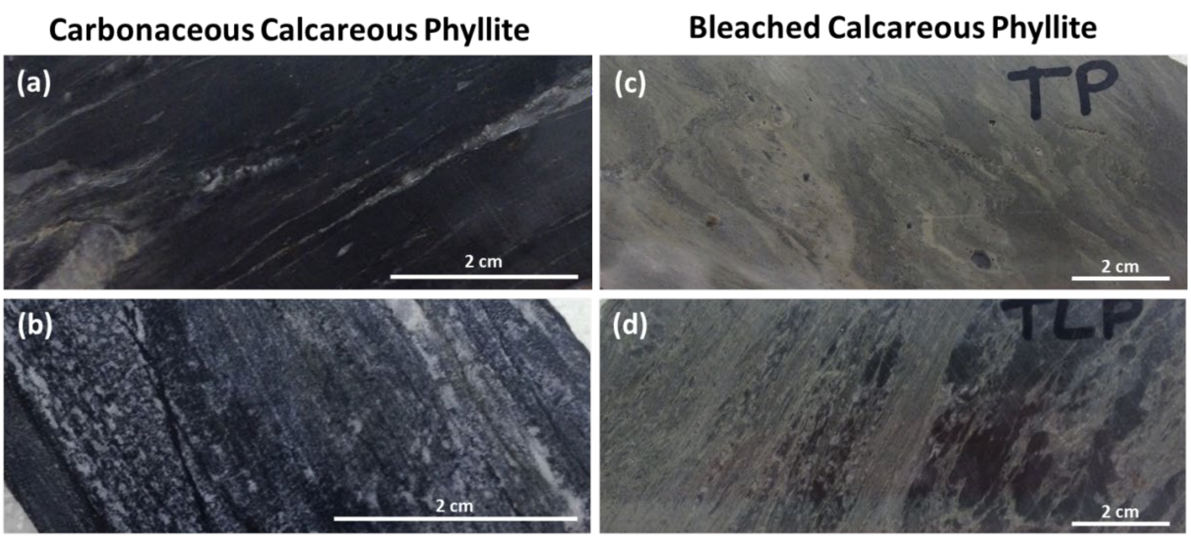
FIGURE 7-2: TYPICAL LIMESTONES AND DOLOSTONES OF THE BORNITE CARBONATE SEQUENCE



(Source: Trilogy Metals, 2017)

(a) Thin Bedded Limestone (TBLS): Limestone textural variant with 1 mm scale banding of light and dark grey carbonaceous seams; (b) Limestone Clastic Breccia (BXLC): Carbonate sedimentary breccia with carbonate clasts in a calcareous, locally phyllitic matrix; (c) Dolostone (DOL): Partially dolomitized carbonate with late dolomite-calcite veining; (d) Dolostone Clastic Breccia (BXDC): Polylithic clasts of dolostone in a dolostone matrix. Hydrothermal matrix or veins (low Fe) dolomite, pyrite, +/- calcite, chalcopyrite, bornite, sphalerite.

FIGURE 7-3: TYPICAL PHYLLITES OF THE BORNITE CARBONATE SEQUENCE



(Source: Trilogy Metals, 2017)

(a) Argillaceous/Carbonaceous Phyllite (AP): Carbonaceous to graphitic, weak to moderately calcareous phyllite with >75% phyllosilicates. Typically 1-2% pyrite; (b) Argillaceous/Carbonaceous Phyllitic Limestone (APL): Carbonaceous limestone (marble) with 5-20% phyllosilicates, especially in dark bands. Typically 1-2% pyrite; (c) Tan Phyllite (TP): Non-carbonaceous, weak-mod calcareous phyllite with > 75% phyllosilicates. Typically contains 1-2% fine-grained pyrite; (d) Tan Phyllitic Limestone (TPL): Non-carbonaceous limestone (marble) with 5-20% phyllosilicates, including white mica. Typically contains 1-2% very fine grained pyrite.

In 2015, Trilogy Metals made an effort to improve the understanding of the distribution and nature of the various lithologic units and their context within a sedimentary depositional model. A new interpretation, based on lithogeochemical signatures of the various units along with their historical visual logging, concluded that stacked debris flows composed of basal non-argillaceous channelized breccias were overlain by upward fining increasingly argillaceous breccias and capped by high calcium (Ca) phyllites occupying channels cut into either massive or thin-bedded carbonates.

Two mineralized stacked debrite successions were named the Lower and Upper Reefs. The Upper Reef grades upward into argillaceous limestones instead of discrete high Ca phyllites indicating a waning of debris supply. Based on this interpretation, a series of individual debrites were identified, and these units form the basis of the mineral resource model presented in Section 14.

In contrast to the locally derived high-Ca phyllites of the debrite-dominated Bornite carbonate sequence, low calcium (Ca) phyllites are abundant in the allochthonous Anirak schist (quartz phyllite) and the Beaver Creek phyllite that underlie and overlie the Bornite carbonate sequence, respectively.

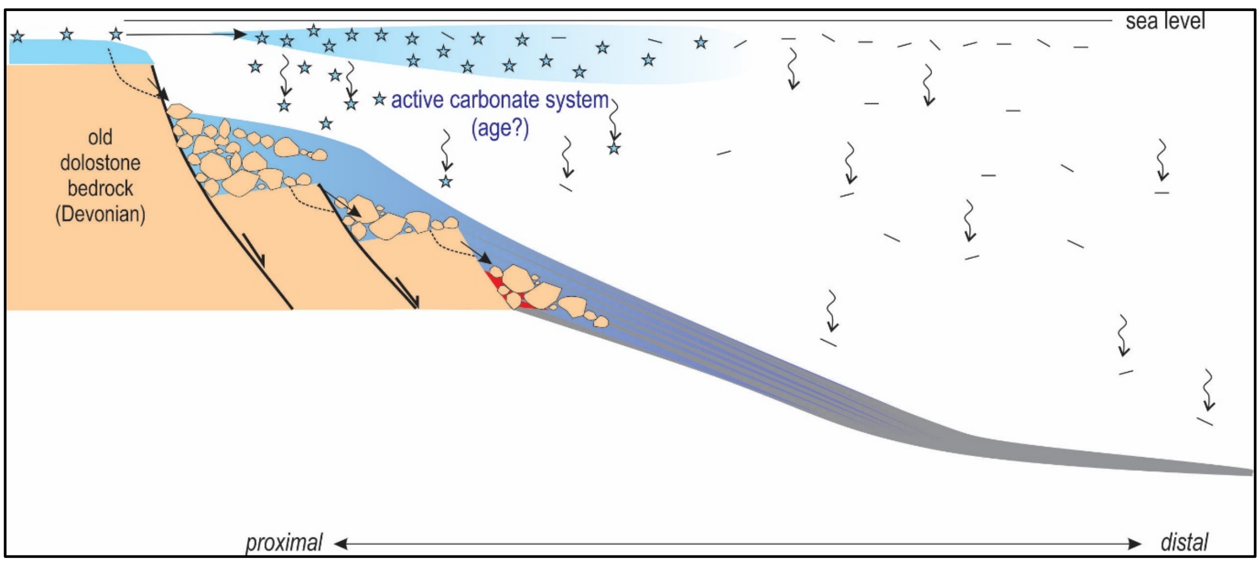
In addition to depositional lithostratigraphy, a crosscutting mineralized breccia called the “P-Breccia” has been identified in and around the South Reef deposit. Though poorly defined due to lack of drilling in the area, the P-Breccia zone—which contains excellent copper grade—lies at the apex of the Iron Mountain discontinuity. Although clearly post-deformational, it remains unclear whether the P-Breccia is a post-depositional structural, hydrothermal or solution-collapse breccia.

A short lithostratigraphic project carried out during the 2021 field season updated the depositional environment of the Bornite succession; this resulted in significant differences when compared to the previously summarized interpretations. The Bornite succession is now understood to be a carbonate slope deposit characterized by (a) lime mudstone, exported to the slope from a contemporaneous shallow-marine carbonate factory, variably mixed with and interlayered with (b) “background” argillaceous sediment that is locally carbonaceous. Superimposed on these calcite-dominated “normal” slope strata are locally impressive thicknesses of dolomudstone-clast conglomerate (formerly “breccia”). Slope limestone and siltstone-mudstone were originally centimetrically to decimetrically bedded, but are commonly ductilely deformed, producing the variably limey ‘phyllites’ that exhibit sub-mm scale foliation. In contrast, the dolostone-clast conglomerates and individual dolomudstone clasts responded brittlely to Brookian stress and show no significant shearing or plastic deformation. Instead, plastic deformation is largely restricted to the various phyllitic layers around the peripheries of the dolostone bodies.

7.3.2 LITHOLOGY INTERPRETATION

The current lithostratigraphic understanding does not support the historical Kennecott interpretation of a talus-dominated fore-reef environment for the development of the high-energy carbonate breccias. The results of the 2021 lithostratigraphy project indicate that no reef is present in the area. Although there are minor debrites of slope-derived lime mudstone and calcareous siltstone casts, the dolomudstone-clast conglomerates are not the product of the active, “normal” carbonate system that produced lime mud that accumulated on the slope. Instead, the dolomudstone clasts are interpreted to have been derived from anomalous faulted sea-floor scarps that exposed older, unrelated dolostone bedrock to gravitational failure, resulting in deposition of dolostone-clast conglomerates by rockfall at and near scarp bases, and their further resedimentation downslope, mixed into the calcareous slope sediment as debrites (Figure 7-4). The syn-sedimentary faults that shed the conglomerates were probably the result of extension during accumulation of the Bornite succession. They also possibly acted as later conduits for mineralizing fluids. Dolostone-clast conglomerates are the main hosts of copper mineralization at Bornite, which is concentrated where the Bornite strata are most doloclast-conglomerate-rich.

FIGURE 7-4: SCHEMATIC CROSS SECTIONAL DIAGRAM OF CARBONATE ENVIRONMENT SHOWING POSITION OF MINERALIZATION (RED)



(Source: Turner, 2021)

7.3.3 STRUCTURE

Structural fabrics observed on the property include rare bedding and two distinct metamorphic foliations. Bedding (S0) can be measured only rarely where phyllite and carbonate are interbedded, and it is unclear to what extent it is transposed. The pervasive foliation (S1) is often mylonitic and exhibits both an imprinted stretching lineation and preferred “top” direction. It is easily measured in phyllites and is commonly reflected by colour banding and/or stylolamination (flaggy habit in outcrop) of the carbonates. Some limestone outcrops, in particular the "TBLS" on Aurora Mountain and the marbles at the base of Coral Hill, also exhibit a stretching lineation. Core-logging shows that S1 is folded gently on a 10 m scale and locally tightly folded at the decimetre scale forming a common S2 axial planar cleavage. S2 is folded gently on a 10 m scale forming an upright mesoscale S3 foliation. S1 and S3 foliations are thought to be Jura-Cretaceous in age.

Structural mapping in 2021 recognized a well-developed stretching lineation (i.e., L-tectonite) in the carbonate-phyllite rocks, typically oriented shallowly towards the NNE or SSW. "Top" direction indicate movement to the S or SSW along the vector of the stretching lineation. Moreover, new mapping indicates that stiff Bornite rocks, in particular metric to hectametric dolostone bodies, have been boudinaged into 3-D ellipsoids. Slip is accommodated by phyllites. Additional mapping is required to determine whether such a tectonic style plays a role in the distribution of copper mineralization.

Owing to their greater rigidity, dolostone bodies of secondary dolostone manifest strain differently: tan hydrothermal dolostone tends to be broken into centimetre- to decimetre-scale blocks, whereas grey (diagenetic?) dolostone may exhibit unusual, contorted forms, some resembling human fingers or swan necks, as evident in outcrop. Dolostone is rarely cut by plastically deformed zones and instead forms metric to hectametric lenses ("augens") encased in plastically deformed calc-mylonite and calc-phyllite. This deformation, presumably a product of the Jura-Cretaceous Brookian orogeny, complicates sedimentological interpretations.

Possibly the earliest and most prominent structural feature in the resource area is the northeast-trending Iron Mountain fault or discontinuity, which is still problematic in its interpretation because it is a "cross structure" that strikes NE at a high angle to the overall Brookian structural trend, as well as that of the South Reef deposit. Numerous drill holes in the South Reef area intersect a thin zone of apparent basal quartz phyllite tectonostratigraphy overlying mineralized carbonate stratigraphy, a relationship that was also documented in a trench dug between Pardner Hill and Aurora Mountain in 2021.

Numerous explanations for the Iron Mountain discontinuity have been suggested, none of which completely accounts for all of the logged observations. Inadequate drilling through the feature into lower stratigraphy and the assumption that the basal quartz phyllite is in fact the "bottom" has limited its resolution. Interpretations offered over time, include: 1) a normal growth fault (that would date to the Devonian); 2) a thrust fault; 3) a kink or fault-propagation fold; 4) a quartz phyllite lens intercalated within the basal part of the carbonate sequence; and 5) a basement-involved drag fold formed during displacement of the Bornite sequence; and 6) a depositional unconformity. Interpretations 2 to 5 would all date to the Brookian orogeny.

Importantly, the recognition of the P-Breccia at or near the apex of the Iron Mountain discontinuity, and its interpretation as a post-depositional structural, hydrothermal, or solution-collapse breccia, suggests a post-lithification origin. Some data would also suggest that the P-Breccia is a syn-depositional slump related to the Iron Mountain discontinuity and the eastern terminus of the thin QP wedge, suggesting that the Iron Mountain structure was already present during the Devonian. Although the spatial distribution of mineralization adjacent to the Iron Mountain feature is unequivocal, a direct link between the discontinuity and mineralization has yet to be demonstrated.

To the north, the Bornite carbonate sequence is in low-angle normal fault contact with the Beaver Creek phyllite along the north-dipping Beaver Creek fault. The fault, a thick, brittle structure of potentially regional significance, defines the approximately bedding-parallel contact of the structurally higher Beaver Creek phyllite with the structurally lower Bornite carbonate sequence in the immediate Bornite area. However, the fault is absent further west, where these units lie in apparent stratigraphic contact.

Both the Beaver Creek fault and the Bornite carbonate sequence were in the past thought to be cut by a series of north-trending high-angle brittle faults of apparent small displacement as shown in Figure 7-1 (Hitzman et al., 1982). These structures have not been identified in outcrop or in drilling at Bornite and are no longer thought to exist. However, recent mapping on Aurora Mountain has identified two high-angle brittle normal faults that strike NW and WNW that have some 50–100 m of throw across them. This set of normal faults may wind up being present in other parts of the Cosmos Hills.

7.4 MINERAL DEPOSITS

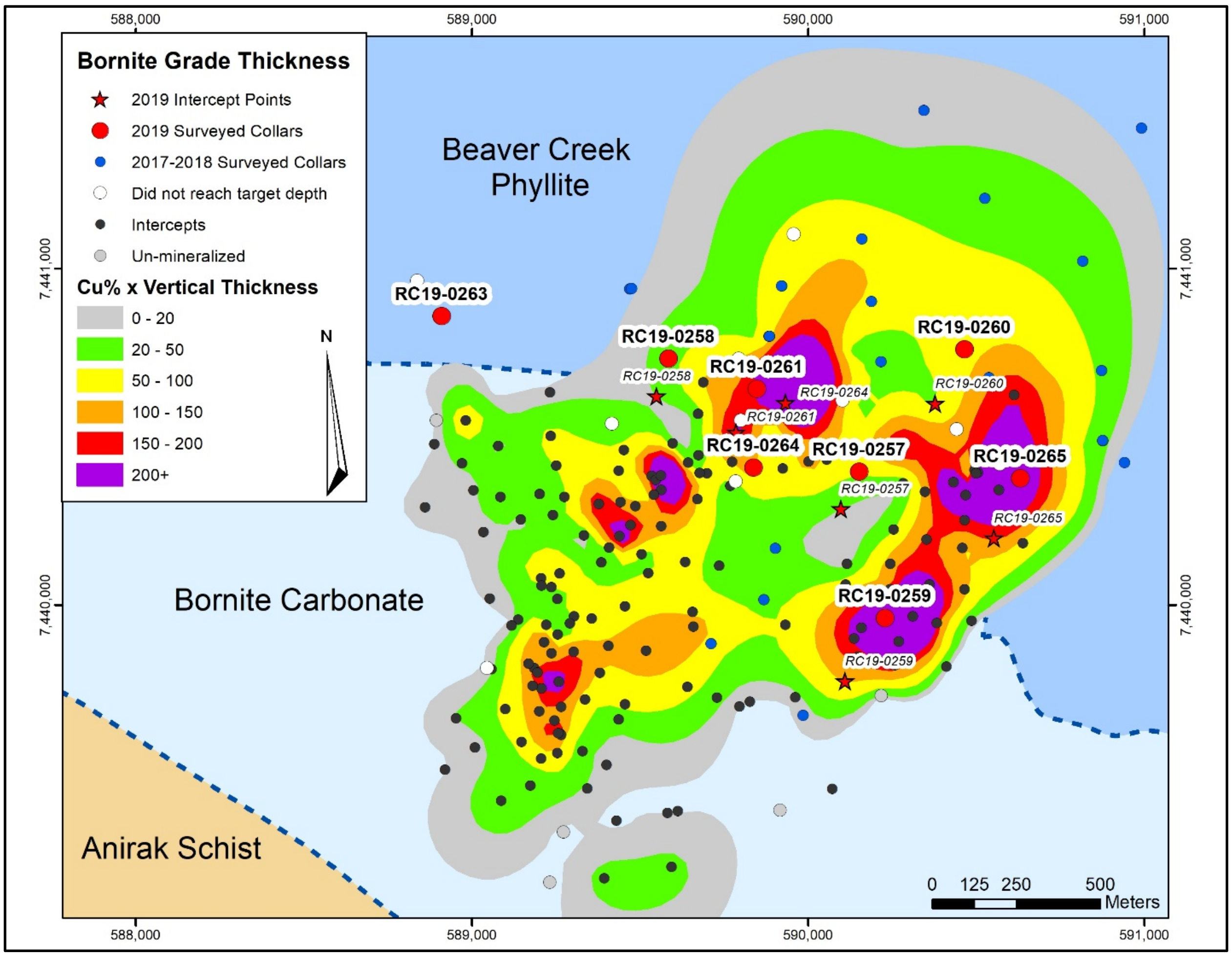
Mineralization at Bornite forms tabular mineralized zones that coalesce into crudely stratabound bodies hosted in dolostone conglomerate/breccia. Two significant dolomitic horizons that host mineralization have been identified by drilling and include: 1) the Lower Reef, a substantial 100 m to 300 m thick dolomitized zone lying immediately above the basal quartz phyllite unit of the Anirak schist and 2) the Upper Reef, a 100 m to 150 m thick dolomite horizon that sits roughly 300 m higher in the section. The Lower Reef is separated from the Upper Reef by a zone of ductilely sheared phyllites up to 60 m thick.

The Lower Reef dolostone outcrops along the southern margin of the Ruby Zone and is spatially extensive throughout the deposit area. It hosts a significant portion of the shallow mineral resources in the Ruby Zone as well as higher grade mineral resources down-dip and to the northeast in the South Reef area. The Upper Reef hosts relatively high-grade mineral resources to the north in the Ruby Zone. The Upper Reef zone appears to lie at an important NE- trending facies transition to the NW of the main drilled area and appears to be at least partially thrust over the Lower Reef stratigraphy to the southeast.

Drill results from 2013 show dolomitization and copper mineralization in the Upper and Lower Reefs coalescing into a single unit along the northern limits of current exploration. The NE-trending Ruby Zone and South Reef areas also coalesce into a roughly 1,000 m wide zone of >200 m thick dolomite containing significant copper mineralization dipping north at roughly 5 to 10 degrees. The 2017 drill results show that the mineralized dolomite interval continues for at least another 700 m down-dip to the northeast from mineralization in the Upper and Lower Reefs.

Figure 7-5 shows the grade thickness (Cu% x thickness in metres) distribution of copper mineralization for the Bornite deposit.

FIGURE 7-5: COPPER GRADE THICKNESS PLAN MAP FOR THE BORNITE DEPOSIT



(Source: Trilogy Metals, 2019)

7.4.1 Mineralization

Copper mineralization at Bornite comprises chalcopyrite, bornite, and chalcocite distributed in stacked, roughly stratiform zones exploiting favourable lithologies (conglomerate/breccia) within the Bornite sequence. Mineralization occurs, in order of increasing grade, as disseminations, irregular and discontinuous stringer-style veining, breccia matrix replacement, and stratabound massive sulphides. Figure 7-6 shows typical mineralization of the Bornite deposit characterized by chalcocite, bornite, chalcopyrite and pyrite.

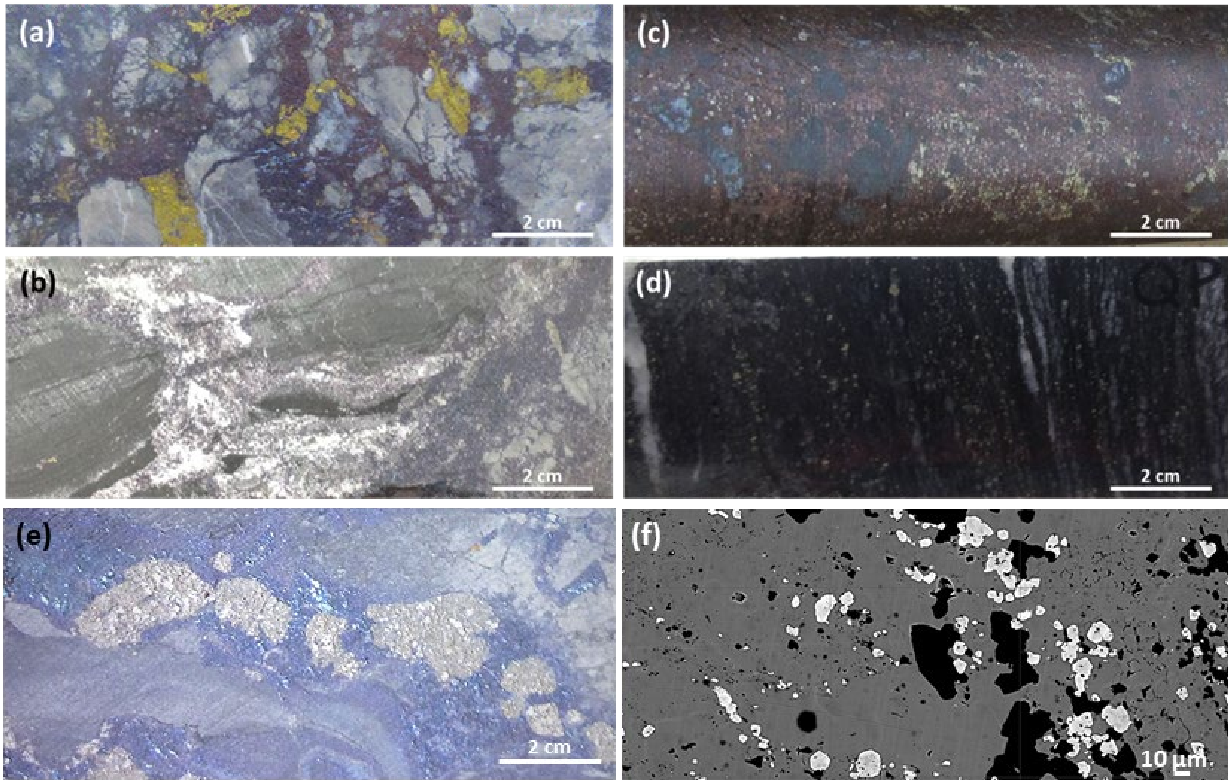
The distribution of copper minerals is zoned around the bottom-centre of each zone of mineralization, with bornite-chalcocite-chalcopyrite at the core progressing outward to a fringe of chalcopyrite-pyrite. Additional volumetrically minor copper minerals include carrollite, digenite, tennantite-tetrahedrite, and covellite (Bernstein and Cox, 1986). Stringer pyrite and locally significant sphalerite occur above and around the copper zones and locally massive pyrite and sparse pyrrhotite are associated with siderite alteration below copper mineralization in the Lower Reef.

Significant cobalt mineralization (for example, drill hole RC11-0187 with 34.7 m at 0.10% Co in the South Reef, and drill hole RC11-0184 with 5.5 m at 0.44% Co in the Upper Reef) is found accompanying bornite-chalcocite mineralization. Cobalt often occurs with high-grade copper as carrollite (Co_2CuS_4) and as cobaltiferous rims on recrystallized pyrite grains (Bernstein and Cox, 1986). Preliminary geometallurgical work by Trilogy Metals showed that cobalt occurs primarily as cobaltiferous pyrite (approximately 80% of the contained cobalt) and within other cobalt minerals, such as carrollite and cobaltite (CoAsS).

In 2021, as part of his Master's thesis, Mahaffey collected detailed handheld XRF analyses on 15 drill holes. Together with reflected light petrography, electron microprobe-based compositional maps, and electron microprobe analyses (EPMA), Mahaffey identified various carrollite and cobaltite compositions, textures and associations with copper sulphides as well as their spatial distribution in the Bornite deposit (Mahaffey, 2021).

Some appreciable silver values (for example, drill hole RC11-0184 with 5.5 m at 30.9 g/t Ag) are also found at Bornite, particularly in association with bornite-rich mineralization in the South Reef area and the Ruby Zone.

FIGURE 7-6: TYPICAL MINERALIZATION OF THE BORNITE DEPOSIT



(Source: Trilogy Metals, 2017)

(a) Typical high-grade chalcocite-bornite-chalcopyrite mineralization; commonly forms stringers, veinlets, disseminations, and breccia fillings; (b) Chalcocite (Cu_2S) appears dark grey to black, occurs in massive sulphide zones and typically replaces bornite. Note the boudinage of the carbonate beds in which the boudin necking zone is filled with white calcite; (c) Massive sulphide mineralization, chalcocite-bornite-chalcopyrite of the historically termed "No. 1 Ore Body" Upper Reef - Ruby Creek; (d) Typical disseminated 1-2% pyrite in ductilely deformed Quartz Phyllite – Rock unit defines the base of the Bornite carbonate sequence, equivalent to the Anirak schist; attenuated foliation parallel white quartz stringers indicate significant ductile deformation has occurred in this unit; (e) Coarse-grained carrollite (Co_2CuS_4) appears shiny and highly reflective resembling aluminum foil and is often found associated with high-grade copper zones; (f) back-scattered electron image showing cobaltite (white rounded grains) growing on chalcopyrite (dark gray).

7.4.2 ALTERATION

A long-held view regarding alteration at Bornite assumes that dolomite is the predominant product of hydrothermal alteration. Dolomite is particularly pronounced in 1) certain massive carbonate units; 2) the Lower and Upper Reef debris flow breccias; and 3) the P-Breccia and in some outcrops in the district, especially in the Pardner Hill area. Similar to the trend in copper grade, more intense and complete dolomitization is expressed at the base of both the Lower and Upper Reefs.

Importantly, copper grade generally has a positive correlation with the intensity of dolomite alteration expressed as Ca/Mg ratios of 0.4 to 0.67. Fe-compositions of the carbonates show a significant negative correlation with copper grade. High Fe carbonate species, such as siderite and Fe-rich “ferroan” dolomite, exhibit almost no grade, whereas low Fe dolomites show strong copper mineralization.

The spatial distribution of the Fe-rich dolomites is zoned with high Fe siderite and ankerite localized down the plunge of the lowermost desbrites in the Lower Reef. Low Fe dolomites, zoned around this basal core of high Fe dolomites, are well mineralized and form an annulus or horseshoe around the core of unmineralized Fe-rich carbonates between the Ruby Zone and the South Reef area. Figure 7-7 shows an oblique NW-looking view of the interpolated distribution of high Fe siderite and ankeritic dolomites surrounded by mineralized low Fe dolomites.

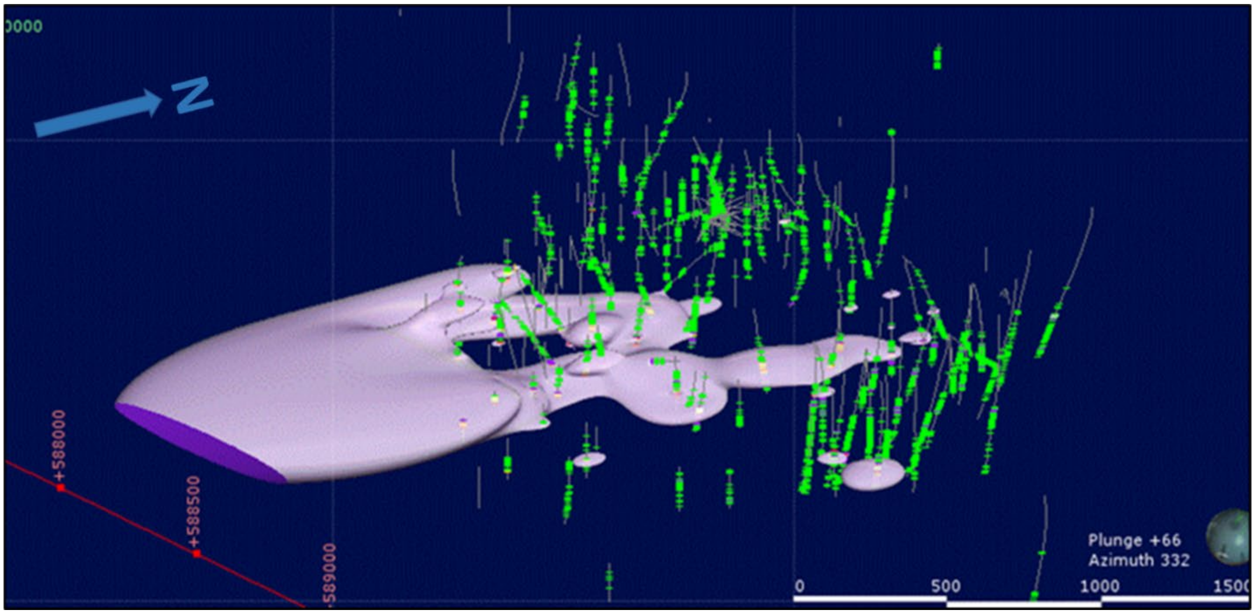
The overall dolomite alteration pattern suggests sourcing of a mineralizing fluid from the south and transport to the north down the principal axes of coarse-grained debris flows. Of critical importance is the limit of Fe-dolomites and the strongly open down-dip extension of low Fe dolomites. This supports the possible continuation of significant grade down-dip on the combined Lower Reef/South Reef extension and could constitute a very effective targeting tool elsewhere in the district.

Alteration within the high calcium (Ca) phyllites capping successive debrites is expressed as albitization of pre-existing K-feldspar and the development of Mg-phengite at the expense of early detrital muscovite, biotite and chlorite. Increased albite and Mg-phengites are characteristically seen as bleaching of the high calcium (Ca) phyllites with highest intensities of alteration immediately below strong copper mineralization in the debrite breccias.

Work in 2021 suggests that dolostone (dolomite) may occur primarily or only as clasts within conglomerate (breccia) and pre-dates mineralization. Additional work is needed to resolve this important discrepancy.

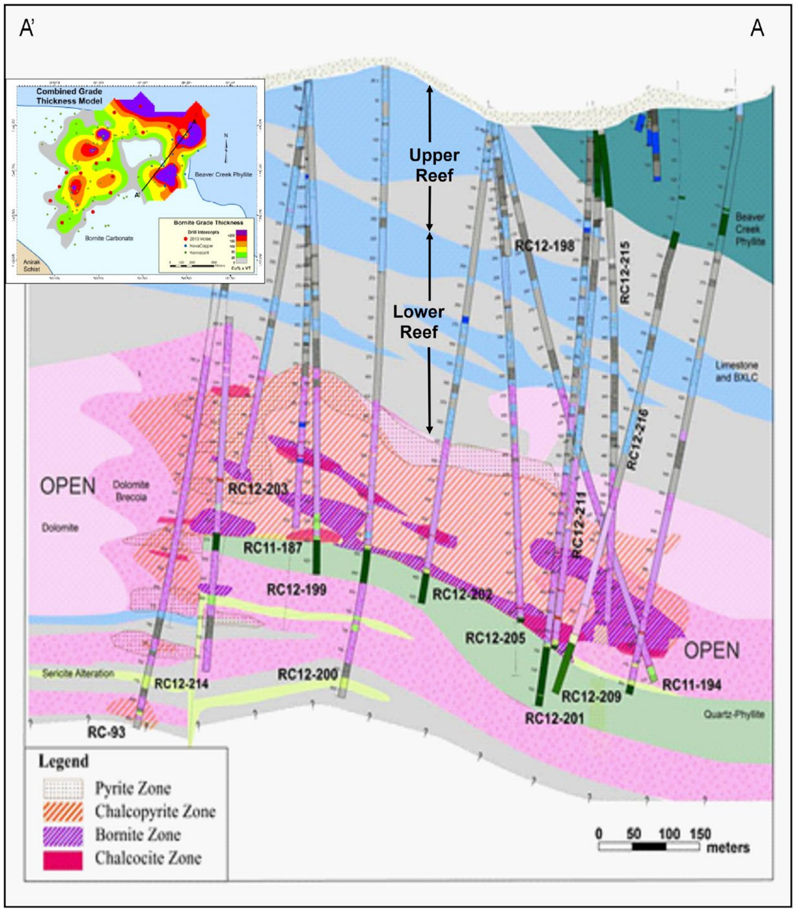
Figure 7-8 shows a southwest-northeast-trending schematic cross section across the South Reef, showing geology, mineralization, and alteration.

FIGURE 7-7: INTERPOLATED HIGH FE SIDERITE/ANKERITE ALTERATION (IN PINK) WITH SURROUNDING LOW FE MINERALIZED DOLOMITES (IN GREEN) - OBLIQUE VIEW LOOKING NW



(Source: Trilogy Metals, 2016)

FIGURE 7-8: SW-NE SCHEMATIC CROSS SECTION THROUGH SOUTH REEF ILLUSTRATING GEOLOGY, ALTERATION AND SULPHIDE MINERAL ZONING



(Source: Trilogy Metals, 2016)

7.5 PROSPECTS/EXPLORATION TARGETS

The Bornite carbonate sequence, host to the mineralization at Bornite, is exposed over approximately 16 km along the north slope of the Cosmos Hills and to a lesser extent on the southern margin of the Cosmos Hills arch (Figure 7-1). Numerous areas of hydrothermal dolomitization and copper mineralization occur across the entire width of outcropping carbonates and are the focus of ongoing regional exploration by Ambler Metals. Most notable of the known prospects are the Pardner Hill and Aurora Mountain areas, where outcropping mineralization was discovered and drill-tested during the Kennecott era.

The Pardner Hill prospect is located 5 km west of Bornite (Figure 7-1) and consists of a 3 km copper (± zinc) soil and rock geochemical anomaly in rubble cropping dolostone. Kennecott drilled 16 holes in the area and defined a stratabound copper mineralized zone approximately 150 m by 400 m and varying from 5 m to 35 m thick at the southern end of the geochemical anomaly. Mineralization is cut off by a low-angle fault but remains open down-dip to the north and to the south.

Dolomitization and anomalous copper and zinc geochemistry also characterize the Aurora Mountain prospect located 6 km west of Bornite (Figure 7-1). Anomalies are distributed along a 2 km mineralized horizon about a third of which has been tested by four Kennecott-era drill holes.

Importantly, the evolving understanding of the spatial distribution of the debrite breccias and their control on fluid flow along with the alteration vectoring pattern from high iron dolomites through progressively iron-depleted dolomites provide an important opportunity to target additional mineralization both down-dip along the Upper and Lower Reefs and in the Pardner Hill and Aurora Mountain areas.

7.6 GENESIS/GENETIC IMPLICATIONS

Recent development of a coherent sedimentary model for the Bornite deposit suggests a carbonate slope environment with a series of debrites characterized by extremely coarse-grained conglomerates ("breccias"). The lateral and vertical controls on the distribution of dolostone-clast conglomerate remain poorly understood but are likely a function of underlying structural controls, such as syn-sedimentary growth faults.

The overall distribution of dolomite alteration suggests sourcing of a mineralizing fluid from the south and transport to the north. The debrites may have provided important permeability and dolomitization would have been associated with volume reduction and permeability enhancement. Texturally, mineralization occupies breccia interstices and overprints dolostone wallrock via irregular fracture patterns.

From a genetic standpoint, the geochemical trends apparent in the alteration and mineralization along the south-to-north fluid path show initial or proximal high Fe, Mg and K with overall low S to distal high Ca, Na and S as the system evolved. Copper is broadly zoned around the high Fe core enclosed by low Fe dolomites. Importantly, the reduced (ferrous) iron present in the early assemblage of chlorite, siderite, and pyrrhotite does not support the model that the principal metal transport mechanism was an oxidized metalliferous brine with sulphide precipitation as a result of encountering reductants such as carbonaceous and pyritic phyllites or the surrounding halo of anthraxolite and other organic-C compounds.

8 DEPOSIT TYPES

Copper-cobalt-silver-zinc mineralization at Bornite forms disseminations, veins, and massive sulphides in stacked, semi-stratiform bodies closely associated with secondary hydrothermal dolomitization. The cross-cutting nature of the mineralization along with the presence of early pyrite and sphalerite in sedimentary breccia clasts suggest an epigenetic origin that was temporally very close after the deposition of host strata. Re-Os dating supports this interpretation (Selby et al., 2009).

Data are limited regarding the sources and nature of the copper-rich fluids that formed the Bornite deposit, but they suggest that mineralizing fluids may have formed from the interaction of saline basin fluids with mafic volcanic rocks in the area.

Given these constraints, Bornite has characteristics similar to other districts and deposits including: the Mount Isa and McArthur River districts in Australia, the Tynagh deposit in Ireland, the Kipushi deposit in the Congo, and the Tsumeb deposit in Namibia. All of these deposits show syngenetic to early epigenetic characteristics, emplacement in carbonate stratigraphy, and early pyrite-dolomite alteration followed by sulphide mineralization.

All of these comparable deposits occur in intra-continental to continental margin settings undergoing extensional tectonics and bimodal volcanism similar to Bornite. Basin-margin faults seem to have been important in localizing mineralization (Hitzman, 1983) although basin margin structures at Bornite have not been directly identified.

9 EXPLORATION

9.1 INTRODUCTION

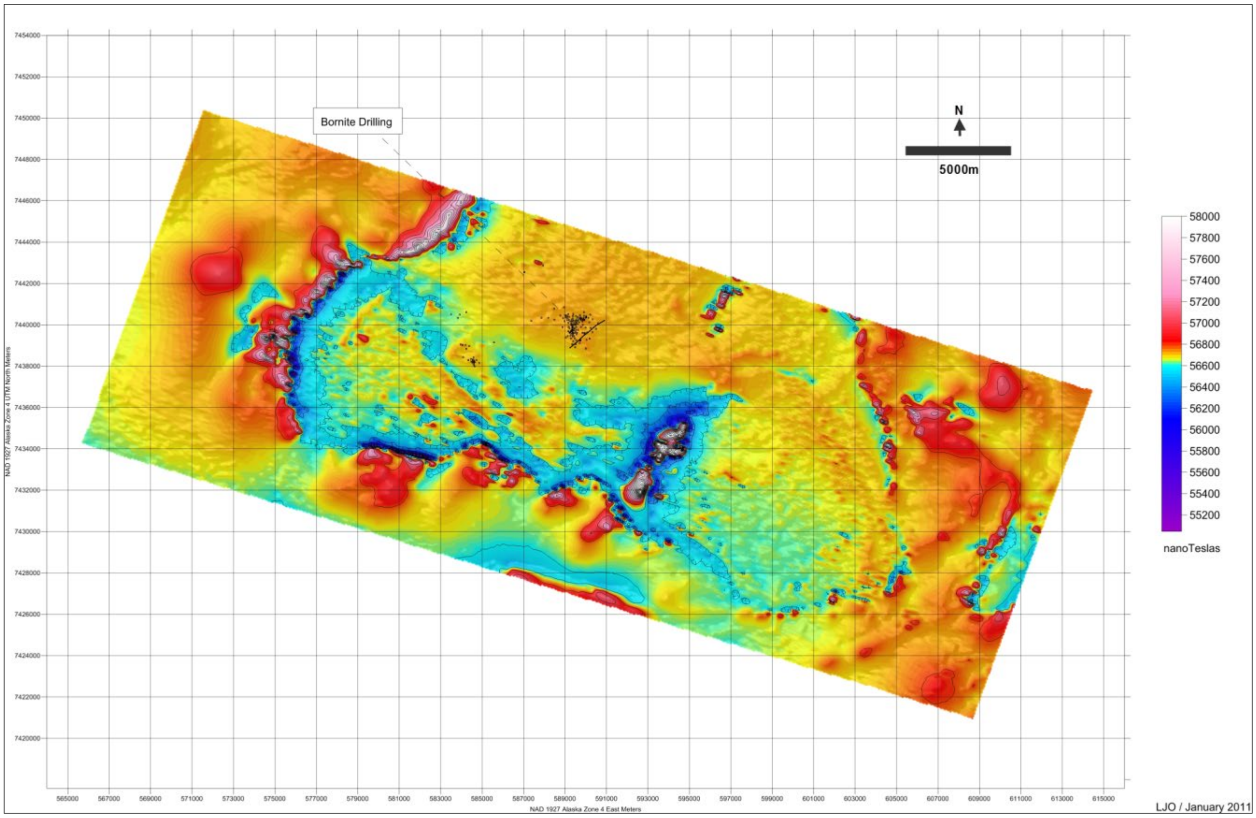
Exploration work completed by previous operators BCMC and Kennecott (1957 through 1998) is summarized in Section 6 of the technical report. In addition to extensive drilling, BCMC and Kennecott completed widespread surface geochemical sampling, regional- and property-scale mapping, and numerous geophysical surveys. The majority of the data was acquired by NovaGold and has formed the basis for further exploration, targeting Bornite-style mineralization in the Bornite carbonate sequence.

9.2 NOVAGOLD (2006)

In 2006, NovaGold contracted Fugro Airborne Surveys (Fugro) to complete a detailed helicopter DIGHEM (frequency-domain EM), magnetic and radiometric survey of the Cosmos Hills. The survey covered a rectangular block approximately 18 km by 49 km which totaled 2,852-line km. The survey was flown at 300 m line spacing with a line direction of N20E. The DIGHEM helicopter survey system produced detailed profile data of magnetics, EM responses and radiometrics (total count, uranium, thorium, and potassium) and was processed into maps of magnetics, discrete EM anomalies, EM apparent resistivity, and radiometric responses.

A report and Fugro-processed maps and grids are available (Fugro, 2007). Figure 9-1 shows total field magnetics from the survey.

FIGURE 9-1: TOTAL FIELD MAGNETICS



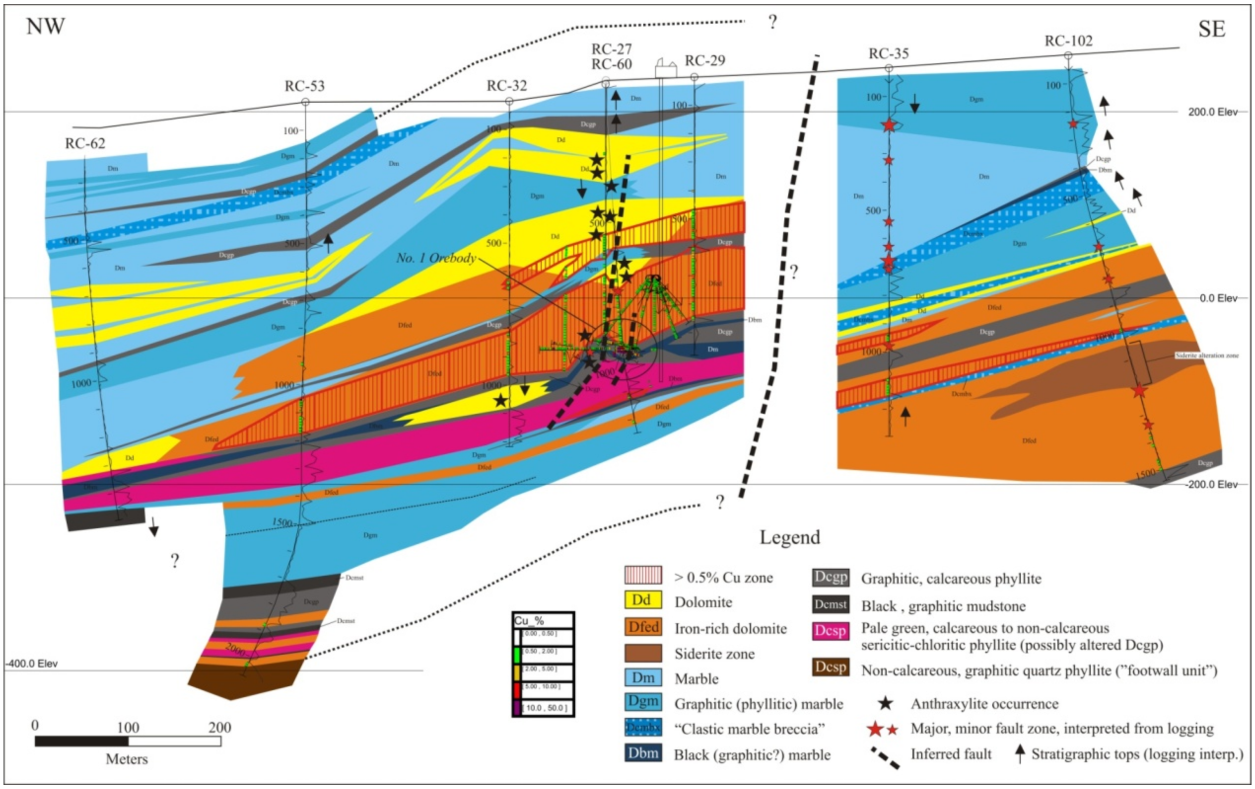
(Source: Fugro, 2007)

9.3 NOVAGOLD (2010)

In 2010, in anticipation of completing the NANA Agreement, NANA granted NovaGold permission to begin low level exploration at Bornite. This consisted of re-logging and re-analyzing select drill holes using a Niton™ portable XRF. A drill section across the Bornite deposit was made using Kennecott surface diamond drill holes: RC-27, -29, -32, -35, -53, -58, -62, and -102, and underground drill hole RU-16 that were re-logged and re-analyzed in the Bornite camp in July and August 2010 (Figure 9-2).

In general, the re-logging and re-interpretation compared moderately well with the 1996 Kennecott interpretation. General relationships apparent in Figure 9-2 include: a thick area of dolomitization centred approximately at drill hole RC-60 corresponding with mineralization and surrounding and overlying the Ruby Zone (Upper Reef); iron-rich dolomite, forming an inner alteration zone; and a strong stratigraphic control with mineralization occurring in dolomitized limestones immediately overlying a graphitic phyllite.

FIGURE 9-2: NW-SE RE-INTERPRETED PROFILE ACROSS THE BORNITE DEPOSIT

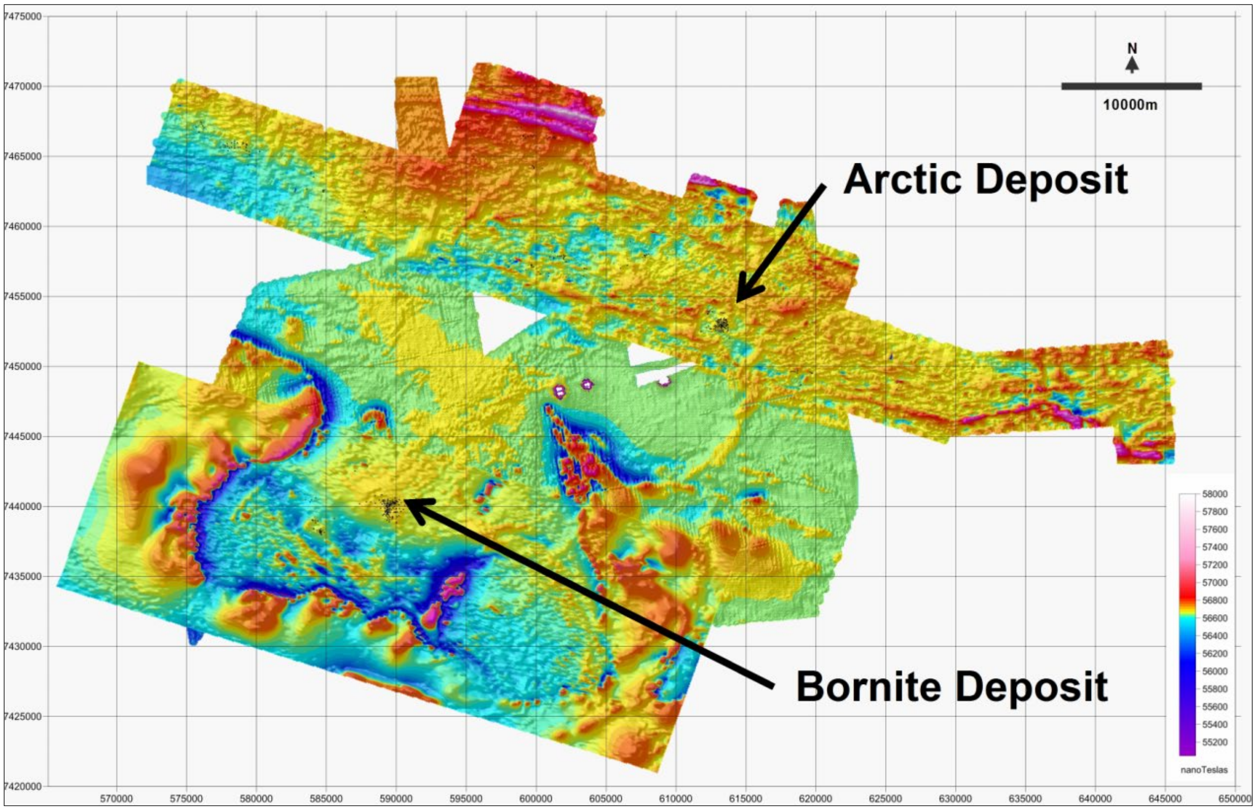


(Source: NovaGold, 2010)

One notable difference from the Kennecott interpretation was the recognition of a significant stratigraphic and structural discontinuity between the southeastern and northwestern parts of the section. A sharp, apparent truncation or offset of mineralization, dolomitization, and stratigraphic units across this boundary is apparent in the re-logging effort. Interpretation of the discontinuity remains unclear at this time, but it could represent either a post-mineral offset or a major facies transition or both. Interpretation of this discontinuity between the Upper and Lower Reef dolomites continues to be problematic in developing a coherent structural and stratigraphic model for the deposit.

In addition to the 2010 re-logging effort, NovaGold contracted a consulting geophysicist, Lou O'Connor, to compile a unified airborne magnetic map for the Ambler Mining District from Kennecott, Alaska DNR, and NovaGold airborne geophysical surveys (Figure 9-3).

FIGURE 9-3: DISTRICT AIRBORNE MAGNETICS COMPILED FROM KENNECOTT, AK DNR AND NOVAGOLD SURVEYS



(Source: O'Connor, 2010)

9.4 NOVAGOLD (2011)

In 2011, NovaGold contracted Zonge International Inc. (Zonge) to conduct both dipole-dipole complex resistivity induced polarization (CRIP) and natural source audio-magnetotelluric (NSAMT) surveys over the northern end of Bornite to develop tools for additional exploration targeting under cover to the north.

NSAMT data were acquired along two lines totalling 5.15 line-km; one line is oriented generally north-south through the centre of the survey area and the other line is the southernmost east-west line in the survey area. CRIP data were acquired on five lines: four east-west lines and one north-south line, for a total coverage of 14.1 line-km and 79 collected CRIP stations. The initial objective of the survey was to investigate geological structures and the distribution of sulphides possibly associated with copper mineralization.

Results from the paired surveys show that wide-spaced dipole-dipole resistivity is the most effective technique to directly target the mineralization package. Broad, low-resistivity anomalies reflecting pyrite haloes and mineralization appear to define the limits of the fluid package. Well-defined and often very strong chargeability anomalies are also present but appear in part to be masked by phyllitic units which also have strong chargeability signatures. NSAMT shows similar resistivity features as the IP, but these are less well resolved.

9.5 NovaCopper (2012)

In light of the success of the 2011 geophysical program, Trilogy Metals contracted Zonge to conduct a major district-wide dipole/dipole IP survey, a down-hole IP radial array survey in the South Reef area, and an extensive physical property characterization study of the various lithologies to better interpret the existing historical geophysical data.

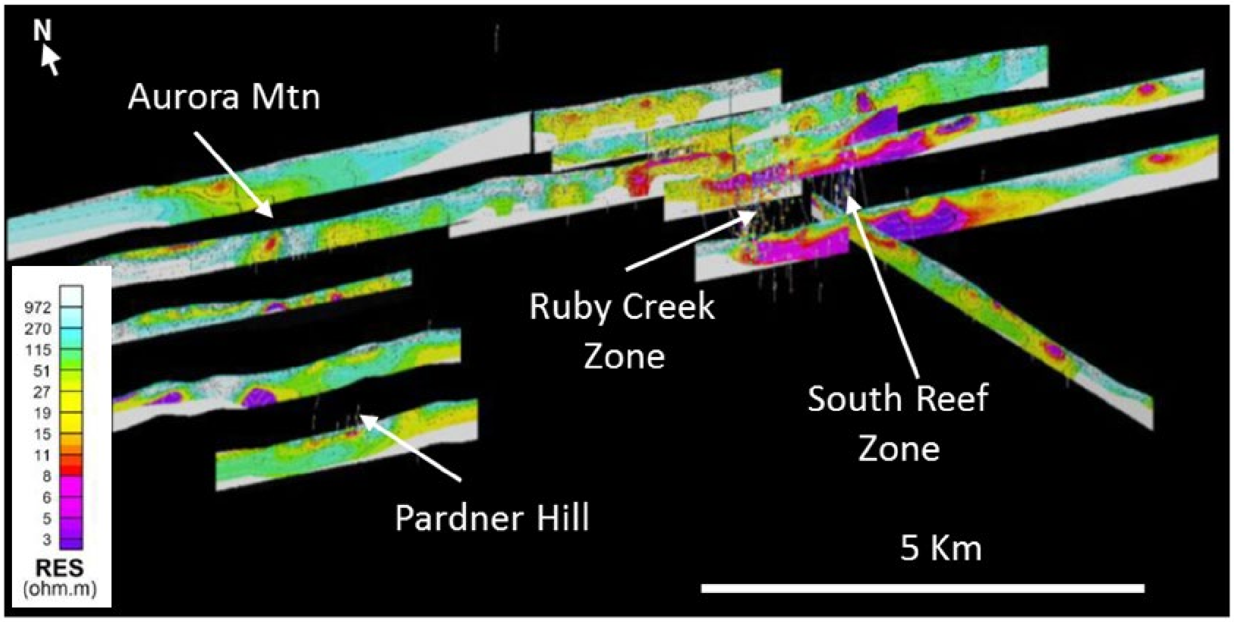
Zonge completed 48 line-km of 200 m dipole/dipole IP during 2012, infilling and expanding on the 2011 survey, and stretching across the most prospective part of the outcropping permissive Bornite carbonate sequence. Figures 9-4 and 9-5 show isometric views of the combined 2011 and 2012 surveys for resistivity and IP, respectively. The results show a well-defined low resistivity area associated with mineralization and variable IP signatures attributed both to mineralization and the overlying Beaver Creek phyllite. Numerous target areas occur in the immediate Bornite area with lesser targets occurring in the Aurora Mountain and Pardner Hill areas and in the far east of the survey area. During the 2012 drill program at South Reef, a single drill hole was targeted on a low resistivity area approximately 500 m to 600 m southeast of the South Reef mineralization trend. Although the drill hole intersected some dolomite alteration in the appropriate stratigraphy, no significant sulphides were encountered.

In addition to the extensive ground IP survey, Zonge also completed 9 km of down-hole radial IP using an electrode placed in drill hole RC12-0197 to further delineate the trend and potential in and around the South Reef.

Extensive physical property data, including resistivity, chargeability, specific gravity, and magnetic susceptibility were captured for use in modelling the existing ground IP and gravity surveys, and the airborne EM and magnetic surveys. In general, some broad comments can be made concerning geophysical domains in and around mineralization at Bornite. Mineralization is characterized by low resistivity < 20 ohms, ambiguous but elevated, often irregular chargeability highs (> 35 milliradians) marginal to the mineralization, and 3-5 milligal gravity anomalies. Mineralization appears to lie along the flanks of 20-150 nT long wave magnetic anomalies which might reflect deep-seated mafic greenstones deeper in the stratigraphy.

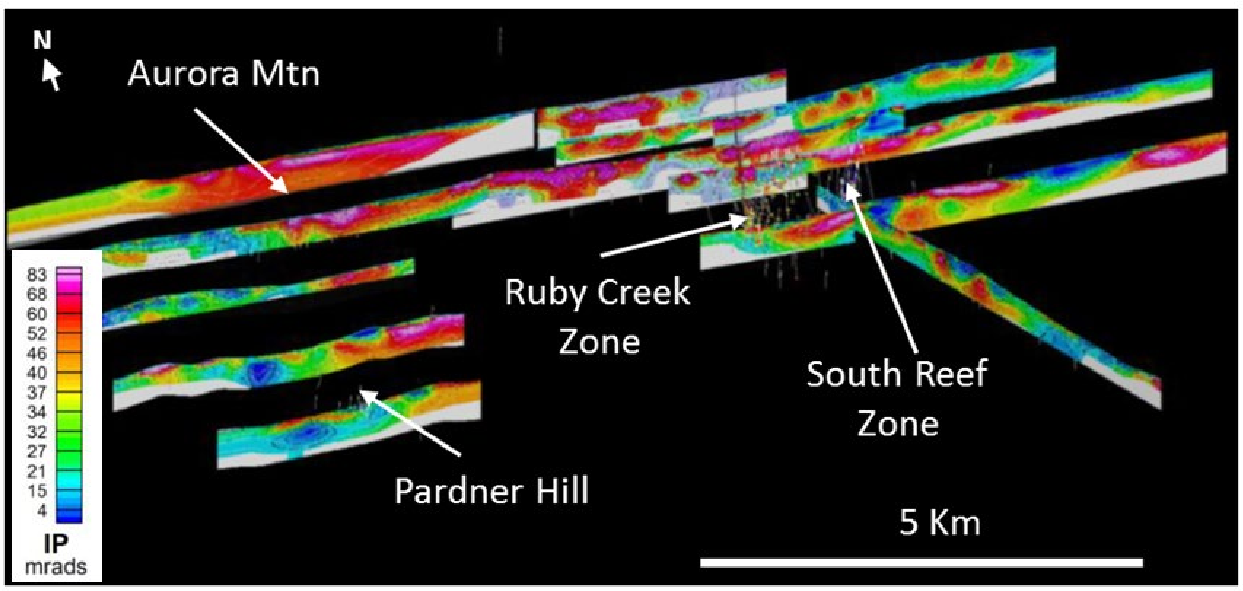
In addition to geophysical-focused exploration, a district-wide geologic map was compiled integrating Kennecott's 1970s mapping of the Cosmos Hills with selective Trilogy Metals mapping in 2012.

FIGURE 9-4: ISOMETRIC VIEW OF 2011 AND 2012 RESISTIVITY PROFILES



(Source: NovaCopper, 2012)

FIGURE 9-5: ISOMETRIC VIEW OF 2011 AND 2012 CHARGEABILITY PROFILES



(Source: NovaCopper, 2012)

9.6 NOVACOPPER (2013)

The emphasis of the 2013 program was to further validate and refine the 2012 geologic map of the Cosmos Hills. A deep penetrating soil and vegetation geochemical orientation survey was completed over the South Reef deposit, using various partial leaches and pH methods. The initial, approximately 1 km test lines suggest a good response for several of the partial leaches of the soils but little response in the vegetative samples. Follow-up sampling was warranted to the north of the deposit into the Ambler Lowlands.

9.7 NovaCopper (2014)

During 2014, exploration work was limited to a re-logging and re-sampling program of historical Kennecott drill core. Work was conducted out of the Fairbanks warehouse and is described in Section 10.

9.8 NovaCopper (2015)

As a follow-up to the 2013 field program, a deep penetrating soil and vegetation geochemical survey was extended north of the deposit into the Ambler Lowlands. Trilogy Metals geologists completed a litho-geochemical desktop study and a comprehensive update to the 3D lithology model.

9.9 Trilogy Metals (2017)

The 2017 field program extended the 2013 and 2015 deep penetrating geochemical (DPG) soil survey another 500 m to the northeast. The 2013 soil line was extended 1,500 m to the east to test over the covered projection of the Two Grey Hills carbonate section. The 3D lithology model was updated to incorporate the 2017 drill program results, which are described in Section 10.

Trilogy Metals also completed a ground gravity survey over a 2 km by 4 km grid with 100 m station spacing over the resource area and extending northeast over the 2017 drill target area. The complete Bouguer anomaly (CBA) residual plot (removes a strong decreasing to the northeast regional gradient) shows good correlation with the Lower Reef mineralization that outcrops on surface with the gravity high gradually decreasing down-dip to the northeast.

As part of the overall gravity program, Mira Geosciences (Mira) created a petrophysical model for the Bornite deposit that synthesized the expected gravity response on surface (forward model) for the 2017 gravity stations. This forward model matches very closely with the actual survey data over the deposit area but diverges on the south end where the expected response of gravity low is actually a strong gravity high that may reflect shallow mineralization up-dip along the South Reef trend. Mira also completed a geologically constrained 3D inversion using the 2017 gravity data. Two areas of anomalously high densities (>2.9 g/cc) were identified. The first area extends up to 750 m to the east-northeast of RC17-0239, which was one of the more successful holes in 2017 and is coincident with the Iron Mountain structure. The second anomaly is located just above the Anirak contact (Lower Reef) to the west of the 2017 target area and 700 m to the north of the closest drill hole (RC-53), which is weakly mineralized along that horizon. This area falls along the northwest-southeast high-grade thickness trend.

9.10 TRILOGY METALS (2018)

During the 2018 field season, Trilogy Metals carried out additional DPG and a 2D seismic survey at Bornite. In addition, geophysical and geochemical data from Bornite were studied using existing datasets.

Soil sampling was completed on the westerly extension of the DPG lines on the northwestern portion of the Bornite deposit. DPG was used to assist with outlining the edges of the deposit as well as to corroborate gravity anomalies defined during the 2017 field season.

A 2D seismic survey was completed by HiSeis (3D seismic imaging) in June 2018. This 2D acquisition program was designed to test whether seismic reflection was suitable for the Bornite deposit and to understand the logistics of any future 3D seismic survey over the project area. Two 6 km 2D seismic lines, a dip line and a strike line, were acquired with a total of 792 unique source locations to attempt to image hanging wall and footwall shears; other faults and shears; folding of stratigraphy; internal (within Bornite sequence) phyllite units; facies changes within the dolostones; and direct detection of massive sulphide mineralization; and any alteration associated with mineralization. Acquisition of this 2D dataset used 500 g seismic charges as a means of producing seismic energy. All seismic vibrations were measured on a “fully active” line of 1,189 geophone receivers which provided up to 6 km of offset on either side of the source using the Aries I seismic acquisition system. Supporting rock property data were acquired from drill core stored in Fairbanks, Alaska.

HiSeis interpreted a zone of weak seismic reflectance (strong bleached zone) within the Bornite carbonate sequence, proximal to the Anirak schist contact. Vertical features (fault array?) extending >3 km deep were identified below this bleached zone. It was hypothesized that the bleached zone represented a zone of alteration within the carbonate sequence near vertical faults that could have acted as fluid-migration pathways. Therefore, this area was identified as prospective for hosting high-grade mineralization. Hole RC18-0254 was designed to target this area up-dip of hole RC18-0224, as the centre of this altered zone had not been adequately tested by previous drilling. The results of this test hole were positive and are discussed in the drilling results below. In conclusion, the results of the 2D survey demonstrate the ability of seismic to image stratigraphy, structure and alteration at Bornite, including zones of low reflectivity related to alteration and possibly indicative of pathways for mineralizing fluids.

Mira Geosciences completed a 3D inversion model of the 100 m spaced ground gravity data that were collected over the Bornite deposit during the 2017 exploration season. Using geology to constrain the model, three areas of anomalously higher gravity were defined. Unfortunately, none of these intervals were properly tested in 2017 with two holes, those at Anomaly “B” and “C”, ending above the gravity anomalies. Two of the three identified anomalies from the 2017 inversion modelling changed in size and relative orientation with the updated geologic model.

Anomaly B, which stretches to the northwest from hole RC17-0238 decreased in extent, likely the result of a thicker-than-previously-modelled Upper Reef carbonate section in RC17-0238. Anomaly C is much broader and less defined, indicating that it may be the result of underestimating the SG in the lithology model (incorrect interpretation). This anomaly remains untested with the failures of drill holes RC17-0242 and RC18-0245 and should be redrilled in the future. Anomaly A is relatively unchanged and remains coincident with the Iron Mountain structure. Holes RC18-0246, RC18-0249, and RC18-0250 tested the southwest edge of the anomaly where it joins the South Reef trend. Hole RC18-0250 suggests that mineralization wanes to the east, though this hole may have just missed mineralization controlled by the Iron Mountain structure. The northeast extent of this anomaly is still considered a viable exploration target.

South32 completed a QA/QC review, lithogeochemical-alteration assessment, and a vectoring/targeting exercise on downhole geochemical data on the Bornite deposit. The purpose of this exercise was to use downhole analyses to assess the geology, alteration, and mineralogy of the deposit to vector towards mineralization. The Bornite sequence can be classified into three geochemical groups including: 1) very low immobiles; 2) low immobiles; and 3) higher immobiles. The latter was then subdivided into five groups based on Al, Cr, and V concentrations. The “very low” and “low immobile” groups are predominately limestones and dolomites (including breccias), whereas increasing Al in “higher immobiles” represent the increasingly argillaceous/micaceous units (phyllites). High Al samples in the lower Bornite sequence can be discriminated from those in the upper sequence based on high Ni:Cu ratios. In the South Reef area, lithogeochemistry supported Trilogy Metals’ geologic model, identified the lower, central and upper Bornite sequence units and distinguished many of the logged phyllites from breccias. The results support Trilogy Metals’ interpretation that the Ruby Zone in the Lower Reef is hosted in units corresponding to the South Reef central sequence. Interestingly, the Beaver Creek phyllite could not be distinguished geochemically from the Anirak schists.

Lastly, research on stable isotopes of oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$), based on Conner’s 2015 Master’s thesis, continued in 2018. Conner (2015) showed that $\delta^{18}O$ becomes depleted with alteration and mineralization in Hole RC12-0202. He concluded that a significant gradient in $\delta^{18}O$ from unaltered marble to dolostone to carbonates is associated with the presence of sulphide mineralization and that ^{18}O equilibrated at the highest temperature experienced by the fluid that interacted with the carbonates. To test this idea, approximately 200 samples were collected from eight drill holes to examine other parts of the Bornite deposit and also from Pardner Hill (Hole PH-179). The results show a general pattern of ^{18}O depletion with increasing depth in the upper portions of the reefs that reverses and becomes heavier toward the bottom of the reef. Nevertheless, the result of this work suggests that a reasonable correlation between mineralization and depleted $\delta^{18}O$ exists. Also, Conner (2015) observed that there is a small population of the tan phyllite suite with the lightest $\delta^{13}C$ and among the lightest $\delta^{18}O$. Basal tan phyllites in or near the Anirak contact show this signature at Bornite and Pardner Hill, as do some tan phyllites higher in the section. However, other tan phyllites with values close to the middle of the trends are interpreted to have possible alteration overprints or have formed from a different protolith.

9.11 Trilogy Metals (2019)

In 2019, Trilogy Metals contracted Geotech Ltd. (Geotech) of Aurora, Ontario to complete VTEM Plus (versatile time domain electromagnetic) and ZTEM (z-axis tipper electromagnetic) airborne helicopter geophysical surveys over the Cosmos Hills and the Ambler VMS belt. These survey methods were considered to be a significant upgrade over the previous DIGHEM survey flown by Kennecott in 1998 over the VMS belt and the DIGHEM survey flown by NovaGold over Bornite in 2006 due to greater resolution and deeper penetration ability. Magnetics were measured using a cesium vapour sensor, while radiometrics was not collected due to snow cover.

Resource Potentials PTY Ltd., a geophysical consulting company in Perth, Australia designed the program with input from the Trilogy Metals technical team, managed the request for proposal (RFP) process, supervised the survey program, and QA/QC'd the data collection by Geotech. Resource Potentials also reprocessed the raw signal data from Geotech and modelled the data.

The VTEM survey was flown along 200 m spaced lines oriented northwest-southeast over the entire Bornite carbonate sequence north of the Cosmos Arch (which hosts the Bornite deposit), with additional lines at 100 m spacing directly above the Bornite resource. A second set of perpendicular lines (southwest-northeast) were flown at 200 m spacing over just the general Bornite area. Tie lines at ~4,000 m spacing were flown perpendicular to the EM flight lines to provide control for the magnetic survey.

The VTEM results from the Bornite sequence are complex and appear to be mostly reflecting bedrock lithologies (the graphitic phyllites). The conductive plates that were modelled are generally coincident with the interpreted phyllite units, as are the apparent anomalies tested by holes RC19-0263 and RC19-0266 (see Drilling Section 10).

9.12 Ambler Metals (2020)

Trilogy Metals and South32 decided not to proceed with the 2020 exploration program due to the coronavirus (COVID-19) pandemic. The Bornite geologic model was updated using the 2019 drill program results. The Irish Centre for Research in Applied Geosciences initiated a machine-learning geochemical modelling project to help define the controls on high-grade copper mineralization.

9.13 AMBLER METALS (2021)

During the 2021 field season, the understanding of the Bornite deposit and the potential for additional deposits was advanced with a new interpretation of the carbonate sequence at Bornite and an improved structural understanding of the Cosmos Hills.

Dr. Elizabeth Turner, specialist in carbonate geology from Laurentian University, re-logged two fences/sections of drill holes, E-W and N-S, through the Bornite deposit, to identify, distinguish and correlate lithofacies within the Bornite sequence and to identify and distinguish different types/ages of dolomitization, including, if possible, their relation to mineralization.

Turner describes the Bornite sequence as a tectonized ”normal” carbonate slope deposit that consists of calcitic material (lime mud) derived from a nearby shallow-marine source area, interlayered with variable amounts of ”background” terrigenous mud (argillaceous proportion increases with distance downslope). The observed sequence includes massive lime mudstone, thin-bedded argillaceous lime mudstone, lime mudstone centimetrically interbedded with terrigenous mudstone, calcareous siltstone, and limestone-clast slope conglomerates. Brookian deformation strained these argillaceous limestone slope deposits to varying degrees producing phyllites and recrystallized, strained limestones/marbles.

Importantly, superimposed on the active limestone slope system is the local presence of dolostone-clast conglomerate. Dolostone clasts are equant and irregular; predominantly dolomudstone (locally with fossil fragments) and are likely derived from subaqueous horst blocks of pre-existing older dolostone and shed into the slope limestone system. The fault scarp(s) that shed dolostone clasts were probably part of a seafloor paleotopographic system that developed during regional extension and associated fault-mediated syn-depositional subsidence.

The Bornite succession contains sedimentary evidence of proximal-distal relationships with respect to both the bedrock doloclast source and the active carbonate slope. Proximal-distal relationships may help locate structures that delivered mineralizing fluids because dolostone conglomerates dominate the stratigraphy in the mineralized areas of the Bornite deposit. Massive sulphide distribution and characteristics suggest that syn-sedimentary faults associated with dolostone-clast conglomerates may have later served as conduits for mineralizing fluids. Turner notes that massive sulphide mineralization seems to preferentially replace matrix of dolostone-clast conglomerates, especially where the dolostone-clast conglomerates dominate the stratigraphy and that sulphides in gangue-filled hydrothermal breccia interstices and veins are also localized to dolostone-clast conglomerates (Turner, 2021).

A better understanding of the configuration of the sedimentary system is recommended as its characteristics could assist in future exploration looking for other Bornite-style deposits. This could be facilitated by developing lithostratigraphic methods to pick out sedimentological characteristics indicating proximity to ancient sea-floor fault(s), lithofacies mapping of all local and regional carbonate exposures that may be affiliated with the "Bornite sequence" to establish their paleogeographic implications relative to the depositional model and geophysical methods to pick out possible evidence of stratigraphic offsets in the subsurface.

Also initiated in 2021 was structural mapping around Pardner Hill and Aurora Mountain by Dr. Jason Price. Initial results indicate: (1) Large carbonate bodies, such as Pardner Hill, Shield Mountain, and probably also Aurora Mountain, are fault klippen in allochthonous contact with the structurally subjacent Anirak schist; (2) Dolostone bodies are typically boudinaged forming metric to hectametric 3-D ellipsoids encased in ductilely deformed phyllites and, in some places, calc-mylonites (limestone protolith); (3) Top-South (to SSW) deformation at a number of outcrops in the Cosmos Hills suggest that this entire structural "block" may have been juxtaposed southward from the position of the Ambler Lowlands or, potentially, from off the top of the Ambler Highlands (Arctic area) during exhumation that was part of the Brookian orogeny; (4) the fault contact with the overlying Beaver Creek phyllite is likely a low-angle normal fault that cuts out of the Bornite deposit to the southeast where Beaver Creek is in structural contact with Anirak schist.

9.14 EXPLORATION POTENTIAL

Outcropping exposures of the mineralization-hosting carbonate stratigraphy along with large areas of dolomite alteration occur over approximately 18 km of strike along the northern flank of the Cosmos Hills. Historical exploration drilling focused solely on outcropping mineralization and subsurface extensions at the Bornite, Aurora Mountain, and Pardner Hill areas. Much of the carbonate belt has still yet to be evaluated. In addition, airborne geophysics completed in 2006 show the Bornite carbonate sequence and the bounding stratigraphy dip to the north under the Ambler Lowlands toward the Ambler Schist Belt. This opens a large area to explore for deposits beneath the till and recent sediments that occupy the lowlands.

Exploration by Kennecott and Trilogy Metals has used a variety of methodologies. In 1999, Kennecott completed an initial gravity survey of the Ambler Lowlands showing significant gravimetric anomalies that may indicate structural dislocations and potential alteration and mineralization (Figure 6-1). In 2011, Trilogy Metals investigated both deep IP and NSAMT geophysical techniques. Results from the 2011 program led to a 2012 district-wide, 200 m dipole-dipole, deep-penetrating IP survey. Along with extensive physical property data captured for all lithologies, airborne EM and magnetic data, the IP data was used to develop a comprehensive geophysical model of the district to support future exploration targeting. In 2017, Trilogy conducted a more detailed gravity survey that delineated significant north-northeast to northeast oriented structures which appear in part to control local basin morphology and mineralization.

Geochemical methods include conventional and deep penetrating geochemistry (DPG) and lithogeochemical vectoring. Test lines using DPG methods with various selective partial leaches of metals proved effective in recognizing margins of South Reef mineralization at significant depths under cover. A recent analysis of the extensive ICP trace element data set at Bornite demonstrates some significant alteration vectors including iron content of various hydrothermal dolomites. Simple XRF analysis of dolomites in the field might prove effective in vectoring toward Fe-poor mineralized dolomite sections.

A better understanding of the basin development and its structural framework is critical to the exploration of Bornite-style systems. Dating of mineralization in the Ambler Mining District suggests that the Ambler schist belt that hosts the Arctic deposit and the Bornite carbonate-hosted mineralization are close to contemporaneous. However, some textural and metamorphic observations suggest a possible Jura-Cretaceous or younger age for Bornite and as such, mineralization at Bornite is suspected to slightly post-date host stratigraphy. This early and extensive syngenetic/early epigenetic signature, along with the overall fluid chemistry of the system investigated by early workers, such as Hitzman (1983 and 1986), point to large saline basin-generated fluid transport as the mechanism controlling the metallogeny of the Ambler Mining District. Importantly, similar metallogenies related to saline, basin-generated fluids and their associated deposits form some of the largest copper districts in the world.

10 DRILLING

10.1 INTRODUCTION

From 1957 to 2019, a total of 273 holes targeted the Bornite deposit during 24 different campaigns; 222 surface core holes and 51 underground core holes were drilled, totalling 106,406 m. All of the drill campaigns prior to 2011 were completed by Kennecott or its exploration subsidiary, BCMC, and the drill campaigns since 2011 were completed by NovaGold (2011), NovaCopper (2012 and 2013) or Trilogy Metals. The distribution of drilling by year is shown in Figure 10-1.

Tables 10.1 and 10.2 summarize the operators, contractors, number of drill holes, and metres drilled on the deposit. Note: split core from all drill holes, except for Kennecott-era drill holes resampled from 2012 to 2014 by NovaCopper/Trilogy and RC13-230 and RC13-232, has been retained in a storage facility at site for future reference or to provide material for metallurgical studies.

In the summer of 2017, Trilogy Metals initiated eleven holes, but four were abandoned due to drilling problems. The seven remaining drill holes stepped-out to the north for distances between 250 m to 400 m from the previous drill holes; these were distances considered too far to support the estimation of mineral resources at that time.

In the summer of 2018, Trilogy Metals conducted a drilling program that included the completion of 12 holes that infilled gaps in previous drilling in the northern, down-dip part of the deposit as well as in the central area between the Ruby Zone and South Reef area. Three additional holes were collared but were abandoned due to drilling problems.

In the summer of 2019, Trilogy Metals completed another drilling program comprising eight holes that tested the continuity of the mineralization within the Bornite deposit and two holes that tested exploration targets located about 1 km south and southeast of the deposit.

Between 2012 and 2014, Trilogy Metals geologists re-logged and re-sampled historical drill holes in the Ruby Zone and South Reef area which were previously drilled and only selectively sampled by Kennecott. Table 10.3 summarizes the target areas and drill holes by year. These assays were used in the estimation of the current mineral resource, except where duplicates of Kennecott samples were collected. In the case of duplicates, the original assay information was given priority in the mineral resource database.

TABLE 10.1: SUMMARY BORNITE DRILL HOLE CAMPAIGNS BY OPERATOR

Year	Surface Drill Holes	Underground Drill Holes	Metres	Operator
1957	8	-	1,749	BCMC
1958	10	-	2,150	Kennecott/BCMC
1959	15	-	4,932	Kennecott/BCMC
1960	14	-	4,482	Kennecott/BCMC
1961	33	-	13,590	Kennecott/BCMC
1962	24	-	8,450	Kennecott/BCMC
1963	1	-	396	Kennecott/BCMC
1966	0	26	1,384	Kennecott/BCMC
1967	0	21	1,862	Kennecott/BCMC
1968	8	4	3,210	Kennecott/BCMC
1969	2	-	781	Kennecott/BCMC
1970	2	-	733	Kennecott/BCMC
1971	2	-	829	Kennecott/BCMC
1972	1	-	466	Kennecott/BCMC
1974	2	-	702	Kennecott/BCMC
1975	1	-	316	Kennecott/BCMC
1976	6	-	2,170	Kennecott/BCMC
1997	3	-	928	Kennecott/BCMC
2011	14	-	5,819	NovaGold
2012	23	-	16,046	NovaCopper
2013	17	-	8,140	NovaCopper
2017	11	-	9,302	Trilogy Metals
2018	15	-	10,363	Trilogy Metals
2019	10	-	7,610	Trilogy Metals
Total	222	51	106,406	

From 1957 to 1976, Kennecott used drilling contractor Sprague and Henwood, a Pennsylvania-based drilling company. Kennecott's 1997 program (three drill holes) was completed by Tonto Drilling Services, Inc. (a NANA-Dynatec company). The 2011 through to 2013 NovaGold/Trilogy Metals programs used Boart Longyear Company as the drill contractor. The 2017 program used Tuuq drilling, a NANA company, who sub-contracted Major Drilling. The 2018 program used both

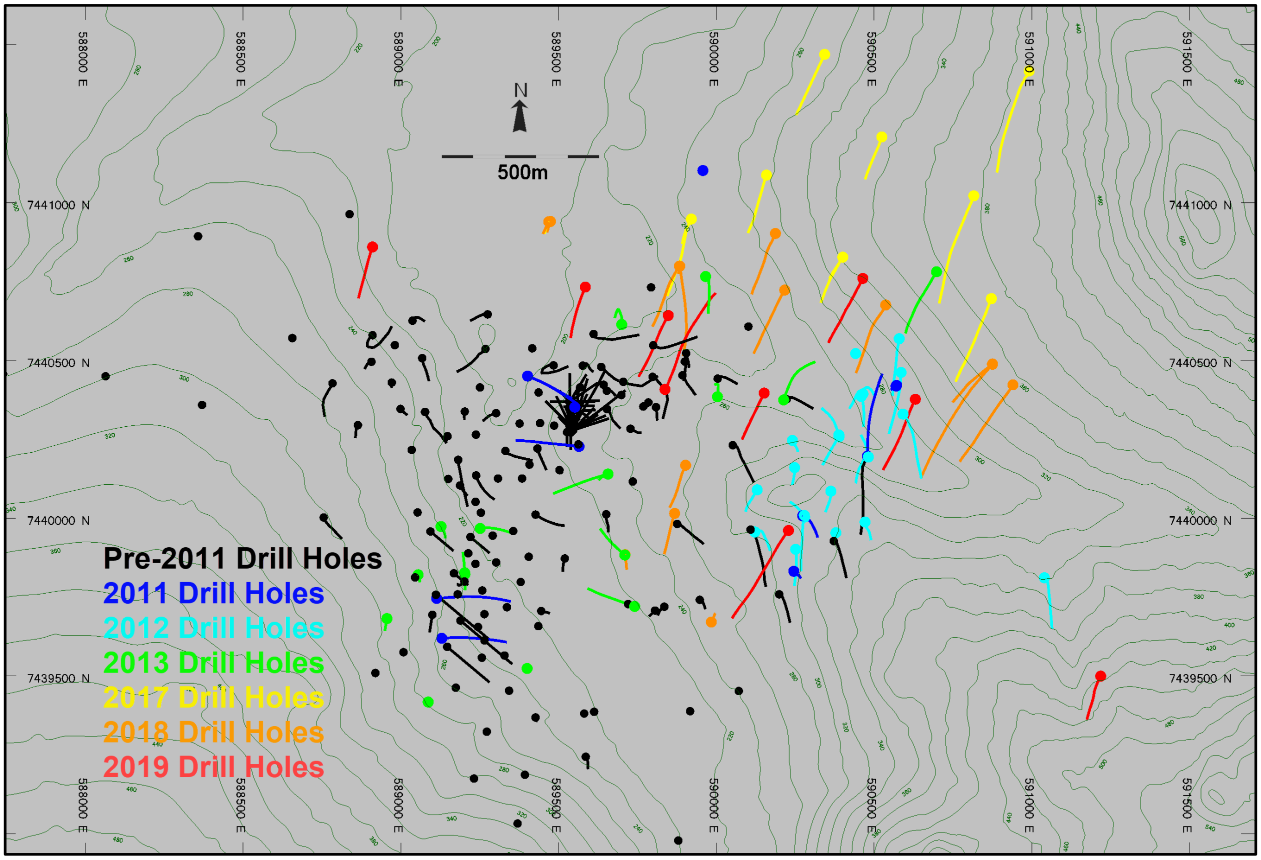
Major and Tuuq as the primary drill contactors and the 2019 program used Major as the primary contractor.

Table 10.2 summarizes the drill campaigns, the core sizes, and the drilling contractors.

TABLE 10.2: SUMMARY OF BORNITE DRILL HOLE CAMPAIGNS BY DRILL CONTRACTOR

Year	Number of Drill Holes	Metres	Core Size	Drill Contractor
1957	8	1,749	AX	Sprague and Henwood
1958	10	2,150	AX	Sprague and Henwood
1959	15	4,932	AX & BX	Sprague and Henwood
1960	14	4,482	AX & BX	Sprague and Henwood
1961	33	13,590	AX, BX, & NX	Sprague and Henwood
1962	24	8,450	AX, BX, & NX	Sprague and Henwood
1963	1	396	BX	Sprague and Henwood
1966	26	1,384	EX & AX	Sprague and Henwood
1967	21	1,862	EX & AX	Sprague and Henwood
1968	12	3,210	BX & AX	Sprague and Henwood
1969	2	781	BX	Sprague and Henwood
1970	2	733	BX	Sprague and Henwood
1971	2	829	BX?	Sprague and Henwood
1972	1	466	BX?	Sprague and Henwood
1974	2	702	NX & BX	Sprague and Henwood
1975	1	316	NX & BX	Sprague and Henwood
1976	6	2,170	NXWL & BXWL	Sprague and Henwood
1997	3	928	NX & HQ	Tonto
2011	14	5,819	NQ & HQ	Boart Longyear
2012	23	16,046	NQ & HQ	Boart Longyear
2013	17	8,140	NQ & HQ	Boart Longyear
2017	11	9,302	NQ & HQ	Tuuq & Major Drilling
2018	15	10,363	NQ & HQ	Tuuq & Major Drilling
2019	10	7,610	NQ & HQ	Major Drilling
Total	273	106,406		

FIGURE 10-1: PLAN MAP SHOWING DRILL HOLE LOCATIONS BY YEAR



(Source: SIM , 2022)

10.2 DRILL CORE PROCEDURES

In the initial years of drilling at Bornite, Kennecott relied on AX diameter core (1.1875 in. or 30.2 mm diameter), but, as drilling migrated towards deeper targets, a change to BX diameter core (1.625 in. or 41.3 mm diameter) was implemented to help limit deviation.

From 1966 to 1967, drilling activity at Bornite moved underground, and EX diameter core (0.845 in. or 21.5 mm diameter) was implemented to define the Ruby Upper Reef zone “No.1 Ore Body”. In 1968, drilling activity moved back to the surface and from 1968 to 1972, BX diameter core was most commonly drilled.

In later years, core size increased to NX (2.125 in. or 54.0 mm diameter) and finally, in 2011, core size increased to NQ (1.874 in. or 47.6 mm diameter) and HQ (2.5 in. or 63.5 mm diameter). Over the years, progressively larger diameter drill rods have been used in an effort to minimize drill hole deviations.

The Kennecott- and Trilogy Metals-era drilling was conducted with drill equipment that used imperial measurement units. For the purposes of data management, all imperial units were converted to metric units in the Trilogy Metals database. Trilogy Metals works exclusively in metric units.

10.2.1 BCMC/Kennecott

There is only limited information with respect to the specific drill core handling procedures used by Kennecott during its tenure at the Bornite deposit. All of the drill data collected during the Kennecott drilling programs (1958 to 1997) were logged on paper drill logs, and copies were stored in the Kennecott office in Salt Lake City, Utah. Electronic, scanned copies of the paper logs, in PDF format, are held by Trilogy Metals.

Drill core was sawed or split in half with a splitter; half was submitted to various assay labs and the remainder was stored in the Kennecott core storage facility at the Bornite deposit. In 1995, Kennecott converted the drill assay data, geologic core logs, and down-hole collar survey data into an electronic format. In 2009, NovaGold geologists verified the geologic data from the original paper logs against the Kennecott electronic format and then merged the data into a Microsoft™ SQL database.

Sampling of drill core by Kennecott and BCMC focused primarily on the moderate- to high-grade mineralized zones. Intervals of visible sulphide mineralization containing roughly >0.5% to 1% Cu were selected for analysis by Union Assay Office Inc. of Salt Lake City, Utah. This approach left numerous intervals, containing weak to moderate copper mineralization, un-sampled in the historical drill core. During the 2012 exploration program, Trilogy Metals began sampling a portion of this remaining drill core in select holes in the South Reef area. Trilogy Metals extended this sampling program to the Ruby Zone in 2013 and 2014 (Table 10.3).

10.2.2 NovaGold/NovaCopper/Trilogy Metals

Throughout Trilogy Metals' tenure at Bornite, the following core handling procedures have been implemented (including programs conducted by NovaGold and NovaCopper) . Core is slung by helicopter, or transported by truck or ATV, from the drill rig to the core-logging facility. Upon delivery, geologists and geo-technicians open and inspect the core boxes for any irregularities. They first mark the location of each drilling block on the core box, and then convert footages on the blocks into metric equivalents. Geo-technicians or geologists measure the intervals (or "from/to") for each box of core and include this information, together with the drill hole ID and box number, on a metal tag stapled to the end of each box.

Geo-technicians then measure the core to calculate percent recovery and rock quality designation (RQD). RQD is the sum of the total length of all pieces of core in a run over 12 cm. The total length of core in each run is measured and compared to the corresponding run length to determine percent recovery.

Core is then logged with lithology and visual alteration features captured on observed interval breaks. Mineralization data, including total sulphide species (recorded as percent), sulphide type (recorded as a relative amount), and gangue and vein mineralogy are collected for each sample interval with an average interval of approximately 2 m. Structural data is collected as point data.

Geologists then mark sample intervals to indicate each lithology or other geologically appropriate intervals. Sample intervals of core are typically between 1 m and 3 m long but are not to exceed 3 m long. Occasionally, if warranted by the need for better resolution of geology or mineralization, smaller sample intervals have been used. Geologists staple sample tags on the core boxes at the start of each sample interval and mark the core itself with a wax pencil to designate sample intervals. This sampling approach is considered sound and appropriate for this style of mineralization and alteration.

Drill core is digitally photographed prior to sampling.

Drill core is cut in half using diamond core saws. Specific attention to core orientation is maintained during core sawing to ensure that representative samples are obtained. One-half of the core is retained in the core box for storage on site or at Trilogy Metals' Fairbanks warehouse, and the other half is bagged and labelled for analysis. Samples are selected for specific gravity measurements as discussed in Section 11 (Sample Preparation, Analyses, and Security) of this technical report.

In 2013 and 2014, 33 historical drill holes and 37 historical drill holes, respectively, in the Ruby Zone area were re-logged, re-sampled, and re-assayed because these holes had only been selectively sampled by Kennecott. Entire holes were re-logged using Trilogy Metals protocols discussed above. Samples were submitted either as half-core where previously sampled or whole core where un-sampled (to ensure that a sufficient volume of material was provided for analysis). Sample intervals were matched to historical intervals whenever possible or selected to reflect Trilogy Metals sampling procedures described above.

The objectives of the re-assay/re-logging program were threefold: to implement a QA/QC program on intervals previously sampled by Kennecott to confirm the validity of its results; to identify additional lower grade (0.2% to 0.5% Cu), which was not previously sampled; and to provide additional multi-element ICP data to assist in the geologic interpretation of the deposit.

A further discussion of the program and its results are incorporated into Sections 11 and 14 of this technical report. A list of historical Kennecott drill holes that were re-logged and re-sampled by Trilogy Metals during 2012, 2013 and 2014 is presented in Table 10.3.

TABLE 10.3: BCMC/KENNECOTT-ERA DRILL HOLES RE-LOGGED & RE-ASSAYED BY TRILOGY METALS

Year Re-logged / Re-assayed	Area	Drill Holes
2012	South Reef	RC-92, RC-93, RC-95, RC-96, RC-99, RC-102, RC-163, RC-168, RC-174
2013	Ruby Zone	RC-3, RC-4, RC-19, RC-29, RC-30, RC-34, RC-35, RC-35W, RC-37, RC-48, RC-50, RC-51, RC-54, RC-55, RC-57, RC-61, RC-64, RC-66, RC-67, RC-68, RC-73, RC-83, RC-84, RC-86, RC-87, RC-111, RC-151, RC-152, RC-153, RC-165, RC-166, RC-169, RC-172
2014	Ruby Zone	RC-22, RC-25, RC-26, RC-32, RC-33, RC-40, RC-44, RC-45, RC-47, RC-49, RC-53, RC-56, RC-58, RC-59, RC-60, RC-65, RC-69, RC-70, RC-71, RC-72, RC-74, RC-77, RC-79, RC-80, RC-81, RC-85, RC-97, RC-100, RC-105, RC-107, RC-112, RC-114, RC-150, RC-157, RC-164, RC-170, RC-173

The 2011 through to 2014 and 2017 NovaGold/Trilogy Metals diamond drilling and re-logging/re-sampling programs used a commercial, computer-based core-logging system for data capture (GeoSpark Logger© developed by GeoSpark Consulting Inc.). During each drill program, all logging data was captured on individual laptops in a Microsoft™ SQL database and then validated and merged into the Bornite Camp server. In 2012, the system was modified to allow each laptop to sync daily to the Data Logger database residing on the Bornite Camp server. The server was periodically backed up, and the database was sent to Vancouver, BC for integration into the master database. The camp server was stored in the Fairbanks field office at the end of each field season. Hardcopies of the 2011 through 2013 drill core logs are stored in the Fairbanks office. Scanned copies of the Kennecott-era drill logs are also stored in the Fairbanks field office.

10.3 DRILL CORE RECOVERY

Generally, core recovery has been very good throughout all of the drilling programs conducted at Bornite. Overall recoveries average 88% over the life of the project, with recoveries in the early programs, conducted in the 1950s through 70s, averaging >86%, and in drilling since 2011, recoveries average 90%. There is minimal difference in core recovery by rock type, with phyllites averaging 87% recovery and dolomites averaging 89% recovery. There is no apparent relationship between recovery and grade in the database.

10.4 Collar Surveys

10.4.1 Kennecott

Kennecott provided NovaGold with collar coordinates for all historical holes in UTM coordinates using the NAD27 datum. During the 2011 field season, the collar locations of 63 historical surface holes were re-surveyed in UTM NAD83 zone 4N datum. The results of this re-survey were compared to the original Kennecott collar survey data as follows:

Horizontal errors were found to cluster tightly around zero, with a mean difference of +1.61 m Easting and -0.80 m Northing. Absolute total horizontal error ranged from 0.39 m to a maximum 24.27 m, with a median absolute error of 1.22 m. The 24.27 m difference was considered to be the result of an individual surveying error. Based on these results, the remaining 68 un-surveyed Kennecott drill hole collars were accepted without application of a horizontal correction.

Vertical errors were identified in the 2011 collar re-survey campaign. The checks revealed a semi-systematic elevation error of about +10 m vertical for most of the historical collar locations compared to the 2011 re-survey. Elevation differences in the existing database were found to range from -2.17 m to +10.91 m, with a median error of +9.61 m. While these errors show some systematic patterns in space and time, a unifying correction factor for elevation based on the survey results was considered inappropriate. Ultimately, Trilogy Metals assigned collar elevations for all historical drill holes that could not be re-surveyed based on the 2010 PhotoSat 1 m resolution digital terrain model (DTM). The collar elevations for the 63 re-surveyed holes were assigned elevations from the 2011 re-survey.

Also, the benchmark for the shaft and the elevation control for the underground drill hole collar surveys could not be located during the re-survey exercise to provide a reasonable elevation check between the underground survey and the surface elevations of the DTM. Therefore, the underground holes were given a standard +10 m vertical correction consistent with the error observed in the re-surveyed surface holes around the underground workings. As a quantitative check, it was confirmed that the lithological contacts constructed from the adjusted drill holes aligned well with the lithological contacts encountered in the 2011 drilling.

10.4.2 Trilogy Metals

In 2011, collar locations for the 14 holes drilled that year were surveyed by NovaGold using a differential GPS relative to benchmark ‘AAA-1' established by Karl Spohn, PLS, WH Pacific, Inc. (WHPacific), in 2010. An Ashtech Promark 2 GPS instrument was used for these surveys.

In 2012, collar locations for 17 of the 23 holes drilled that year were surveyed by WHPacific professional land surveyors using a differential GPS relative to benchmark ‘AAA-1’. The remaining six holes were surveyed by Trilogy Metals using an Ashtech Promark 2 GPS instrument relative to benchmark ‘AAA-1’.

In 2013, collar locations for all 17 drill holes were surveyed by Trilogy Metals using an Ashtech Promark 2 GPS instrument relative to benchmark ‘AAA-1’.

The 2017 collar locations were originally surveyed using a hand-held GPS. Following the 2018 drilling program, the 2017 and 2018 collars were surveyed by DOWL (A.W. Stoll) using a differential GPS relative to benchmark “AAA-1”.

The 2019 drill hole collars were surveyed by Windy Creek Surveys using a differential GPS.

All collar surveys completed since 2011 were conducted in the UTM NAD83 zone 4N datum coordinate system relative to benchmark “AAA-1”.

10.5 Down-Hole Surveys

Approximately 63% of the drill holes in the database have associated down-hole surveys. On a core-length basis, this represents approximately 82% of the drilling, because the more recent holes, which typically have down-hole surveys, tend to be longer compared to the historical drilling.

Since 1961, Sperry-Sun single-shot surveys were conducted on drill holes that encountered significant mineralization. Drill holes with marginal mineralization were often not surveyed. In 1961, Kennecott attempted to conduct down-hole surveys in holes drilled in 1959 and 1960. Of the 51 underground holes, only 11 were surveyed. From 1968 through 1997, down-hole surveys were sporadic. The first six holes of the 1968 campaign, and all holes drilled in 1971 and 1997, were not surveyed.

Four Kennecott drill holes at South Reef that were never surveyed have been assigned projected deviations based on nearby (surveyed) holes (down-hole surveys have been assigned to holes RC-96, RC-95, RC-99 and RC-163). The resulting locations of mineralized intervals in these drill holes mesh better with the overall geologic interpretation of the deposit.

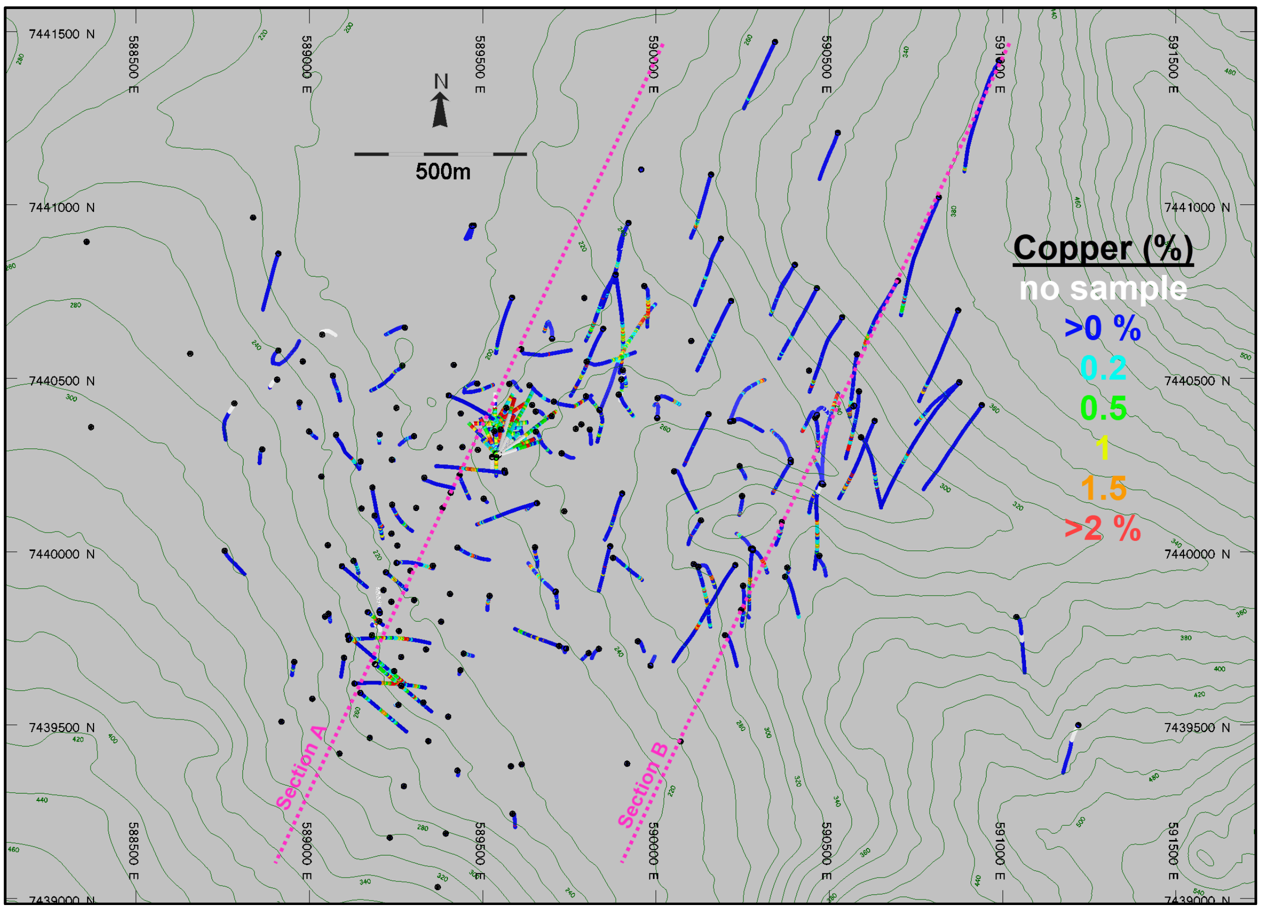
Many of the Kennecott holes in the Ruby Zone are relatively short and, therefore, deviation is not a significant issue. In the deeper drilling at South Reef, Trilogy Metals has appropriately used implied deviations based on local experience. It is believed that the lack of down-hole survey data in some of the Kennecott drill holes does not have a material effect on the estimation of mineral resources at Bornite.

NovaGold (in 2011) and NovaCopper/Trilogy Metals (in 2012, 2013 and 2017) completed down-hole surveys of all of their drill holes using a Reflex Easy-Shot instrument. Trilogy Metal's 2018 program used the Reflex Easy-Trac instrument and the 2019 program used both the Reflex Easy-Trac and Gyro-Sprint instruments. Down-hole surveys were taken on 30 m intervals in 2011, 2017, 2018 and 2019 and on 45 m intervals in 2012 and 2013.

10.6 Summary of Drill Results

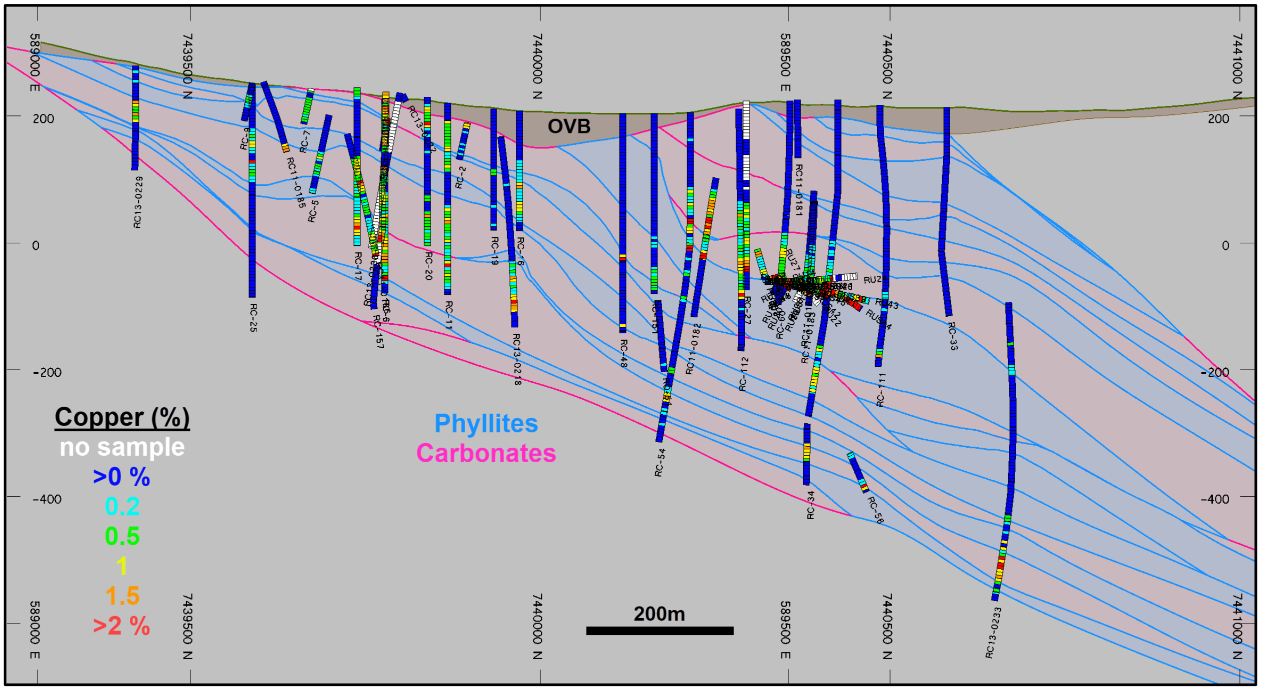
Drilling on the Bornite deposit covers an area measuring roughly 2,500 m east-west by 2,500 m north south with holes that approach 1200m below surface. The distribution copper in drilling is shown in plan in Figure 10-2 and in vertical cross-sectional views through the Ruby Zone area in Figure 10-3 and through the South Reef area in Figure 10-4.

Figure 10-2: Plan Map Showing Copper in Drilling on the Bornite Deposit



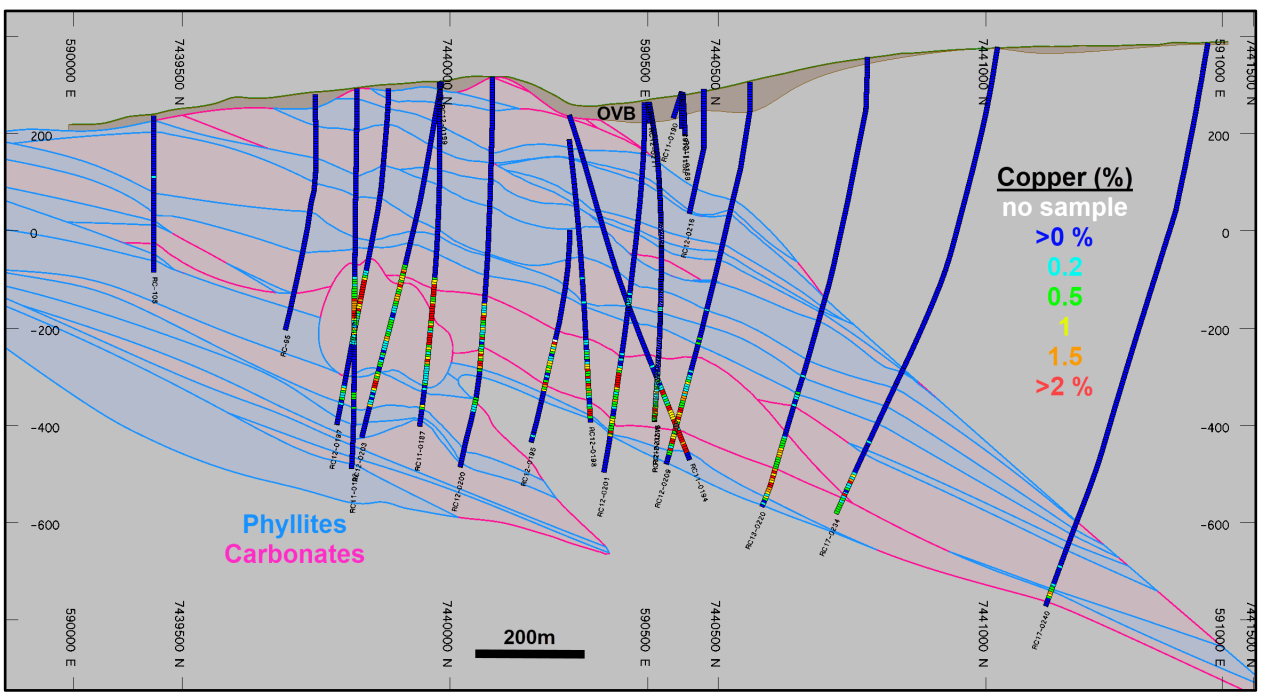
(Source: SIM, 2022)

FIGURE 10-3: VERTICAL CROSS SECTION (SECTION A) SHOWING COPPER IN DRILLING IN THE RUBY ZONE AREA



(Source: SIM, 2022)

FIGURE 10-4: VERTICAL CROSS SECTION (SECTION B) SHOWING COPPER IN DRILLING IN THE SOUTH REEF AREA



(Source: SIM, 2022)

11 SAMPLE PREPARATION, ANALYSES, AND SECURITY

11.1 SAMPLE PREPARATION

The drill core sampling procedures are described in Section 10 (Drilling) of this technical report.

After the drill core was sawed in half, one half was retained for future reference and the other half was sent to ALS Minerals (formerly ALS Chemex) in Vancouver, BC for analyses.

Core samples were shipped from the Bornite Camp when backhaul capacity was available on the chartered aircraft; this was generally five to six days a week. Rice bags, containing two to four individual poly-bagged core samples, were marked and labelled with the ALS Minerals address, project name (Bornite), drill hole number, bag number, and the enclosed sample numbers. Rice bags were secured with a pre-numbered plastic security tie, assembled into loads for transport by chartered flights on a commercial airline to Fairbanks, Alaska, and delivered directly to the ALS Minerals preparation facility by a contracted expeditor. Control samples were also inserted into these shipments at the approximate rate of one standard, one blank, and one duplicate per 17 core samples, as follows:

- Standards: Typically, four to five certified standards were used each year at the Bornite Project (Table 11.1). Standard reference material was purchased from a commercial supplier (CDN located in Vancouver, BC or OREAS located in Melbourne, Australia). Standards were “blindly” incorporated into the sample sequence. When required, the core cutter inserted a sachet of the appropriate standard, as well as the sample tag, into the sample bag.
- Blanks: Blanks were composed of unmineralized marble drill core from an abandoned hole and split to mimic a regular core sample. Blanks were also incorporated “blindly” into the sample sequence. When required, the core cutter inserted about 150 g of a blank, as well as the sample tag, into the sample bag.
- Duplicates: The assay laboratory was instructed to split the duplicate sample and run both splits as two separate samples. The core cutter inserted a sample tag into an empty sample bag.

On arrival, samples were logged into a tracking system at ALS Minerals and weighed. Samples were then crushed and dried, and a 250 g split was pulverized to greater than 85% passing 75 µm.

TABLE 11.1: STANDARD REFERENCE MATERIALS USED BY YEAR

2011	2012	2013	2014	2017	2018	2019
Std-ME09	CDN-ME-09	CDN-ME-09	CDN-ME-09	CDN-ME-09	CDN-ME-09	CDN-ME-09
Std-OREAS-111	CDN-ME-18	CDN-ME-18	CDN-ME-1201	CDN-ME-1208	CDN-ME-1208	CDN-ME-1208
Std-OREAS-75a	GBMS304-5	OREAS-24b	CDN-ME-1210	CDN-ME-1409	GBM 911-11	-
Std-OREAS-90	Std-OREAS-90	OREAS-92	OREAS-24b	GBM 911-11	GBM 301-8	-
-	-	Std-OREAS-90	-	OREAS-165	OREAS-165	OREAS-165
-	-	-	-	OREAS-24b	OREAS-24b	-

11.1.1 DENSITY DETERMINATIONS

Density determinations were not conducted by BCMC/Kennecott on any of the older drill holes. Trilogy Metals has conducted SG measurements on some select historical drill holes during the 2013 and 2014 re-sampling programs.

A total of 7,476 SG determinations were collected by NovaGold and Trilogy Metals during the various drilling programs. SG values range from 2.12 to 5.20. One anomalously high SG value of 8.3 was excluded from the database. NovaGold and Trilogy Metals geologists collected "full-assay-width" SG determinations from available historical split core and NovaGold/Trilogy Metals whole core. The samples averaged 2.01 m long and were collected continuously within mineralized zones estimated to have ≥ 1% chalcopyrite ($CuFeS_2$) or its equivalent copper content (0.3% Cu). In unmineralized zones, samples were collected every 10 m to 15 m. A digital Intell-Lab Balance was used to determine a weight-in-air value for dried core, followed by a weight-in-water value. The wet value was determined by submerging the entire assay interval within a wire basket into a water-filled tote. The SG value was then calculated using the following formula:

$$\frac{\text{Weight in air}}{[\text{Weight in air} - \text{Weight in water}]}$$

Samples were not sealed with wax prior to measuring the weight-in-water. There is relatively minimal porosity evident in the rocks at Bornite and, as a result, this is not considered to be a significant factor in determining density measurements. The density measurements appear to be appropriate for a deposit of this type.

11.2 SECURITY

Security measures taken during historical Kennecott and BCMC programs are not known to Trilogy Metals; however, Trilogy Metals is not aware of any reason to suspect that any of these samples have been tampered with. The 2011 to 2019 samples were either in the custody of NovaGold or Trilogy Metals personnel or the assay laboratories at all times, and the chain of custody of the samples is well documented.

11.3 ASSAYING AND ANALYTICAL PROCEDURES

The laboratories used during the various exploration, infill, and step-out drill analytical programs completed on the Bornite Project are summarized in Table 11.2.

Copper and cobalt data were derived using an additional 48-element suite assayed by inductively coupled plasma-mass (ICP-MS) and atomic emission spectroscopy (ICP-AES) methodologies, following a four-acid digestion. Over limit (>1.0%) copper and cobalt analyses were completed by atomic absorption (AA), following a four-acid digestion. In 2011 and 2012, gold assays were determined using fire analysis followed by an atomic absorption spectroscopy (AAS) finish. Gold was not analyzed in 2013 or 2014. The lower detection limit was 0.005 ppm Au; the upper limit was 10 ppm Au.

ALS Minerals has attained International Organization for Standardization (ISO) 9001:2000 registration. In addition, the ALS Minerals laboratory in Vancouver is accredited to ISO 17025 by the Standards Council of Canada for a number of specific test procedures, including fire assay of gold by AA, ICP and gravimetric finish, multi-element ICP, and AA assays for silver, copper, lead and zinc. Trilogy Metals has no relationship with any of the primary or check assay labs used on the Bornite Project.

TABLE 11.2: ANALYTICAL LABORATORIES USED BY OPERATORS OF THE BORNITE PROJECT

Laboratory Name	Laboratory Location	Years Used	Accreditation	Comment
Unknown	Unknown	Pre-2011 specific years unknown	Unknown	-
ALS Analytical Lab	Fairbanks, Alaska	2011 2012–2013 2014 2017 2018 2019	In 2004, ALS Chemex held ISO 9002 accreditations but changed to ISO 9001 accreditations in late 2004. ISO/International Electrotechnical Commission (IEC) 17025 accreditation was obtained in 2005.	2011 to 2014 and 2017 to 2019 Prep-Lab Facility
ALS Analytical Lab	Vancouver, BC	2011 2014 2017 2018 2019	In 2004, ALS Chemex held ISO 9002 accreditations but changed to ISO 9001 accreditations in late 2004. ISO/International Electrotechnical Commission (IEC) 17025 accreditation was obtained in 2005.	2011 to 2014 and 2017 to 2019 Primary Assay Lab
Acme Labs	Vancouver, BC	2012 2013 2015 2017	Since inception in 1971, AcmeLabs® has been recognized as one of the leading geochemical and assaying laboratories by geologists and stock exchanges world-wide. Holds ISO 9001 and ISO/IEC 17025:2005 accreditations	2012 and 2013 Secondary Check Sample Lab and DPG soil geochemistry
SGS	Vancouver, BC	2014 2017 2018 2019	ISO/IEC 17025 Scope of Accreditation	2014, 2017 to 2019 Secondary Check Sample Lab

11.4 QUALITY ASSURANCE/QUALITY CONTROL

11.4.1 CORE DRILLING SAMPLING QA/QC

Previous data verification campaigns are described in the "Technical Report for the Bornite Deposit, South Reef and Ruby Creek Zones, Northwest Alaska, USA" (Trilogy Metals, 2013).

In 2012, 2013, 2014, and 2017 through to 2019, Trilogy Metals staff performed continuous validation of the drill data during the logging process and after the field program was complete (West, 2013). Trilogy Metals also retained independent consultant Caroline Vallat, P.Geo. of GeoSpark Consulting Inc. (GeoSpark) to import digital drill data to the master database and conduct QA/QC checks upon import; conduct a QA/QC review of paired historical assays and Trilogy Metals 2012, 2013 and 2014 re-assays; monitor an independent check assay program for the 2012, 2013 and 2014 campaigns; and generate a QA/QC report for each of the drilling campaigns conducted in 2012, 2013, 2014, 2017, 2018 and 2019, including a 2017 review of the cobalt data.

The following paragraphs summarize the results and conclusions of the GeoSpark QA/QC review:

11.4.2 Trilogy Metals QA/QC Review on Historical Analytical Results

The 2014 re-logging and re-sampling of the Bornite drill core has added a substantial amount of sample assays to the database and has also provided new assays covering previously analyzed intervals of the drill core. Similar re-sampling also occurred during the 2012 and 2013 exploration programs at the Bornite Project.

A detailed review of the 2012, 2013 and 2014 re-assay analytical results compared to the historical, analytical results for copper has provided insight into the reliability and potential bias within the original, historical results. The scatter and difference plots related to the re-sample copper assays show, overall, no significant bias, but variation at a higher sample grade is likely attributable to the nature of the mineralization at the project.

11.4.3 QA/QC Review on Trilogy Metals (2011 to 2019) Analytical Results

GeoSpark has conducted a series of QA/QC reviews on the NovaGold and Trilogy Metals Bornite Project 2011, 2012, 2013, 2014, and 2017 to 2019 analytical results. These QA/QC reviews serve to infer the accuracy and precision of the analytical assay results through examination of duplicate, standard, and blank control samples.

11.4.4 QA/QC Report For Bornite Project, Cobalt Assays Reported From 2011 to 2017

GeoSpark conducted a QA/QC review of all NovaGold- and Trilogy Metals-era cobalt analyses used in the 2017 cobalt mineral resource update. A review of control samples, duplicate sample pairs, and secondary lab check duplicates shows, overall, very good quality for cobalt results within the 2011 to 2017 Bornite Project assay database.

The QA/QC reviews are documented in a series of memos (Vallat 2012, 2013a, 2013b, 2014, and 2017 to 2020). The reviews are summarized in the following subsections by year of campaign:

2011

The 2011 exploration program QA/QC was monitored by NovaGold. GeoSpark reported no indication of significant assay quality deficiency.

2012

The 2012 exploration program at the Bornite Project included the drilling of 20 new drill holes (RC12-0195 to RC12-0215w) and a re-sampling and re-assaying program on nine historical drill holes. The 2012 sampling amounted to 6,764 samples totalling 14,819 m.

A review of the control sample analytical results indicates that the assay results are of sufficient quality to adequately represent the tenor of the mineralization intersected in drill holes at the Bornite Project.

2013

The 2013 exploration program at the Bornite Project included the drilling of 17 new drill holes (RC13-0217 to RC13-0233) and a large re-sampling and re-assaying program on 33 historical drill holes (31 prefixed RC and 2 prefixed NANA). The 2013 sampling amounted to 9,045 samples totalling 18,657 m.

A review of the control sample analytical results indicates that the assay results are of sufficient quality to adequately represent the tenor of mineralization intersected in drill holes at the Bornite Project.

2014

The 2014 exploration program at the Bornite Project included a large re-sampling and re-assaying program on 37 historical drill holes. Of the 5,819 submitted samples, 5,134 (11,149 m) were from previously un-sampled and un-assayed drill core. The remaining 685 samples (1,503 m) were from drill core that was previously sampled by Kennecott and sent for re-assaying to confirm results.

A review of the control sample analytical results indicates that the assay results are of sufficient quality to adequately represent the tenor of mineralization intersected in drill holes at the Bornite Project.

2017

The 2017 exploration program at the Bornite Project included the completion of seven drill holes that primarily tested the northern, down-dip area of the deposit (RC17-0234 to RC18-0242). Four additional holes were initiated during the program but were abandoned due to drilling problems. There are a total of 2,799 individual samples covering 5,097 m from the 2017 program. Some of the intervals drilled in the hanging wall of the deposit show no visible signs of mineralization and, as a cost saving measure, no samples were collected for analyses.

A review of the control sample analytical results indicates that the assay results are of sufficient quality to adequately represent the tenor of mineralization intersected in drill holes at the Bornite Project.

2018

The 2018 exploration program at the Bornite Project included 15 holes (RC18-0242R to RC18-0256), but three of these holes were abandoned due to drilling problems. There are a total of 4,005 samples in the database from the 2018 program representing 7,554 m of drilling. Some intervals near the top of the holes were not sampled because they showed no visible signs of the presence of mineralization.

A review of the control sample analytical results indicates that the assay results are of sufficient quality to adequately represent the tenor of mineralization intersected in drill holes at the Bornite Project.

2019

The 2019 exploration program at the Bornite Project included the drilling of 10 new drill holes (RC19-0257 to RC19-0266). A total of 3,561 samples were collected and analyzed representing 6,827 m of drilling. Some intervals near the top the holes were not sampled as they showed no visible signs of mineralization.

A review of the control sample analytical results indicates that the assay results are of sufficient quality to adequately represent the tenor of mineralization intersected in drill holes at the Bornite Project.

11.4.5 Density Determinations QA/QC

A QA/QC review of the 2011, 2012, 2013, and 2017 SG determinations for the Bornite Project were conducted by Trilogy Metals staff and are documented in a series of memos. Where SG determinations have matching assay from/to intervals, a stoichiometric check was completed (West, 2014). The wet/dry measurements compare well with the stoichiometrically estimated values. In addition, extreme SG determinations (below 2.0 and above 5.0) were flagged and evaluated individually by the project geologist.

11.5 Author's Opinion

BMD and SGI believe the database meets or exceeds industry standards for data quality and integrity. They also believe the sample preparation, security, and analytical procedures are adequate to support the estimation of mineral resources.

12 DATA VERIFICATION

12.1 Drill Collar Validation

The locations of all drill hole collars were surveyed using differential GPS. This included the re-surveying of older holes drilled in the 1950s, 60s and 70s when the collars were still present. Collar elevation data were validated by comparing surveyed elevations with the Lidar digital elevation model (DEM) over the project area. Most elevation differences at the drill hole collars were less than 1 m compared to the DEM surface.

12.2 Down Hole Survey Validation

The down-hole survey data were validated by searching for the presence of any large discrepancies between sequential dip and azimuth readings. Two of the older drill holes (RC33, 1959; RC-56, 1961) showed somewhat irregular deviations. There are no known magnetic minerals that would produce these results, and it was not possible to re-survey these drill holes. These holes occurred in areas of Inferred mineral resources, and their influence on the overall estimate of mineral resources is relatively small. If it were possible to re-survey these two drill holes, the impact on the estimate of mineral resources would likely be insignificant.

12.3 Comparisons of Vintages of Drilling Data

Much of the drill core generated from the historical Kennecott drilling remained on site. Trilogy Metals has re-sampled many of these older holes, and these results have been verified through the inclusion of a QA/QC program.

For the holes that have not been re-sampled, a visual and statistical comparison shows that there is good correlation between the historical drilling results and the modern drilling conducted by Trilogy Metals. The results suggest there is no significant difference in the observed drilling results when either the old or new drill holes are used.

12.4 Site Visit Observations

Bruce Davis visited the Property on several occasions (July 26 to 27, 2011; September 25, 2012; August 10 to 12, 2015; and August 28 to 29, 2019), and Robert Sim visited the Property from September 20 to 22, 2018. During these visits, they met with site personnel and observed any active drilling operations. Core handling and sampling procedures were observed and reviewed, as well as procedures used to collect SG measurements. Tours of the deposit area and the surrounding Property were conducted by helicopter, and stops were made to observe active drilling activities as well as stops at several of the areas where previous drilling had occurred.

Drill core from a series of randomly selected holes was reviewed and compared to the information in the database. The geologic descriptions appeared to be reasonable, and visual observations of the copper-bearing minerals present reflected the grades in the sample database. No duplicate samples were taken by the QPs to verify the results during the site visits. In the opinion of the QPs, the exploration activities used on the project follow generally accepted industry standards

12.5 DRILL DATA VERIFICATIONS

Following the generation of the South Reef mineral resource model in 2012, Robert Sim, P.Geo., SIM Geological Inc., randomly selected four Trilogy Metals-era drill holes for manual validation. The collar, survey, and assay information for these holes in the electronic database was checked against original data sources, and no significant errors or differences were found.

Following the completion of the 2013 mineral resource model, an additional five holes drilled by Trilogy Metals during the 2013 program, were randomly selected for validation purposes. Once again, no significant errors or differences were found.

Following the generation of the mineral resource estimate described in the June 2018 technical report, the data from seven drill holes, representing about 5% of the database at that time, were randomly selected and the copper and cobalt grades were manually compared to the certified assay certificates. No significant errors were found.

Five drill holes from the 2018 program and four holes from the 2019 program were randomly selected and the copper and cobalt values in the database were manually compared to the values listed in the certified assay certificates. No errors were found.

12.6 CONCLUSIONS

Bruce Davis and Robert Sim have reviewed Trilogy Metals' drilling and sampling procedures and confirm that they follow accepted industry standards. The accuracy and precision of all Trilogy Metals samples have been maintained through the application of a QA/QC program that follows accepted industry standards. Trilogy Metals has conducted a series of validation checks that exhibit a reasonable degree of confidence with respect to the location and assay results from the older Kennecott drill holes.

Given the assay check results, the review of the drilling and core sampling, and the comparison of certificates to the electronic database, the sample assay data are within acceptable limits of precision and accuracy to generate a mineral resource estimate.

BMD and SGI believe the database has been generated using accepted industry standards, and the contained data are sufficient for the estimation of Indicated and Inferred mineral resources.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 METALLURGICAL TEST WORK REVIEW

13.1.1 INTRODUCTION

A number of metallurgical studies have been completed on samples collected from the Bornite deposit with metallurgical test work campaigns conducted at the Kennecott Research Centre (KRC), ALS Metallurgy (Kamloops) and SGS Mineral Services (Vancouver). A majority of the test work has been completed under the direction of Trilogy Metals. Studies to date are limited to the recovery of copper from the Bornite deposit samples. There have been no detailed studies to date that evaluate the process characteristics of the cobalt mineralization present at the Bornite deposit.

13.1.2 HISTORICAL TEST WORK REVIEW

In 1961, Kennecott collected 32 coarse reject samples from five drill holes intersecting the Bornite deposit (RC-34, RC-54, RC-60, RC-61, and RC-65) to support preliminary metallurgical test work conducted at KRC. Samples targeted high-grade (>10%) copper mineralization from the Upper Reef Ruby Zone (“No.1 Ore Body”) (BCMC, 1961).

All sample intervals, weighing approximately 68 kg (150 lbs) in total, were composited using weighted compositing methodology. Prior to compositing, each sample was crushed and screened to pass a 10-mesh screen. The grade of the composited sample, based on the assay results of the individual samples, was 13.9% Cu.

Locked-cycle laboratory test work suggested that 97.64% of the copper was recoverable in a concentrate assaying 43.90% Cu. Fine-grinding to 5% passing +200-mesh was required to obtain the liberation of copper minerals from pyrite necessary for such a high recovery. Mineralogical test work on the composite sample showed high-grade mineralization of the “No.1 Ore Body” is dominated by bornite with subordinate chalcocite and chalcopyrite.

It is not known whether the test work conducted by Kennecott used samples representative of the various types of high-grade mineralization or whether any deleterious elements were encountered during the tests.

13.1.3 Metallurgical Test Work Programs Initiated By Trilogy Metals

Introduction

A total of four metallurgical test work programs have been conducted on materials from the Bornite Property under the supervision of Trilogy Metals. A summary of the test work schedule and samples completed by Trilogy Metals is shown in Table 13.1.

Table 13.1: Summary of Bornite Metallurgical Test Work Programs Initiated by Trilogy Metals

Year of Test Work	Research Facility, Project No. and Report Date	Comments on Test Work Program
2012–13	ALS Metallurgy, KM3621: June 20, 2013	Test work on 4 high-grade South Reef Composites
2017–18	SGS Canada Ltd., CAVM 50296-001: July 4, 2018	Flotation and Comminution Testing 5 Composites
2018–19	ALS Metallurgy, KM5705: April 18, 2019	Flotation and Comminution Testing 9 Composites
2020–21	ALS Metallurgy, KM6184: March 12, 2021	Flotation and Comminution Testing 5 Composites

In 2012, Trilogy Metals contracted ALS Metallurgy of Kamloops, BC to conduct preliminary sample characterization and flotation test work on mineralized samples collected from the South Reef area of the Bornite deposit. To the extent known, the samples are representative of the styles and types of mineralization present in the South Reef area and do not represent proposed open pit recoverable resources. The test work program at ALS Metallurgy was based on traditional grinding and flotation test work aimed at producing saleable copper concentrates. The test work continued into 2013, and the results were summarized in a report dated June 20, 2013.

In 2017, Trilogy Metals contracted SGS of Vancouver, BC to conduct detailed metallurgical test work on a series of samples that represent lower grade mineralization that is considered to be potentially amenable to open pit extraction methods. This test work followed the preliminary flowsheet and process options outlined in the 2012–13 test work. This test work continued into 2018, and the results were summarized in a report dated July 4, 2018.

Additional metallurgical testing was conducted by ALS Metallurgy of Kamloops, BC in 2018–19 and again in 2020–21 which followed on from the process development of the earlier test work. The results of these test programs were presented in two reports dated April 18, 2019 and March 12, 2021.

Test Samples

The composition of the various composites used in metallurgical testing initiated by Trilogy Metals are summarized in Table 13.2. Details of all of the test sample intervals are contained within the respective test work reports.

The 2012–13 test work program at ALS Metallurgy used 71 individual drill core (half core) sample intervals totalling 262 kg of material from the Bornite deposit. Individual samples were combined into four composites, which were prepared to represent a range of copper grades (0.5–1.0% Cu, 1.0–2.0% Cu, 2.0–10.0% Cu, and >10.0% Cu). The samples were obtained from drill holes completed in 2012 in the South Reef area and represent typical higher grade mineralization located between 400 m and 600 m below surface.

The 2017–18 test work program at SGS prepared five large composite samples (development composites) from two drill holes for use in detailed flotation test work. As well, 15 variability samples were prepared as sub-samples for use in grinding test work from this same drill core. These samples represent lower grade mineralization that is considered more amenable to open pit extraction methods.

The 2018–19 ALS Metallurgy test program was conducted on nine large composite samples, each representing approximately 40 m of drill core intercept. Composites were selected over a range of grades that generally reflect both open pit and underground mining scenarios. Significant differences in overall copper recovery were observed, with the higher grade samples showing higher copper recoveries when compared to the lower grade samples. Detailed recovery data are shown in Table 13.4.

The 2020–21 ALS Metallurgy test program was conducted on five large composite samples, each representing approximately 40 m of drill core intercept. These were higher grade samples that generally reflect material obtained through underground mining methods.

TABLE 13.2: SUMMARY OF CHEMICAL ANALYSIS OF METALLURGICAL COMPOSITES COMPILED BY TRILOGY METALS

Sample	Cu (%)	Fe (%)	S (%)	Zn (%)	Au (g/t)	Ag (g/t)
2012–13 Samples KM3621						
Composite 0.5–1.0	0.65	4.9	2.04	0.02	0.01	<1.0
Composite 1.0–2.0	1.21	4.9	3.29	0.01	0.01	1.0
Composite 2.0–10.0	4.04	11.6	13.9	0.70	0.12	1.0
Composite >10.0	17.3	14.6	18.1	0.71	0.24	13.0
2017–18 Samples CAVM 50296-001						
Dev. Composite 1	1.11	7.72	8.29	0..21	0.02	<0.02
Dev. Composite 2	0.91	5.97	4.91	0.11	0.05	<0.02
Dev. Composite 3	0.91	6.01	4.87	0.1	0.03	<0.02
Dev. Composite 4	1.45	10.4	11.6	0.09	0.04	<0.02
Dev. Composite 5	1.00	9.12	10.2	0.16	0.03	0.04
2018–19 Samples KM5705						
Composite 1	1.56	6.7	5.88	0.18	0.03	2
Composite 2	0.95	10.0	10.4	0.28	0.02	1
Composite 3	1.03	8.2	8.4	0.03	0.02	2
Composite 4	2.29	6.6	5.77	0.22	0.04	3
Composite 5	1.80	4.6	4.19	0.02	0.01	2
Composite 6	0.76	5.8	4.69	0.03	0.01	1
Composite 7	1.98	7.4	7.48	0.05	0.04	1
Composite 8	3.00	7.5	6.94	0.17	0.03	2
Composite 9	4.16	6.2	6.65	0.01	0.13	1
2020–21 Samples KM6184						
Composite 10	1.30	7.1	7.22	-	0.04	2
Composite 11	2.01	10.6	11.2	-	0.06	5
Composite 12	3.21	6.5	5.13	-	0.04	1
Composite 13	1.88	3.4	1.62	-	0.04	3
Composite 14	2.12	5.4	4.08	-	0.10	1

MINERALOGICAL INVESTIGATION

All of the metallurgical test work programs contained some component of mineralogical analysis of the various Bornite feed samples. Details of mineralogical evaluations are contained in the respective test work reporting.

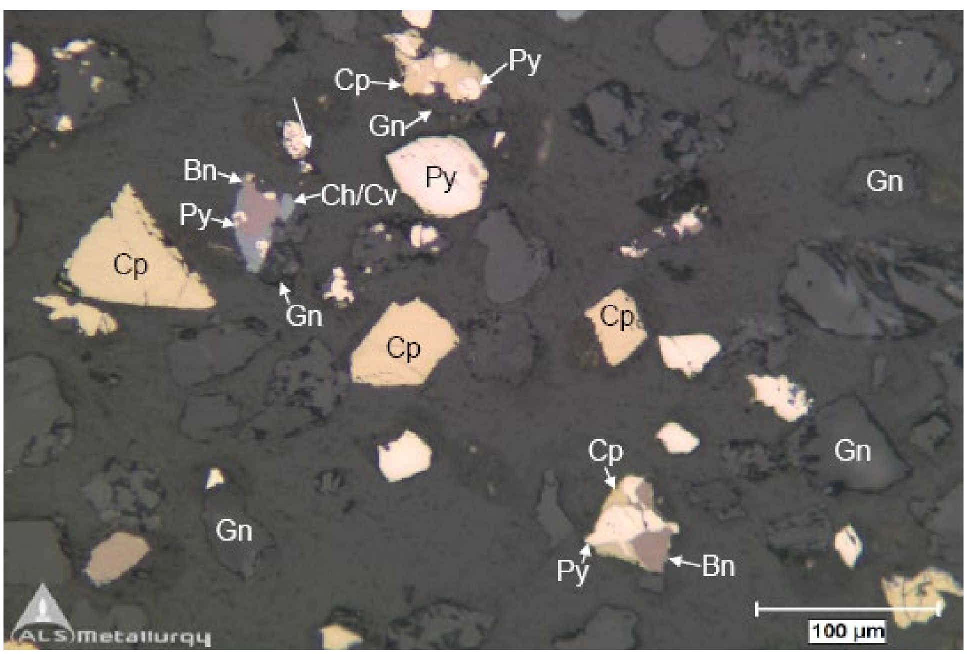
In summary, the Bornite materials require grinding to approximately 100 microns to achieve liberation targets supporting a rougher flotation stage in order to maximize the recovery of copper.

Re-grinding of copper rougher flotation concentrates requires fine grinding in the range of 10 to 20 microns to achieve liberation targets for final concentrate production. A portion of the copper mineralization is fine grained and associated with gangue minerals requiring the fine re-grind prior to flotation cleaning stages.

A typical photomicrograph of the 1.0–2.0% Cu composite from the 2013 ALS Metallurgical test program is shown in Figure 13-1; typical, liberated copper minerals are shown as well as somewhat complex chalcopyrite/pyrite/bornite multiphase particles.

It should be noted that higher grade materials contain significant concentrations of bornite, chalcocite and covellite which may lead to the production of higher-than-average copper concentrates, when the flotation process is finally optimized.

FIGURE 13-1: TYPICAL GRAIN-SIZE DISTRIBUTION OBSERVED AT THE BORNITE DEPOSIT (KM3621)



Notes: Cp-Chalcopyrite, Bn-Bornite, Ch/Cv-Chalcocite/Covellite, Py-Pyrite, Gn-Gangue.
(Source: Trilogy Metals, 2018)

SAMPLE HARDNESS TEST RESULTS

Composite samples from all four of Trilogy Metals metallurgical test work programs were subject to a Bond Ball Mill Work Index determination, and the results are summarized in Table 13.3. Based on these results, the Bornite materials can be considered to be soft, or easily ground in traditional grinding mills. It is also apparent that the Bornite materials are very consistent in terms of hardness, with little variation between samples. The classification size used in all of the test work was 150 microns.

TABLE 13.3: SUMMARY OF BOND BALL MILL WORK INDEX DETERMINATIONS

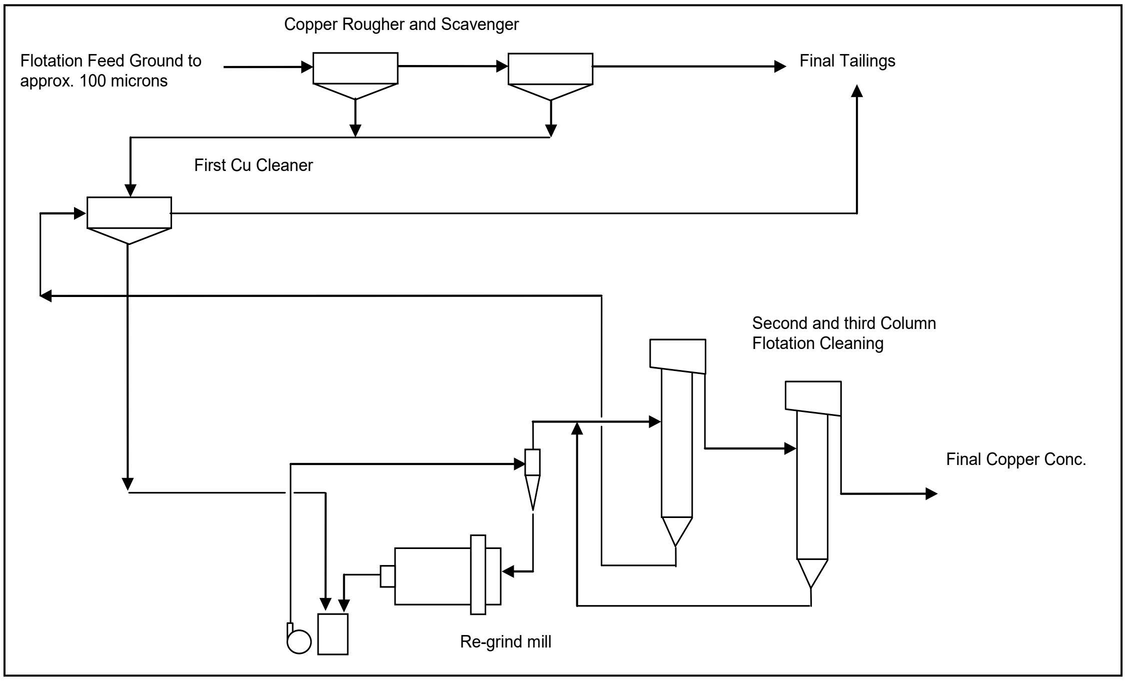
Sample	Bond Ball Mill Work Index
Number of Samples Tested	33
Average Bond Ball Mill Work Index	9.52 kWhr/tonne
Maximum Bond Ball Mill Work Index	10.9 kWhr/tonne
Minimum Bond Ball Mill Work Index	7.8 kWhr/tonne

FLOTATION TEST RESULTS

ALS Metallurgy and SGS have both provided detailed test reports outlining the results of flotation test work programs. All test composites responded well to the recovery of copper minerals using the flowsheet shown in Figure 13-2. The proposed recovery process, generally considered standard in the industry, is expected to incorporate the following key unit operations:

1) Primary crushing
2) SAG milling and ball milling to approximately 100 microns
3) Rougher flotation
4) Rough concentrate re-grinding to approximately 10 to 20 microns
5) Flotation cleaning to produce final copper concentrates
6) Concentrate de-watering
7) Tailings deposition of tailings solids

FIGURE 13-2: PROPOSED BORNITE FLOTATION FLOWSHEET



The recovery of copper and related copper concentrate grades observed in the ALS Metallurgy and the SGS test work is summarized in Table 13.4. Generally speaking, the test work conducted in the ALS Metallurgy test work program KM3621 was not optimized and is preliminary in terms of results. The SGS flotation test work and the balance of ALS Metallurgy test work, by comparison, is more exhaustive in terms of process optimization, and these results show higher copper recoveries and better overall results.

Flotation parameters used in the test work are considered typical of a copper operation and included copper flotation collectors such as xanthates and Aerophine® copper collectors. Lime was used for pH control in the flotation process.

The latter ALS Metallurgy programs and the SGS program followed similar metallurgical test work protocols, and fairly consistent metallurgical results were obtained across all samples tested. The copper recovery and concentrate grades from process simulation testing is also summarized in Table 13.4. These results show a consistent trending of copper recovery increasing with higher copper feed grades. This is consistent with mineralogical observations and points to higher expected recoveries for underground mine production when compared to typically lower grade open pit production material.

TABLE 13.4: SUMMARY OF PROCESS SIMULATION TEST WORK RESULTS - LOCKED CYCLE TESTS

Sample	Feed Grade % Cu	Copper Recovery %	Final Conc. Grade % Cu
2012–13 ALS Metallurgy KM3621			
Composite 0.5–1.0	0.65	67.5	30.9
Composite 1.0–2.0	1.21	78.0	29.4
Composite 2.0–10.0	4.04	85.2	24.5
Composite >10.0	17.3	98.0*	30.0*
2017–18 SGS CAVM 50296-001			
Dev. Composite 1	1.11	90.4	30.3
Dev. Composite 2	0.91	87.0	24.3
Dev. Composite 3	0.91	89.7	25.6
Dev. Composite 4	1.45	91.6	33.5
Dev. Composite 5	1.00	90.9	28.0
2018–19 ALS Metallurgy KM5705			
Composite 1	1.56	88.6	25.8
Composite 2	0.95	75.6	16.7
Composite 3	1.03	87.8	25.0
Composite 4	2.29	88.3	27.2
Composite 5	1.80	89.3	29.8
Composite 6	0.76	80.5	26.4
Composite 7	1.98	94.1	24.0
Composite 8	3.00	94.1	28.5
Composite 9	4.16	94.7	34.2
2020–21 ALS Metallurgy KM6184			
Composite 10	1.30	76.1	26.7
Composite 11	2.01	86.3	26.4
Composite 12	3.21	90.3	32.3
Composite 13	1.88	88.9	36.9
Composite 14	2.12	85.5	34.1

*open circuit test result only due to high-grade feed sample.

Test work results point to estimated copper recoveries of 87% to 90% for lower grade feed samples of 1% to 2% copper and increased copper recoveries of 90% to 94% for higher grade mineralized material, in excess of 2% Cu, that would be generally derived using underground mining methods.

CONCENTRATE QUALITY TARGETS

Analysis of the final copper concentrates was completed within the various test work programs, and the results are summarized in Table 13.5.

TABLE 13.5: TYPICAL CONCENTRATE ANALYSIS – KM5705 FINAL COPPER CONCENTRATES

Element	Symbol	Unit	Comp 1	Comp 3	Comp 5	Comp 8
Antimony	Sb	%	0.0021	0.0136	0.145	0.0099
Arsenic	As	%	0.023	0.018	0.130	0.120
Cadmium	Cd	%	0.0084	0.0026	0.0017	0.0055
Cobalt	Co	g/t	1515	516	1466	1505
Copper	Cu	%	25.8	25.0	29.8	28.5
Iron	Fe	%	26.4	29.9	27.9	28.0
Mercury	Hg	g/t	6	7	10	9
Sulphur	S	%	32.8	34.8	32.6	33.7
Zinc	Zn	%	2.60	0.56	0.23	1.16

The concentrates are unlikely to contain payable precious metals as these appear to be below accepted splitting limits within traditional concentrate sales terms.

The concentrates are also considered to contain low levels of penalty elements and elements such as arsenic, antimony, mercury, cadmium and selenium. The concentrates will likely not incur any financial penalty under traditional sales terms. Zinc may incur a payable penalty if levels are consistently above about 3% Zn. It would be an added transportation expense at those levels as well. Zinc is typically not payable within copper concentrates.

COBALT SPECIATION STUDIES

A preliminary cobalt mineral speciation investigation was conducted by Trilogy Metals in 2017 using both the tails- and concentrate-test products of the 2012–13 and 2017 metallurgical test work. Microprobe analysis and backscatter electron mapping of the products show that the majority of cobalt (~80%) is contained within cobaltiferous pyrite at low cobalt contents, while the remaining cobalt (20%) occurs as carrollite and/or cobaltite. A majority of the cobalt contained in the Bornite deposit is contained within pyrite minerals and not as a distinct cobalt mineral.

13.2 RECOMMENDED TEST WORK

Additional metallurgical test work is required to support the Bornite Project as it moves through the development process. Key areas that require additional test work are as follows:

- Additional sample material will need to be tested as the mineral resource is better delineated by additional exploration. This is to better understand the potential variability (both grade and spatial) that may be present in the deposit. This additional test work can take the form of additional grinding and flotation test work, along the lines of the recently completed metallurgical test work programs.
- Concentrate quality should continue to be monitored in any future test work.
- At some point, detailed test work involving settling and filtering will be required for concentrates and tailings produced from test work.

14 MINERAL RESOURCE ESTIMATE

14.1 INTRODUCTION

This section describes the generation of the mineral resource estimate for the Bornite Project. The mineral resource estimate was prepared by Robert Sim, P.Geo., SIM Geological Inc. (SGI) with the assistance of Bruce M. Davis, FAusIMM, (BMD). Both are Independent qualified persons (QPs) as defined in National Instrument 43-101 (NI 43-101).

Trilogy Metals Inc. (Trilogy Metals), formerly NovaCopper Inc., has filed several technical reports on the Bornite deposit. The previous report had an effective date of June 5, 2018.

In the summer of 2017, seven holes were drilled that tested the down-dip continuity of the northern part of the Bornite deposit. These drill holes successfully intersected the mineralized target horizon, but the spacing of these holes was considered too far apart to support the generation of additional mineral resource estimates at that time, and as a result, the estimate of copper mineral resources remained unchanged in the June 2018 report from those reported in the previous technical report dated April 2016, and the June 2018 technical report included an estimate of cobalt mineral resources.

In the summer of 2018, Trilogy Metals conducted a drilling program on the Bornite deposit that included the completion of 12 holes that infilled gaps in previous drilling in the northern, down-dip part of the deposit as well as in the central area between the Ruby Zone and South Reef area.

In the summer of 2019, another drilling program was conducted on the Property comprising eight holes that tested the continuity of the mineralization within the Bornite deposit and two holes that tested exploration targets located about 1 km south and southeast of the deposit.

From 2011 through 2017, Trilogy Metals implemented an expanded program of re-sampling and re-assaying for an extended suite of elements, including cobalt. Analyses of these additional elements were continued on samples collected during the 2018 and 2019 drilling programs, and once again, estimates of both copper and cobalt mineral resources are included in this report.

The effective date of the mineral resource estimate presented in this report is December 31, 2021.

This section describes the mineral resource estimation methodology and summarizes the key assumptions considered by the QPs. In the opinion of the QPs, the mineral resource evaluation reported herein is a sound representation of the copper and cobalt mineral resources for the Bornite Project at the current level of sampling. The mineral resources were estimated in conformity with generally accepted CIM *Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines* (November 2019) and are reported in accordance with the Canadian

Securities Administrators' NI 43-101. Mineral resources are not mineral reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the mineral resource will be converted into a mineral reserve.

The QPs audited the database used to estimate the Bornite Project mineral resource, and the QPs are of the opinion that the current drilling information is sufficiently reliable to confidently interpret the boundaries for copper and cobalt mineralization, and the assay data are sufficiently reliable to support mineral resource estimation.

The mineral resource estimate was generated using MinePlan® v15.80-2. Some non-commercial software, including the Geostatistical Library (GSLib) family of software, was used for geostatistical analyses.

14.2 Sample Database and Other Available Data

Trilogy Metals provided the Bornite database in Microsoft™ Excel format, exported from the master database (GeoSpark Core Database System). The files contain collar, survey, assay, lithology, and specific gravity data, and other geological and geotechnical information. Note: For simplicity purposes, work done by NovaGold (in 2011) and NovaCopper (in 2012 through 2016) may be refered to as work conducted by "Trilogy Metals" in this section of the report.

The Project database comprises a total of 273 diamond drill (core) holes totalling 106,406 m; 203 holes target the Ruby Zone to the west and 58 holes target the South Reef area to the east. The remaining 12 holes in the database are exploratory in nature and test for satellite mineralization proximal to the Bornite deposit or represent holes that encountered problems and were therefore abandoned. The database contains a total of 39,740 samples that were analyzed for copper content and 34,177 that were analyzed for cobalt content. Most holes drilled by Trilogy Metals, plus a few select historical holes drilled by Kennecott Mines Company (Kennecott), contain additional analyses for elements such as zinc, lead, gold, silver, and cobalt; at this time, only copper and cobalt show any significant economic potential, and the others were excluded from the estimation of mineral resources.

During the 2012, 2013 and 2014 field seasons, Trilogy Metals collected samples from drill hole intervals that Kennecott never sampled. It is assumed that Kennecott did not sample these intervals because, visually, they did not exhibit the presence of high-grade copper mineralization (amenable to underground mining). In previous mineral resource estimates, these un-sampled intervals were assigned a default grade of 0% Cu. At this current stage, the majority of the core drilled by Kennecott has been sampled and analyzed for copper content. The sampling and assaying for cobalt is less extensive. Where assay data are not available, these intervals are assigned a zero grade for copper (0% Cu) when the host rocks are phyllite, or they left as "missing" when the host rocks are carbonates. No adjustments were made to intervals where cobalt grades are missing, and mineral resource estimates are estimated using the available sample data.

Individual sample intervals range from 3 cm to 39.58 m long and average 2.09 m.

Drill hole spacing at the Ruby Zone varies from approximately 10 m to 20 m for underground holes and 50 m to 100 m or more for holes drilled from surface. All holes testing the South Reef area are collared from surface and typically intersect mineralization at approximately 100 m to 200 m spacing.

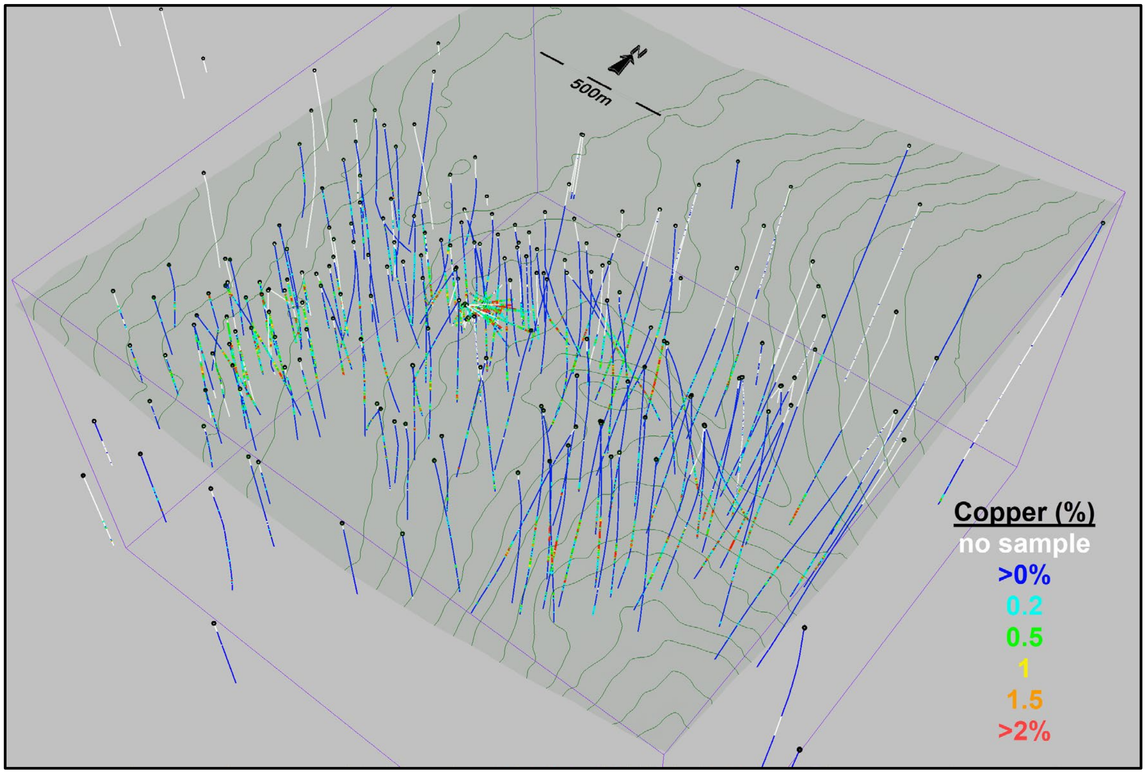
Specific gravity (SG) measurements were conducted on 7,476 samples in the database and range from a minimum of 2.12 to a maximum of 5.20 and average 2.89. The distribution of SG data is considered sufficient to support block model estimation.

Drill core recovery was recorded for approximately one half of the drill holes at the Ruby Zone and in essentially all of the South Reef drill holes. Overall, core recoveries are considered to be very good with an average of 86% for the Project. Only 8% of samples have recoveries ≤ 50%, and approximately 85% of samples have core recoveries ≥ 75%. There is no apparent correlation between copper grade and drill core recovery. There were no adjustments or omissions to the mineral resource database in response to drill core recoveries.

Trilogy Metals provided a topographic digital terrain surface derived from a 2010 PhotoSat 1 m resolution model. Drill hole collar locations, surveyed using a differential GPS, correlate very well with the local, digital terrain (topographic) surface.

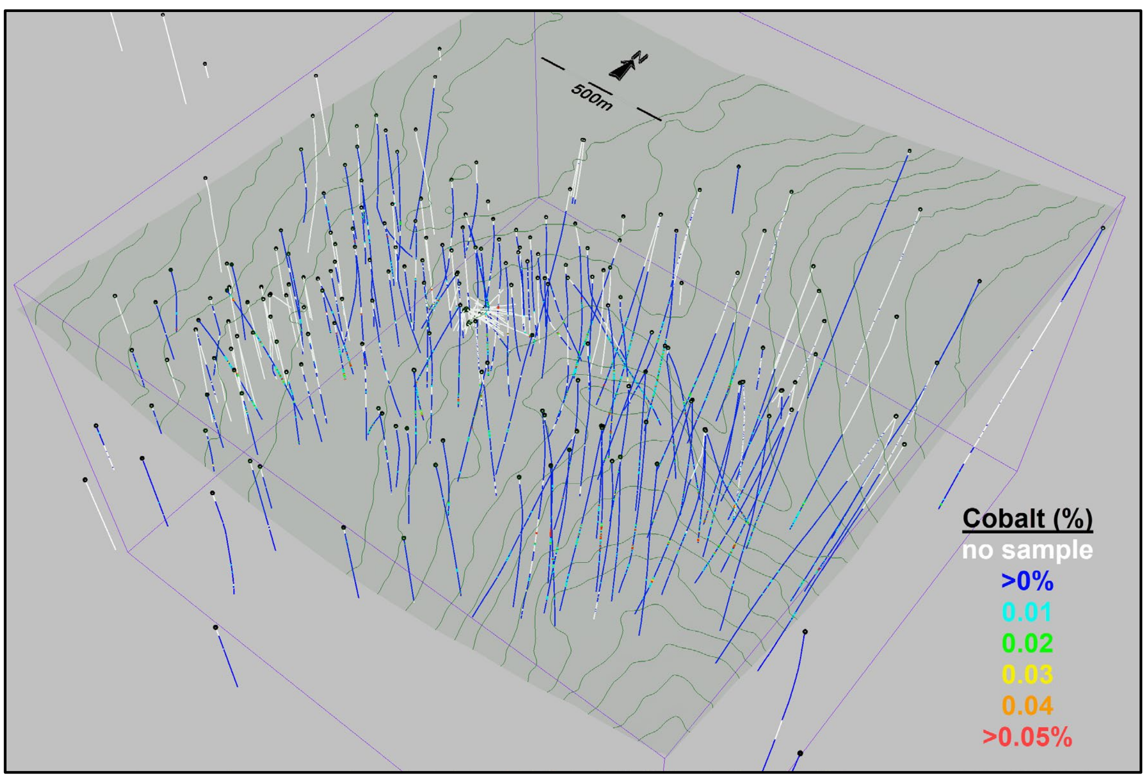
The distribution of copper grades in drill holes is shown in Figure 14-1. The distribution of cobalt grades in drill holes is shown in Figure 14-2. The distribution of drilling by vintage, including the re-sampling completed in 2012, 2013 and 2014, is shown in Figure 14-3 and summarized in Table 14.1.

FIGURE 14-1: COPPER GRADES IN DRILL HOLES



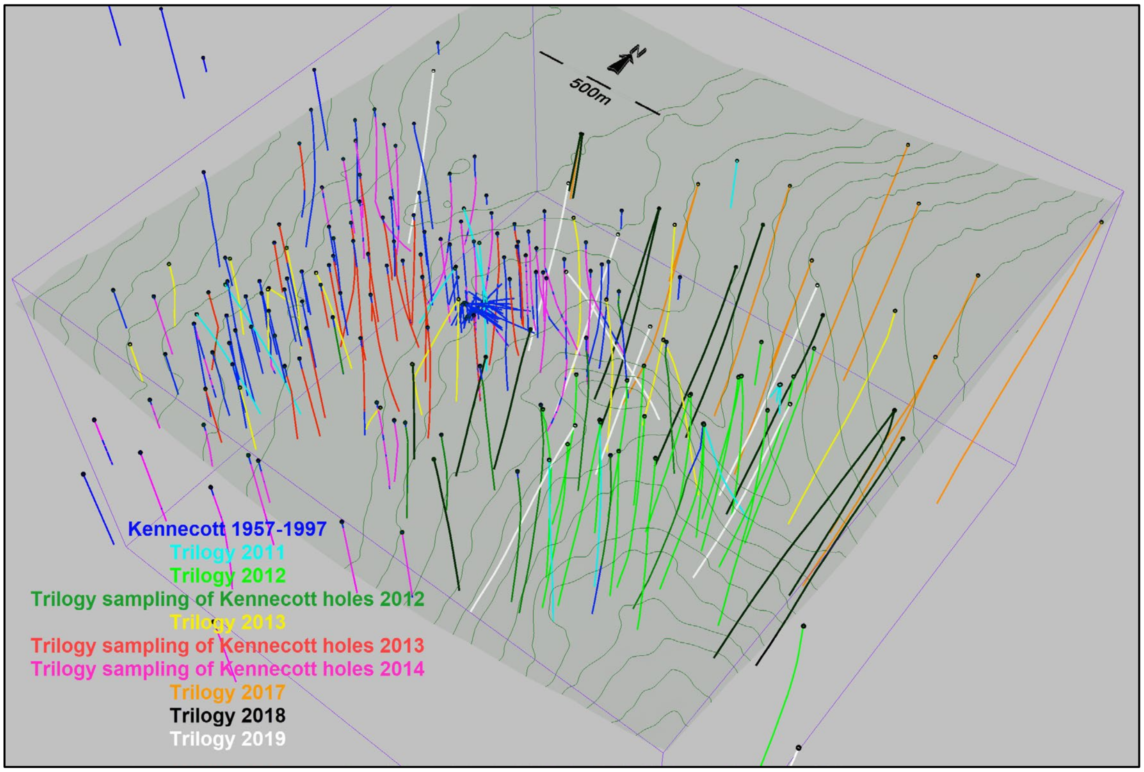
(Source: SIM, November 2021)

FIGURE 14-2: COBALT GRADES IN DRILL HOLES



(Source: SIM, November 2021)

FIGURE 14-3: VINTAGE GRADES OF DRILLING AND SAMPLING



(Source: SIM, November 2021)

TABLE 14.1: SUMMARY OF DRILLING DATA FOR THE BORNITE PROJECT

Company	Years	Number of Drill Holes	Number of Samples	Total Sample Length (m)
Kennecott	1957–1997	182	7,503	15,963
NovaGold	2011	14	2,328	5,497
NovaCopper	2012	22	6,698	14,464
NovaCopper sampling of Kennecott holes	2012	11	2,148	4,743
NovaCopper	2013	15	3,109	6,701
NovaCopper sampling of Kennecott holes	2013	31	4,535	9,703
NovaCopper sampling of Kennecott holes	2014	41	5,060	10,965
Trilogy Metals	2017	11	2,799	5,097
Trilogy Metals	2018	12	4,005	7,554
Trilogy Metal	2019	10	3,561	6,827

Historical drilling at the Bornite Project was conducted by Kennecott. It was a leading technical exploration company during its tenure, known for rigorously controlled drilling programs which typically included the insertion of quality control samples. Unfortunately, records from the Kennecott era are incomplete and direct validation of some portions of the database cannot be completed. A comparison of declustered datasets, derived from the two vintages of drilling, indicate that both the Kennecott and Trilogy Metals drilling produce essentially the same results. For validation purposes, Trilogy Metals re-sampled drill core originally sampled and analyzed by Kennecott. The results of this resampling suggest that it is reasonable to believe the sample results produced during historical drilling are not significantly different from those generated by Trilogy Metals.

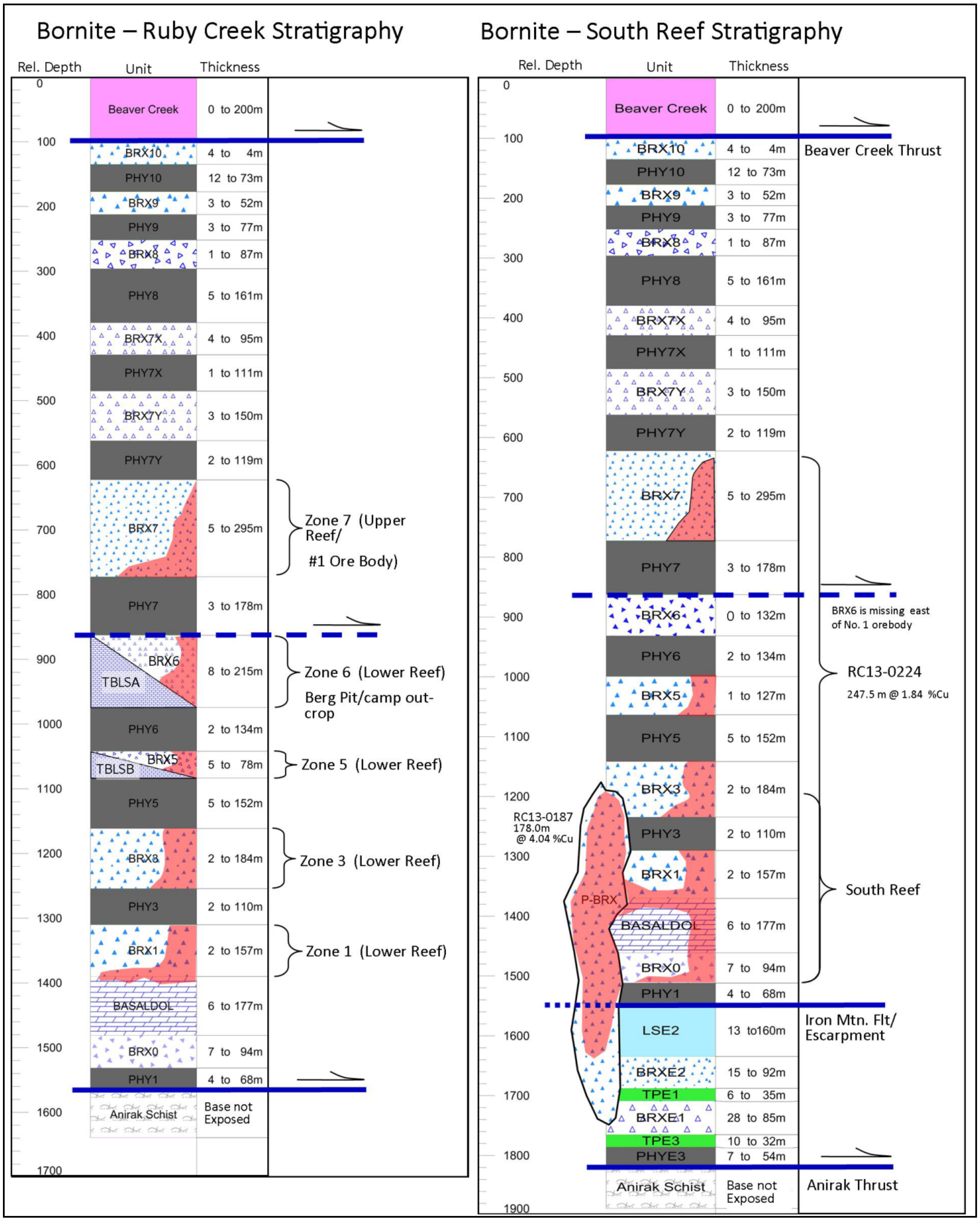
With the drilling completed by Trilogy Metals, plus the additional re-sampling of the historical drill core, the original Kennecott sample data represent a relatively minor proportion of the overall database. All of the historical drilling has been included in the Bornite mineral resource estimate, and no adjustments were made to any of this historical data.

14.2.1 Geologic Model

The geologic model interpreted for the Bornite deposit consists primarily of a series of inter-bedded carbonate and phyllitic rocks that dip gently to the north and overlay a quartz-phyllite footwall. Copper and associated cobalt mineralization occurs primarily as massive, semi-massive, stringer, veinlet and disseminated accumulations of chalcopyrite, bornite and chalcocite in dolomitized portions of the sedimentary host rocks. Cobalt minerals such as carrolite and cobaltiferous pyrite tend to be associated with the copper mineralization. The geologic model comprises 18 individual phyllite domains and 16 separate carbonate domains plus a series of separate domains representing the hanging wall (Beaver Creek phyllite), the footwall (quartz-phyllite Anirak schist), and the overlying overburden. Some of the phyllite and carbonate units are continuous across the entire deposit area and others “pinch out” and are more localized.

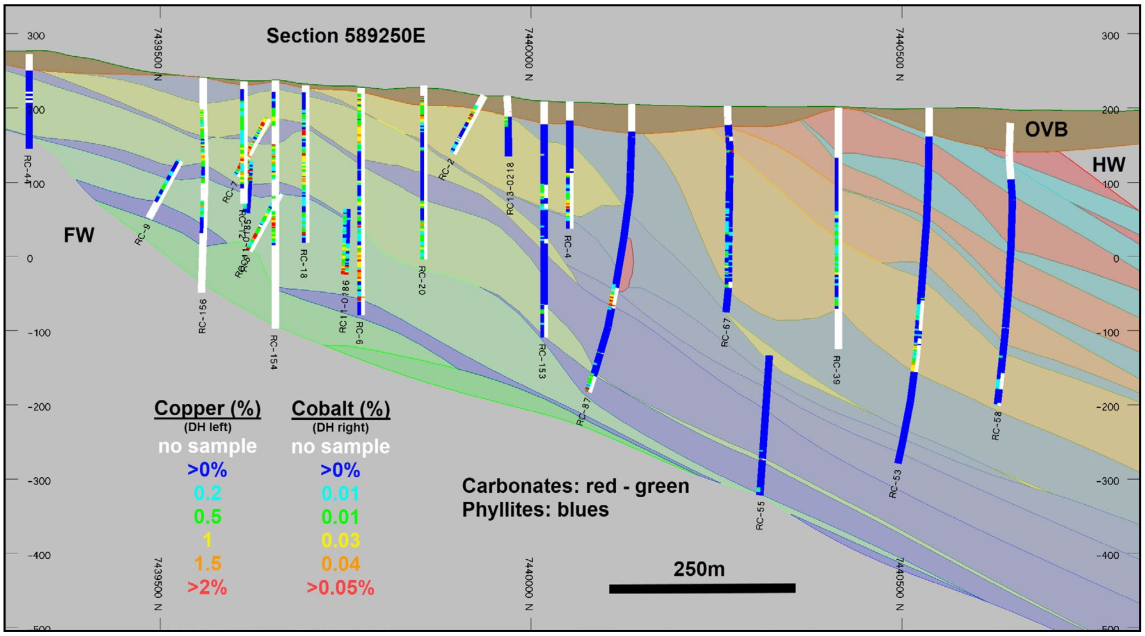
Figure 14-4 shows a general stratigraphic column of the lithologic units in the Ruby Zone and South Reef areas. Figures 14-5 and 14-6 show vertical cross sections through the lithologic model in the Ruby Zone and South Reef areas, respectively.

FIGURE 14-4: GENERAL STRATIGRAPHIC COLUMN FOR THE RUBY ZONE AND SOUTH REEF LITHOLOGIES



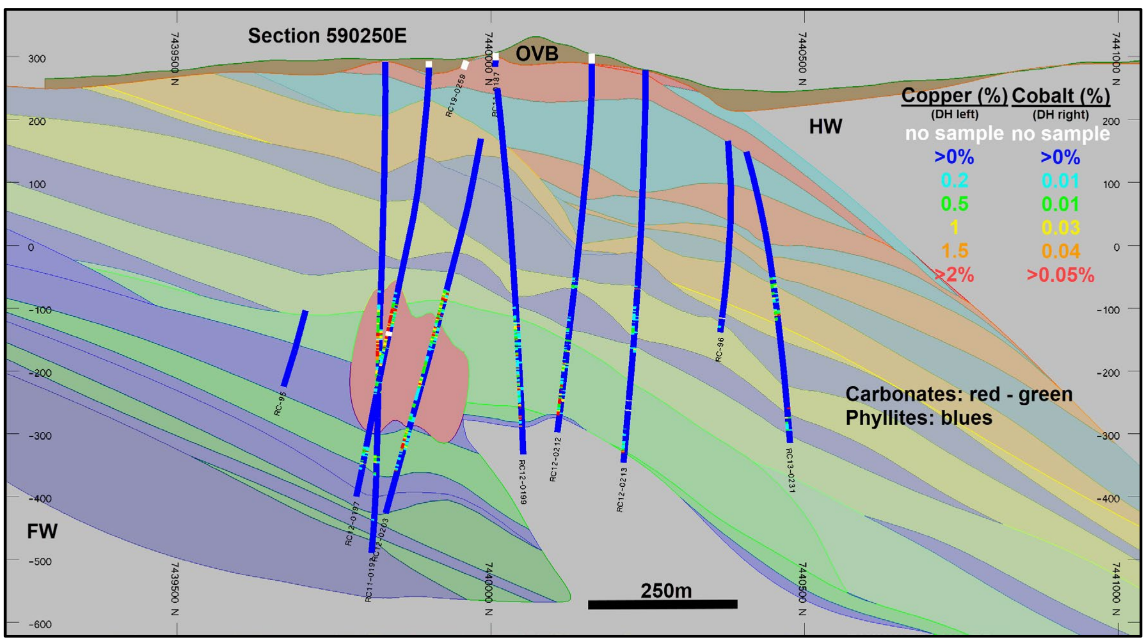
(Source: Trilogy Metals, 2016)

FIGURE 14-5: CROSS SECTION SHOWING LITHOLOGY DOMAINS IN THE RUBY ZONE



(Source: SIM, November 2021)

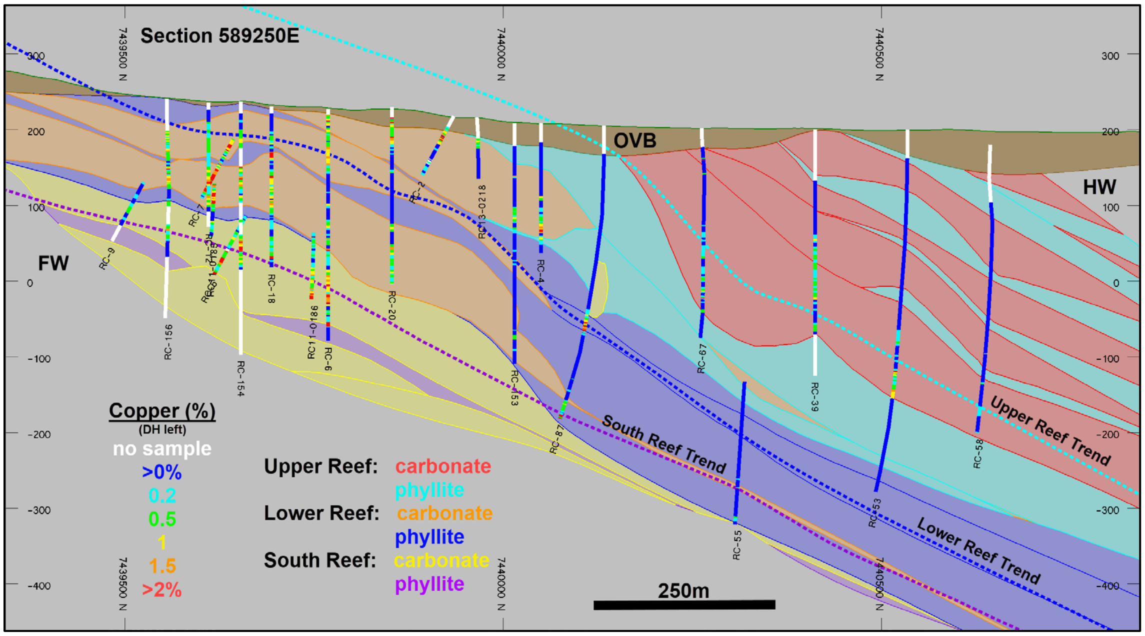
FIGURE 14-6: CROSS SECTION SHOWING LITHOLOGY DOMAINS IN THE SOUTH REEF AREA



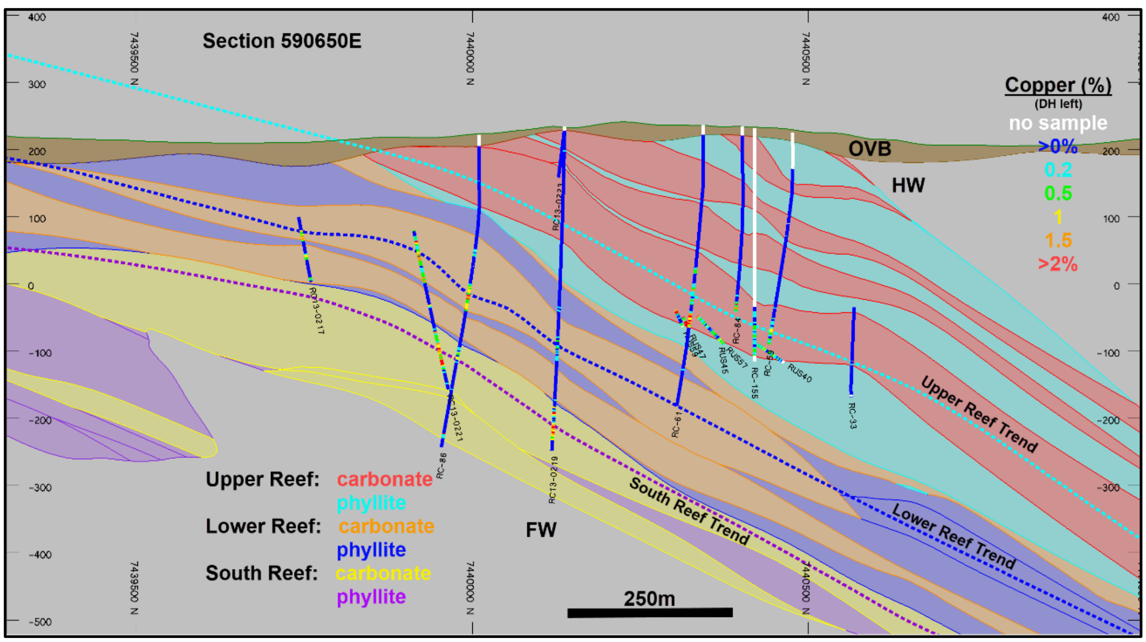
(Source: SIM, November 2021)

To replicate the stratiform nature of the mineralization in the mineral resource model, a dynamic anisotropy approach relative to the overall trend of copper and cobalt mineralization was applied. Three-dimensional surfaces were interpreted and they represent the general trend of the copper mineralization: one plane for the South Reef units, one for the Lower Reef units, and another for the Upper Reef lithologic units. The vertical cross sections in Figure 14-7 show the interpreted trend planes, indicated by dashed lines, across several areas of the deposit. These trend planes are used to control search orientations during subsequent interpolations in the model. Variograms are generated using distances relative to the trend planes rather than the true sample elevations. This approach essentially flattens out the zone during interpolation relative to the defined trend plane.

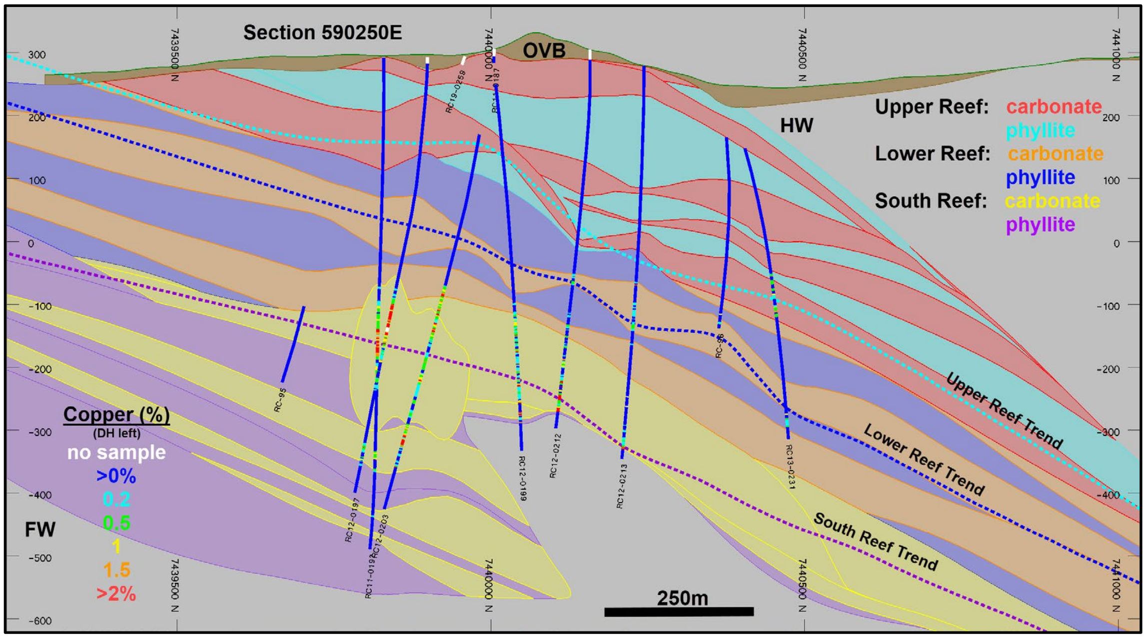
FIGURE 14-7: VERTICAL CROSS SECTIONS SHOWING TREND PLANES USED TO CONTROL DYNAMIC ISOTROPY



(Source: SIM, November 2021)



(Source: SIM, November 2021)



(Source: SIM, November 2021)

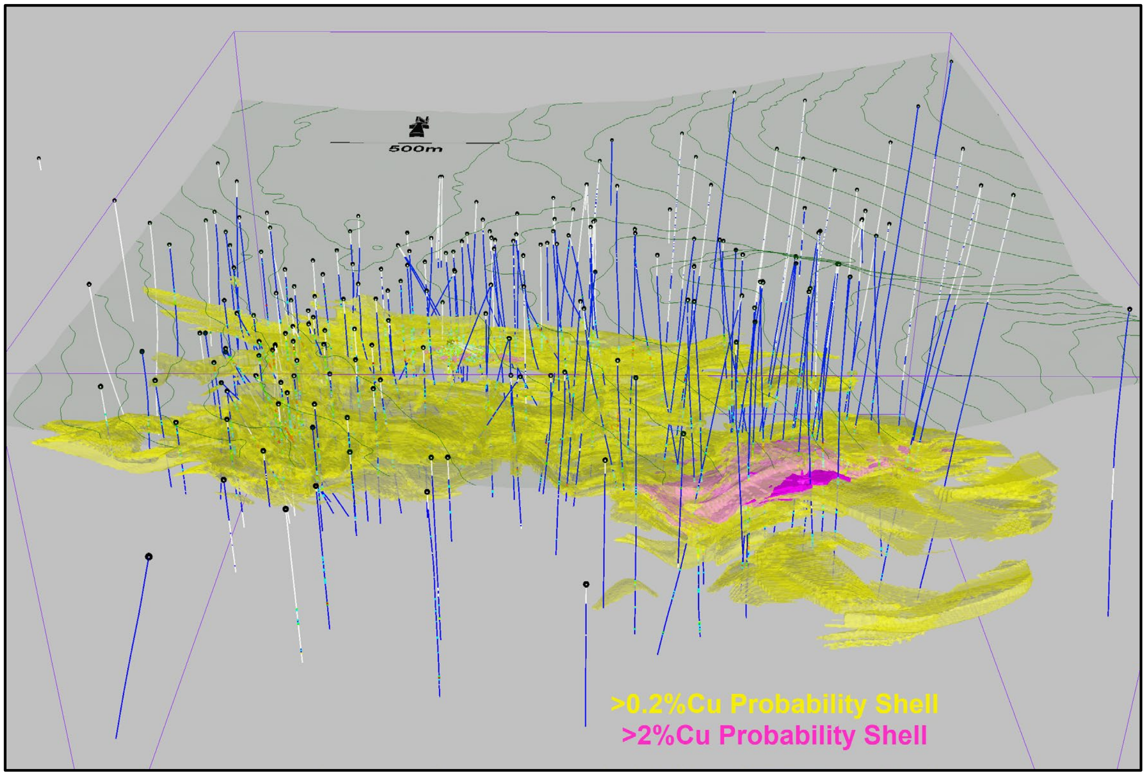
The parts of the deposit with the highest grades occur within areas where semi-massive and massive sulphides are present. The density of drilling is insufficient in most areas to allow for the interpretation of these massive sulphide domains, and a probability shell approach is used to identify areas where higher grade mineralization is likely to occur.

Two probability shells were generated: one at a threshold of 2% Cu and another at a threshold of 0.2% Cu. The 2% Cu shell generally correlates with the presence of massive and semi-massive zones of bornite and chalcopyrite mineralization, and the 0.2% Cu shell correlates with the visual presence of chalcopyrite mineralization. Cobalt mineralization is strongly associated with both sets of copper mineralization. The higher grade shell occurs mainly in the South Reef area and is based primarily on visual observations of the distribution of sample data suggesting that a relatively continuous zone of higher grade copper mineralization occurs above a threshold grade of 2% Cu. Note: Approximately 90% of the sample data in the South Reef area is below 2% Cu and 10% of the data is greater than 2% Cu. A relatively small (>2%) copper probability shell is also generated in the Upper Reef area of the Ruby Zone.

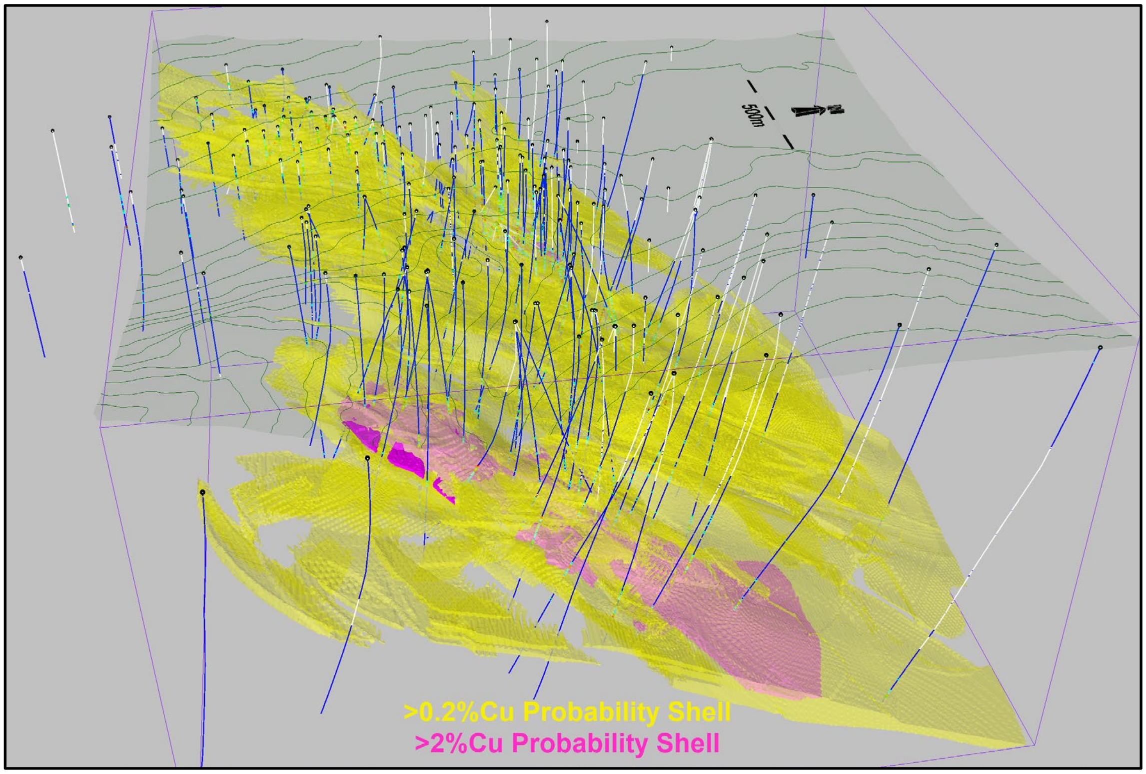
Approximately one half of the samples in the carbonate domains have copper grades above the lower grade threshold of 0.2% copper. This limit roughly segregates areas of “mineralized” versus “unmineralized” (including cobalt) rocks and is still below the anticipated cut-off grade of the mineral resource, ensuring that sufficient internal dilution is retained in the mineral resource model. There are also areas where the phyllite domains contain appreciable copper or cobalt grades (above the 0.2% copper threshold), but these tend to be rare and localized occurrences.

Indicator values are assigned to 2 m composites at the grade thresholds described here, and indicator variograms are produced. Probability values are estimated in model blocks using ordinary kriging; the vertical range and locations are controlled dynamically using elevations relative to the trend planes described previously. A series of shells are generated at varying probability thresholds and are then compared to the distribution of the underlying sample data. The higher grade shell represents areas where there is greater than a 30% probability that the grade will be more than 2% Cu. The lower grade shell envelopes areas where there is a greater than 50% probability that the grade will exceed 0.2% Cu. The shape and location of the probability shells are shown in Figure 14-8. Note: As shown in data analyses contained in Section 14.4 , the distribution of appreciable cobalt primarily occurs in the copper probability shells, and as a result, these are also used in the estimation of cobalt grades in the mineral resource block model.

FIGURE 14-8: COPPER PROBABILITY SHELLS



(Source: SIM, November 2021)



(Source: SIM, November 2021)

14.2.2 Summary of Geologic Domains

The interpreted geologic domains are summarized in Table 14.2.

Table 14.2: Summary of Lithology and Probability Shell Domains for Copper and Cobalt

Domain	Lithology Unit	DOMN	Lithology Unit	DOMN
	Carbonate domains		**Phyllite domains**	
Upper Reef	BRX10	214	PHY10	117
	BRX9	213	PHY9	116
	BRX8	212	PHY8	115
	BRX7x	211	PHY7x	114
	BRX7y	210	PHY7y	113
	BRX7	209	PHY7	112
	-	-	LS6,TBLSA	111
Lower Reef	BRX6	208	PHY6	110
	BRX5	207	TBLSB	109
	BRX3	206	PHY5	108
	-	-	PHY3	107
South Reef	PBRX	301	PHYL1	106
	BRX1	205	PHY1lower	105
	Basal Dol	204	LSE2	104
	BRX0lower	203	TPE1	103
	BRXE2	202	TPE3	102
	BRXE1	201	PHYE3	101
	-	-	PHYE2	118
Probability Shells	2% Cu Probability Shell in South and Upper Reef areas			
	0.2% Cu Probability Shell in Upper, Lower and South Reef areas			

14.3 Compositing

Compositing drill hole samples standardizes the database for further statistical evaluation. This step eliminates any effect the sample length may have on the data. To retain the original characteristics of the underlying data, a composite length that reflects the average, original sample length is selected; a composite that is too long can sometimes result in a degree of smoothing that can mask certain features of the data.

The average sample length at both the Ruby Zone and South Reef areas is 2.09 m. As a result, a composite length of 2 m was selected for the Bornite deposit.

Drill hole composites were length-weighted and generated down-the-hole, meaning composites began at the top of each drill hole and were generated at constant intervals down the length of the drill hole. Composites were broken at lithology domain boundaries. Once composites were generated, probability shell codes were assigned on a majority basis. Several holes were randomly selected, and the composited values were checked for accuracy. No errors were found.

14.4 EXPLORATORY DATA ANALYSIS

Exploratory data analysis (EDA) involves statistically summarizing groups of samples to quantify the characteristics of the data. The main purpose of EDA is to determine whether there is any evidence of spatial distinctions in grade; if this occurs, a separation and isolation of domains during interpolation may be necessary. An unwanted mixing of data is prevented by applying separate domains during interpolation; the result is a grade model that better reflects the unique properties of the deposit. However, applying domain boundaries in areas where the data are not statistically unique may impose a bias in the distribution of grades in the model.

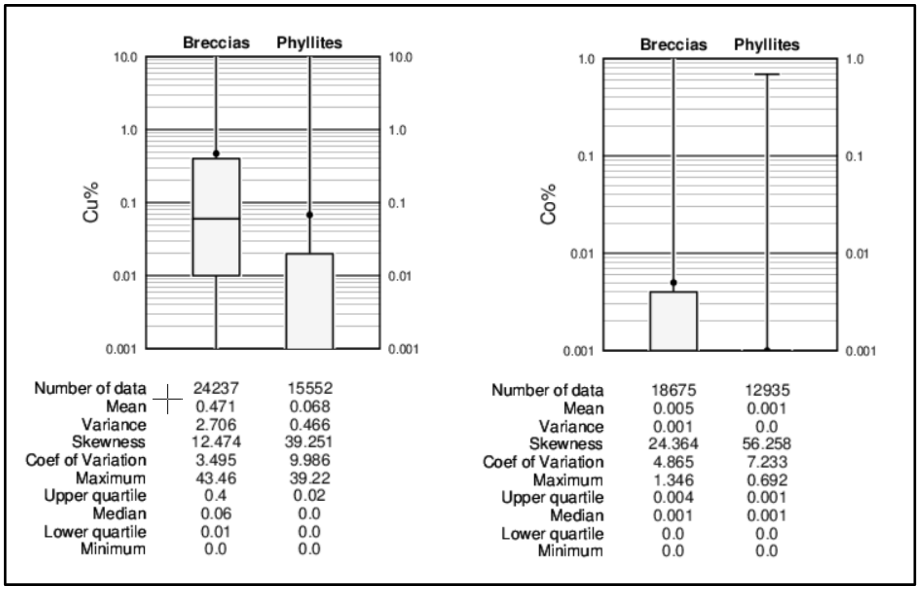
A domain boundary, which segregates the data during interpolation, is typically applied if the average grade in one domain is significantly different from that of another domain. A boundary may also be applied when there is evidence that a significant change in the grade distribution exists across the contact.

The original variable length drill hole samples were composited to 2 m intervals prior to analysis. The interpreted wireframe domains were then used to “backtag” the composited sample data, assigning unique domain codes. The EDA described here is based on composited sample data which are segregated based on the interpreted wireframe domains. While the EDA focuses on copper, cobalt mineralization tends to be related to the copper mineralization. Cobalt is largely contained within the estimation domains developed for copper as demonstrated in the contact profile shown in Figure 14-20.

This EDA consists primarily of a series of boxplots and contact profiles. Boxplots summarize many aspects of the frequency distributions of the data in simple graphical displays for comparison purposes. Contact profiles evaluate the nature of grade trends between two domains: they graphically display the average grades at increasing distances from the contact boundary. The numbers beside the data points represent the amount of data averaged together at a particular separation distance. Those contact profiles that show a marked difference in grade across a domain boundary indicate that the two domain datasets should be isolated during interpolation. Conversely, if a more gradual change in grade occurs across a contact, the introduction of a hard boundary (e.g., segregation during interpolation) may result in a much different trend in the grade model; in this case, the change in grade between domains in the model is often more abrupt than the trends seen in the raw data. Finally, a flat contact profile indicates no grade changes across the boundary; in this case, hard or soft domain boundaries will produce similar results in the model. Note: The boxplots and contact profiles presented in this section of the report are based on all available sample data following the 2018 drilling program; they do not include information from the few additional drill holes completed in 2019 because the impact of the 2019 drill hole results would be negligible.

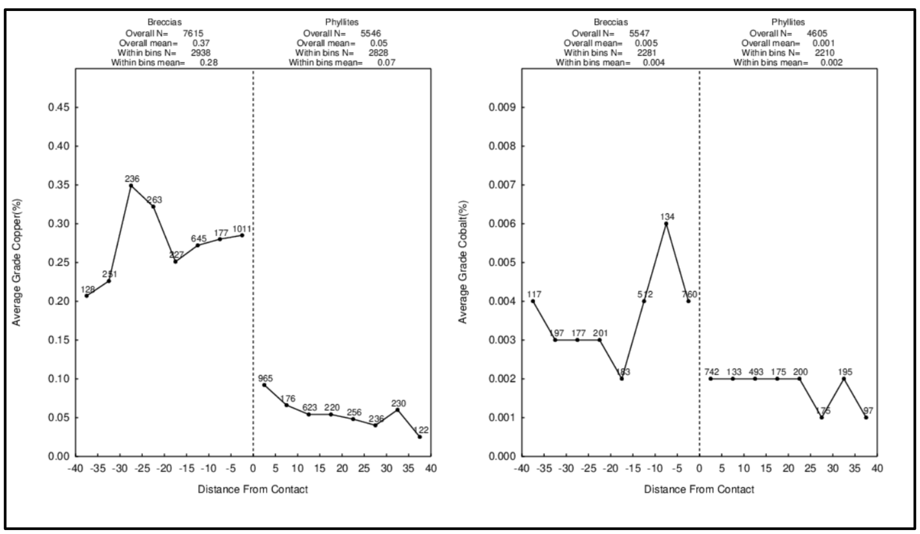
The boxplot in Figure 14-9 shows there is a major difference between the grades in the carbonate breccias versus the phyllite domains. The contact profile, shown in Figure 14-10, shows the difference in the vicinity of the boundaries. The carbonate breccias delimit zones of higher copper and cobalt grades.

FIGURE 14-9: BOXPLOTS OF TOTAL COPPER AND COBALT IN CARBONATE BRECCIAS AND PHYLLITES



(Source: SIM, March 2019)

FIGURE 14-10: CONTACT PROFILES FOR TOTAL COPPER AND COBALT BETWEEN CARBONATE BRECCIAS AND PHYLLITES

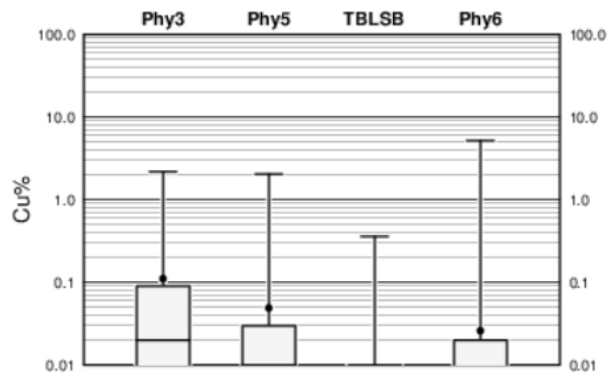


(Source: SIM, March 2019)

Figure 14-11 shows the boxplots for copper in the phyllites in the Lower Reef. Note that while a large majority of the sample grades fall below 0.1% Cu, there are a few high-grade samples present which show that localized copper mineralization does exist in the phyllite units. This is a pattern that is also repeated in the South and Upper Reefs. Some of these mineralized phyllites are proximal to well-mineralized carbonates, but the majority of the very high grades occurring in the phyllites tend to be isolated and cannot be associated with high grades in other units or any geological feature, such as structure.

Figure 14-12 shows the copper sample grade distribution boxplots for the Lower Reef breccias. The distributions have a significantly greater number of high-grade areas than in the phyllites. The carbonate breccia domains tend to be a better host to mineralization, but as the boxplots show, there are still volumes of lower grade within the carbonate breccia units. This pattern of breccias hosting better mineralization applies to cobalt as well as copper.

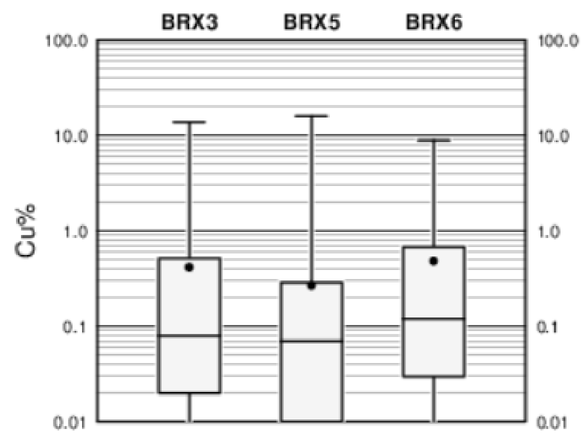
FIGURE 14-11: BOXPLOTS FOR COPPER IN THE LOWER REEF PHYLLITE DOMAINS



	Phy3	Phy5	TBLSB	Phy6	
Number of data	824	1942	185	2595	Number of data
Mean	0.111	0.049	0.005	0.026	Mean
Variance	0.063	0.025	0.001	0.018	Variance
Skewness	4.406	7.423	13.63	24.59	Skewness
Coef of Variation	2.259	3.242	5.235	5.19	Coef of Variation
Maximum	2.19	2.05	0.36	5.18	Maximum
Upper quartile	0.09	0.03	0.01	0.02	Upper quartile
Median	0.02	0.01	0.0	0.0	Median
Lower quartile	0.0	0.0	0.0	0.0	Lower quartile
Minimum	0.0	0.0	0.0	0.0	Minimum

(Source: SIM, March 2019)

FIGURE 14-12: BOXPLOTS FOR COPPER IN THE LOWER REEF CARBONATE BRECCIA DOMAINS

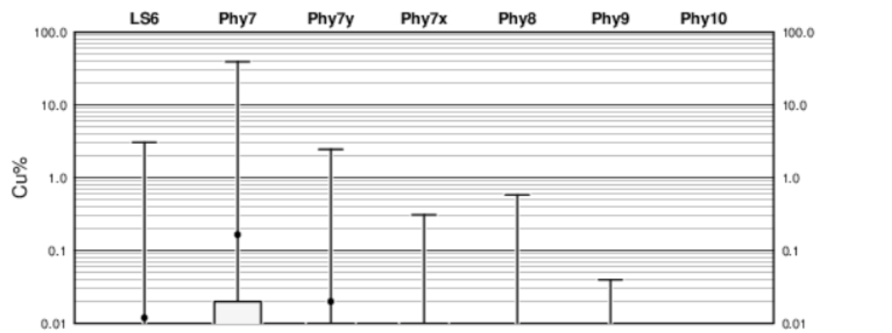


	BRX3	BRX5	BRX6	
Number of data	3566	2954	1095	Number of data
Mean	0.418	0.27	0.487	Mean
Variance	0.722	0.329	0.691	Variance
Skewness	5.725	8.793	4.095	Skewness
Coef of Variation	2.033	2.121	1.708	Coef of Variation
Maximum	13.77	15.97	8.92	Maximum
Upper quartile	0.52	0.29	0.68	Upper quartile
Median	0.08	0.07	0.12	Median
Lower quartile	0.02	0.01	0.03	Lower quartile
Minimum	0.0	0.0	0.0	Minimum

(Source: SIM, March 2019)

Figures 14-13 and 14-14 show boxplots for copper in the phyllites and carbonate breccias for the Upper Reef. The phyllites are less mineralized than in the Lower Reef, but rare very high values continue to occur in most of the phyllite units. Breccia units higher up in the stratigraphic section tend to contain less mineralization, as seen in Figure 14-14. The same trends apply to cobalt.

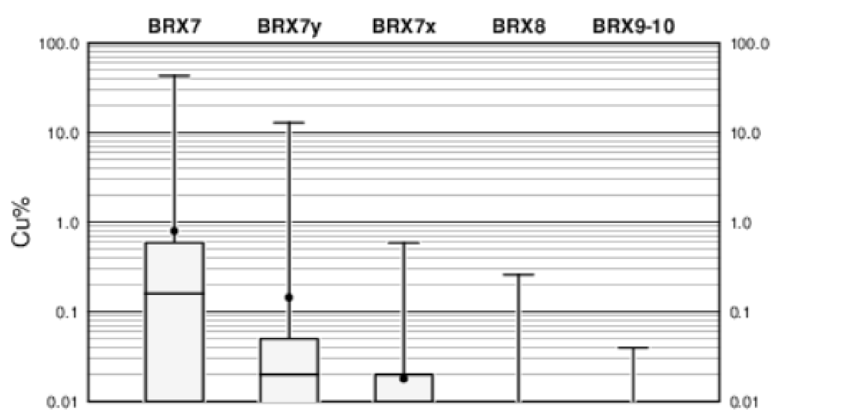
FIGURE 14-13: BOXPLOTS FOR COPPER IN THE UPPER REEF PHYLLITE DOMAINS



	LS6	Phy7	Phy7y	Phy7x	Phy8	Phy9	Phy10	
Number of data	865	2098	1044	992	1630	335	9	Number of data
Mean	0.012	0.166	0.02	0.008	0.003	0.002	0.0	Mean
Variance	0.015	2.919	0.008	0.0	0.0	0.0	0.0	Variance
Skewness	19.48	17.759	12.608	8.427	25.838	3.445	0.0	Skewness
Coef of Variation	10.478	10.267	4.452	2.322	5.751	2.835	0.0	Coef of Variation
Maximum	3.06	39.22	2.46	0.31	0.58	0.04	0.0	Maximum
Upper quartile	0.0	0.02	0.01	0.01	0.0	0.0	0.0	Upper quartile
Median	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Median
Lower quartile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Lower quartile
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Minimum

(Source: SIM, March 2019)

FIGURE 14-14: BOXPLOTS FOR COPPER IN THE UPPER REEF CARBONATE BRECCIA DOMAINS

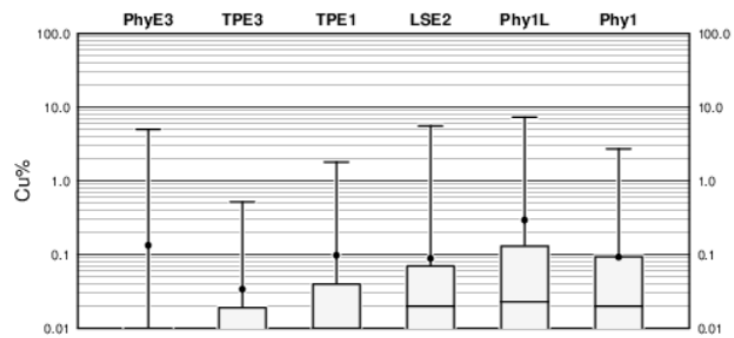


	BRX7	BRX7y	BRX7x	BRX8	BRX9-10	
Number of data	5472	1721	1264	1037	182	Number of data
Mean	0.8	0.145	0.018	0.003	0.002	Mean
Variance	8.001	0.319	0.001	0.0	0.0	Variance
Skewness	8.455	11.517	7.89	11.684	4.099	Skewness
Coef of Variation	3.536	3.891	2.072	4.008	2.753	Coef of Variation
Maximum	43.46	12.97	0.59	0.26	0.04	Maximum
Upper quartile	0.59	0.05	0.02	0.0	0.0	Upper quartile
Median	0.16	0.02	0.01	0.0	0.0	Median
Lower quartile	0.01	0.0	0.0	0.0	0.0	Lower quartile
Minimum	0.0	0.0	0.0	0.0	0.0	Minimum

(Source: SIM, March 2019)

The boxplots in Figures 14-15 and 14-16 show the grade distributions in South Reef. The grade distribution in phyllite unit PHY1L tends to be more like a carbonate breccia grade distribution due to local mineralization related to shearing. The copper grade in carbonate breccia BRXE1 resembles a phyllite-grade distribution due to its location on the unmineralized footwall side of the Iron Mountain fault structure. As in the other reefs, the phyllite units continue to host a sprinkling of high-grade samples.

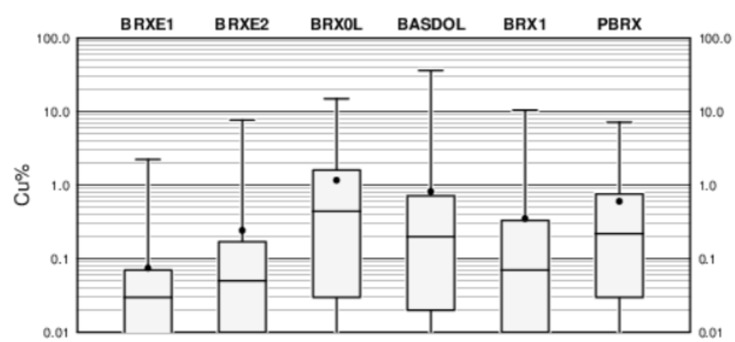
FIGURE 14-15: BOXPLOTS FOR COPPER IN THE SOUTH REEF PHYLLITE DOMAINS



	PhyE3	TPE3	TPE1	LSE2	Phy1L	Phy1
Number of data	95	57	150	489	217	304
Mean	0.134	0.034	0.098	0.089	0.295	0.093
Variance	0.5	0.009	0.081	0.109	0.812	0.056
Skewness	6.209	3.83	3.893	11.252	5.164	6.386
Coef of Variation	5.277	2.763	2.9	3.698	3.053	2.557
Maximum	5.01	0.52	1.81	5.59	7.32	2.74
Upper quartile	0.01	0.019	0.04	0.07	0.13	0.094
Median	0.0	0.0	0.01	0.02	0.023	0.02
Lower quartile	0.0	0.0	0.0	0.0	0.0	0.0
Minimum	0.0	0.0	0.0	0.0	0.0	0.0

(Source: SIM, March 2019)

FIGURE 14-16: BOXPLOTS FOR SOUTH REEF CARBONATE BRECCIA DOMAINS

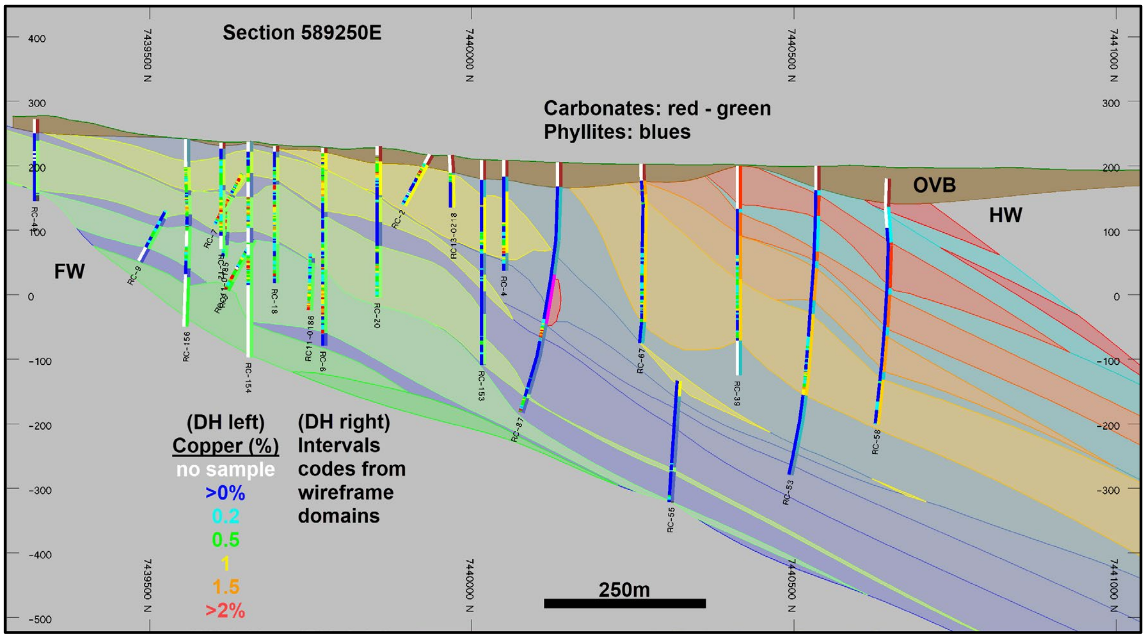


	BRXE1	BRXE2	BRX0L	BASDOL	BRX1	PBRX
Number of data	406	632	693	1844	2490	881
Mean	0.075	0.243	1.172	0.821	0.352	0.605
Variance	0.035	0.401	3.578	5.34	0.552	0.917
Skewness	7.238	6.212	3.128	8.532	5.339	2.759
Coef of Variation	2.517	2.602	1.614	2.815	2.113	1.582
Maximum	2.24	7.68	15.0	36.4	10.45	7.2
Upper quartile	0.07	0.17	1.604	0.72	0.33	0.76
Median	0.03	0.05	0.44	0.2	0.07	0.22
Lower quartile	0.0	0.01	0.03	0.02	0.01	0.03
Minimum	0.0	0.0	0.0	0.0	0.0	0.0

(Source: SIM, March 2019)

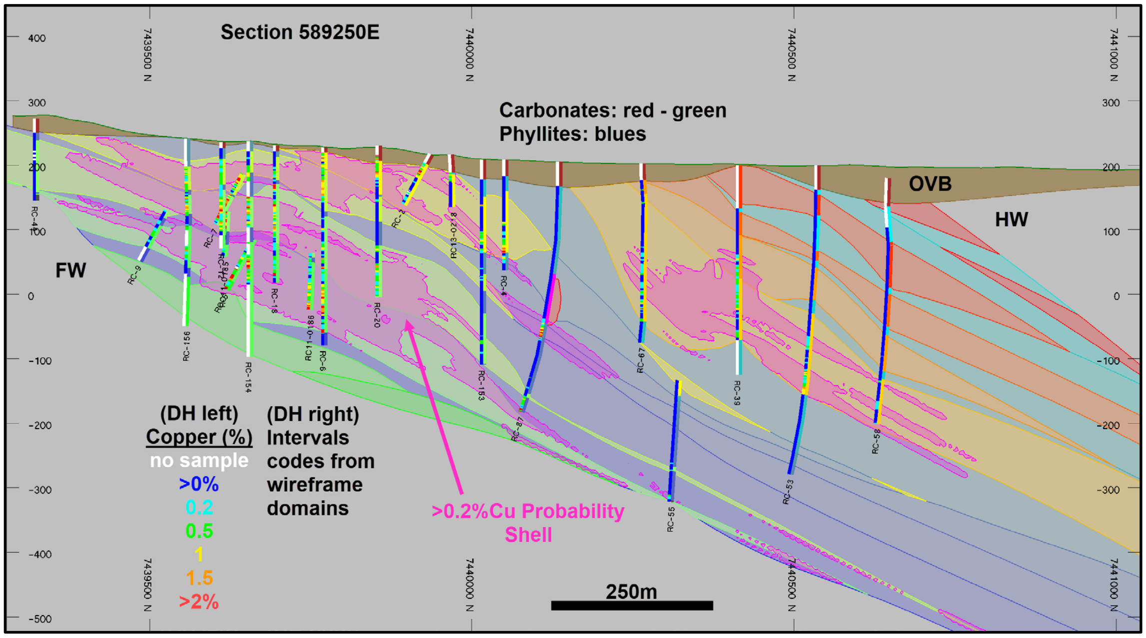
Figure 14-17 shows a drill-hole vertical section with the sample grades and the interpreted phyllite and carbonate breccia units. The section illustrates the fact that mineralization in breccia units occurs in more limited volumes and, therefore, it is necessary to confine the interpolation of grades in the breccias, and rarely in the mineralized phyllites, to the mineralized volumes. To properly constrain the interpolation of grade, probability shells were constructed, as described in Section 14.2, and they are used in conjunction with the stratigraphic units, segregating areas using both stratigraphy and probability shell domains during block grade interpolation. Figure 14-18 shows an example of the 0.2% Cu probability shell overlain on the stratigraphic units.

FIGURE 14-17: SECTION 589250 E WITH INTERPRETED STRATIGRAPHIC UNITS



(Source: SIM, November 2021)

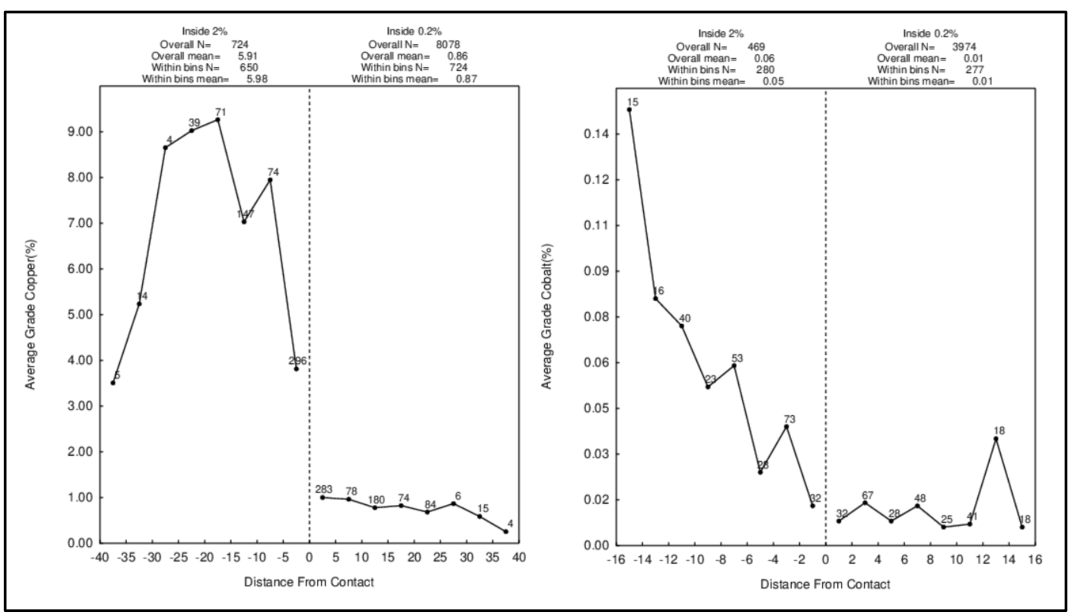
FIGURE 14-18: SECTION 589250 E WITH 0.2% COPPER PROBABILITY SHELL



(Source: SIM, November 2021)

Figure 14-19 compares copper and cobalt sample grades inside the 2% copper shell with samples inside the surrounding 0.2% copper shell. There is a pronounced change in copper grade at this boundary suggesting that it should be recognized during block-grade estimation. A similar, but less pronounced, change in cobalt grade also occurs at the boundary of these two domains at the scale of blocks (5 m) in the model.

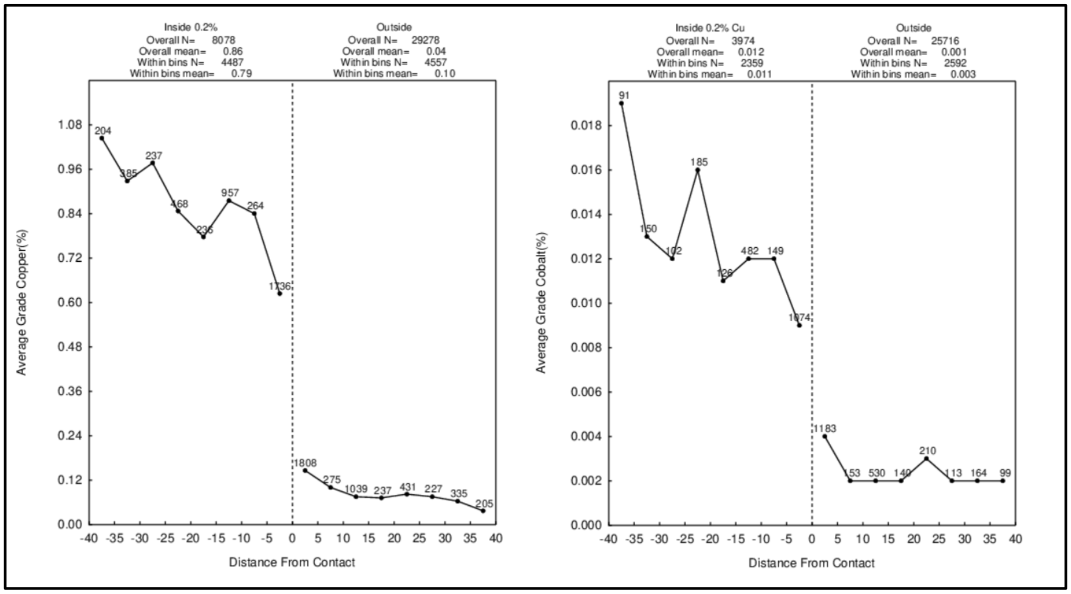
FIGURE 14-19: CONTACT PROFILE OF COPPER AND COBALT IN 2% VS. 0.2% COPPER SHELLS



(Source: SIM, March 2019)

Figure 14-20 shows distinct changes in copper and cobalt grade at the 0.2% copper shell boundary. This is an indication that the 0.2% copper shell does, in general, segregate mineralized from unmineralized rocks.

FIGURE 14-20: CONTACT PROFILE OF COPPER AND COBALT IN/OUT OF THE 0.2% COPPER SHELL



(Source: SIM, March 2019)

14.4.1 MODELLING IMPLICATIONS

The boxplot and contact profile analysis shows distinct differences in sample data contained in carbonate and phyllite domains, indicating that these data should remain segregated during the estimation of copper grades in the block model. Analysis of the probability grade shells also indicates that these encompass differing populations of samples that should not be mixed during copper grade interpolations.

Based on these results, a combination of lithology and probability grade shell domains are used to control the distribution of copper in the mineral resource block model. These "estimation domains" are summarized in Table 14.3. These domains are generally segregated: the typically mineralized carbonates are on the left side and the typically unmineralized phyllite domains are on the right side. Each estimation domain is further separated during grade interpolation by the probability shells.

TABLE 14.3: SUMMARY OF COPPER/COBALT ESTIMATION DOMAINS
(LISTED STRATIGRAPHICALLY TOP TO BOTTOM)

Reef	DOMN	ESTDM	DOMN	ESTDM
	Carbonate Domains		Phyllite Domains	
Upper	213, 214 (BRX9, BRX10)	22	117 (PHY10)	29
	212 (BRX8)	21	116 (PHY9)	28
	211 (BRX7x)	20	115 (PHY8)	27
	210 (BRX7y)	19	114 (PHY7x)	26
	209 (BRX7)	18	113 (PHY7y)	25
	-	-	112 (PHY7)	24
	-	-	111 (LS6, TBLSA)	23
Lower	208 (BRX6)	13	110 (PHY6)	17
	207 (BRX5)	12	109 (TBLSB)	16
	206 (BRX3)	11	108 (PHY5)	15
	-	-	107 (PHY3)	14
South	204, 205, 301 (BRX1, Basal Dol, PBRX)	4	106 (PHYL1)	10
	203 (BRX0lower)	3	105 (PHY1lower)	9
	202 (BRXE2)	2	104 (LSE2)	8
	201 (BRXE1)	1	103 (TPE1)	7
	-	-	102 (TPE3)	6
	-	-	101 (PHYE3)	5
	-	-	118 (PHYE2)	30
>2% Copper Probability Shell – used as hard boundary domain together with Estimation domains				
>0.2% Copper Probability Shell – used as hard boundary domain together with Estimation domains				

14.5 TREATMENT OF OUTLIER GRADES

Histograms and probability plots were generated from 2 m composited sample data to show the distribution of copper in each estimation domain. These were used to identify the existence of anomalous outlier grades in the composite database. The physical locations of these potential outlier samples were reviewed in relation to the surrounding data, and it was decided that their effects could be controlled primarily through the use of outlier limitations.

An outlier limitation approach limits samples above a defined threshold to a maximum distance of influence during grade estimates. In the South Reef domains, drill holes tend to intersect the mineralized zone at roughly 100 m intervals, and as a result, samples above the outlier threshold are limited to a maximum distance of influence of 50 m during block grade interpolation (½ the distance between drill holes).

In the Lower and Upper Reef domains, drilling tends to be more closely spaced and, therefore, samples above the outlier thresholds are limited to a maximum distance of influence of 25 m during block grade interpolation. One exception applies to the 2% copper shell in the Upper Reef, which is densely drilled with numerous closely spaced underground drill holes. Here, samples above the outlier threshold grade of 20% Cu are limited to a maximum range of 10 m during block grade interpolation. In addition to the outlier limitations described here, samples inside the 2% copper probability shell in the South Reef area were top-cut to 30% Cu prior to block grade interpolation.

Tables 14.4 and 14.5 summarize the treatment of outlier sample data and the resulting effects on the estimate of contained metal in the models.

TABLE 14.4: SUMMARY OF TREATMENT OF OUTLIER COPPER SAMPLE DATA

Reef	Carbonate Domains				Phyllite Domains			
	DOMN	ESTDM	Grade Threshold (Cu%)		DOMN	ESTDM	Grade Threshold (Cu%)	
			Inside 0.2% Cu Shell	Outside 0.2% Cu Shell			Inside 0.2% Cu Shell	Outside 0.2% Cu Shell
Upper	213,214 (BRX9, BRX10)	22	-	-	117 (PHY10)	29	-	-
Upper	212 (BRX8)	21	-	-	116 (PHY9)	28	-	-
Upper	211 (BRX7x)	20	-	-	115 (PHY8)	27	-	-
Upper	210 (BRX7y)	19	5	-	114 (PHY7x)	26	-	-
Upper	209 (BRX7)	18	25	2	113 (PHY7y)	25	1.5	1.5
Upper					112 (PHY7)	24	-	1.5
Upper					111 (LS6,TBLSA)	23	-	-
Lower	208 (BRX6)	13	-	2	110 (PHY6)	17	1.5	1.5
Lower	207 (BRX5)	12	-	2	109 (TBLSB)	16	10	-
Lower	206 (BRX3)	11	6	2	108 (PHY5)	15	-	2
Lower					107 (PHY3)	14	-	1
South	204, 205, 301 (BRX1, Basal Dol, PBRX)	4	7	-	106 (PHYL1)	10	-	2
South	203 (BRX0lower)	3	2	2	105 (PHY1lower)	9	4	0.5
South	202 (BRXE2)	2	2	2	104 (LSE2)	8	-	2
South	201 (BRXE1)	1	-	-	103 (TPE1)	7	-	-
South					102 (TPE3)	6	-	-
South					101 (PHYE3)	5	-	-
South					118 (PHYE2)	30	-	-
South	Inside 2% Cu Probability Shell		Samples top-cut to 30% Cu. Samples above 15% Cu limited to 50 m maximum range during block grade interpolation.					
Upper	Inside 2% Cu Probability Shell		Samples above 20% Cu limited to 10 m maximum range during block grade interpolation.					

TABLE 14.5: METAL LOST DUE TO TREATMENT OF OUTLIER COPPER SAMPLE DATA

DOMN Group	% Metal Lost
Carbonates	-4.3%
Phyllites	-12.0%
2%Cu Probability Shell	-10.5%

The proportion of metal lost is calculated in model blocks in the combined Indicated and Inferred categories. Overall, these measures have reduced the total amount of contained copper by 5.8%. The amount of copper metal lost in the carbonate domains, which host the majority of the mineral resources at Bornite, is considered appropriate for a project at this level of delineation drilling. The greater losses exhibited in the phyllites are due to the effects of these limitations on the skewed grade distributions in these domains. The effect of these measures also tends to have a greater impact on the high-grade parts of the deposit inside the 2% Cu probability shell. Overall, the proportions of metal lost due to top-cutting and outlier restriction measures are considered appropriate for a project with this level of exploration.

Due to the more limited distribution of sample data, potentially anomalous cobalt samples were evaluated in a somewhat more generalized approach, with outlier grade thresholds of 0.4% Co, 0.2% Co and 0.4% Co applied to the carbonate units in the Upper, Lower and South Reef zones, respectively. The threshold in the phyllite units was 0.04% Co. All samples above the threshold grade limits were restricted to a maximum distance of 35 m during block grade interpolation. Overall, these measures have reduced the contained cobalt in the model by 5.4%.

14.6 SPECIFIC GRAVITY DATA

Specific gravity (SG) measurements were conducted on 7,476 samples in the database and range from a minimum of 2.12 to a maximum of 5.20 and average 2.89. Approximately 40% of the available SG data occur in the probability grade shell domains. The remaining SG data represent phyllite and carbonate rocks outside of the grade shells. Copper content and SG are moderately correlated. There is minimal variation in the SG values for the various estimation domains with coefficient-of-variation values that are typically less than 0.1.

SG data are available for the majority of drill holes with measurements typically made at 10 m to 20 m intervals down drill holes with continuous sampling through the mineralized areas.

The distribution of SG data is considered sufficient to support estimation in the mineral resource model. The relatively low variability in the sample data indicates that SG values can be reliably estimated into model blocks. SG values in the block model are estimated using inverse distance-squared (ID^2) moving averages. The copper grade estimation domains are used as hard boundaries during the estimation of densities in the model.

14.7 VARIOGRAPHY

The degree of spatial variability and continuity in a mineral deposit depends on both the distance and direction between points of comparison. Typically, the variability between samples is proportionate to the distance between samples. If the variability is related to the direction of comparison, then the deposit is said to exhibit anisotropic tendencies which can be summarized by an ellipse fitted to the ranges in the different directions. The semi-variogram is a common function used to measure the spatial variability within a deposit.

The components of the variogram include the nugget, the sill, and the range. Often samples compared over very short distances (including samples from the same location) show some degree of variability. As a result, the curve of the variogram often begins at a point on the y-axis above the origin; this point is called the *nugget*. The nugget is a measure of not only the natural variability of the data over very short distances, but also a measure of the variability which can be introduced due to errors during sample collection, preparation, and assay.

Typically, the amount of variability between samples increases as the distance between the samples increase. Eventually, the degree of variability between samples reaches a constant or maximum value; this is called the *sill*, and the distance between samples at which this occurs is called the *range*.

The spatial evaluation of the data was conducted using a correlogram instead of the traditional variogram. The correlogram is normalized to the variance of the data and is less sensitive to outlier values; this generally gives cleaner results.

Many of the individual estimation domains do not contain sufficient sample data from which reasonable correlograms can be generated. As a result, separate correlograms for copper and cobalt were generated for samples inside the 0.2% copper probability shell in each of the South, Lower and Upper Reefs, and these were applied to each of the respective carbonate domains. A separate correlogram was produced from all samples outside of the 0.2% copper probability shell, and this was used to estimate grades in the phyllite domains. Finally, a separate correlogram was used to estimate the distribution of copper and cobalt inside of the 2% copper probability shell domain.

Correlograms were generated using the commercial software package SAGE2001 developed by Isaaks & Co. Correlograms were generated using elevations relative to the trend planes described in Section 14.2 of this report. This ensures that the local undulations of the typically banded mineralization are replicated in the block model. The correlograms are summarized in Tables 14.6 and 14.7.

TABLE 14.6: COPPER CORRELOGRAM PARAMETERS

Domain	Nugget	S1	S2	1st Structure			2nd Structure		
				Range (m)	AZ	Dip	Range (m)	AZ	Dip
Upper Reef Carbonates	0.100	0.784	0.116	23	319	61	554	212	11
	Spherical			11	170	25	538	54	78
				6	74	13	73	123	-4
Lower Reef Carbonates	0.150	0.761	0.089	96	91	43	1079	181	0
	Spherical			28	333	26	95	91	0
				10	223	36	38	32	90
South Reef Carbonates	0.150	0.787	0.063	24	77	34	2427	215	0
	Spherical			21	292	51	562	125	0
				9	179	18	33	146	90
Phyllites	0.450	0.519	0.031	27	280	51	573	343	37
	Spherical			22	38	21	413	77	5
				12	321	-31	381	354	-52
2% Cu Probability Shell	0.200	0.724	0.076	35	216	80	1871	137	0
	Spherical			11	111	3	438	47	42
				6	20	10	52	46	-48

Note: Correlogram generated from 2 m composited sample data using elevations relative to trend plane of mineralization.

TABLE 14.7: COBALT CORRELOGRAM PARAMETERS

Domain	Nugget	S1	S2	1st Structure			2nd Structure		
				Range (m)	AZ	Dip	Range (m)	AZ	Dip
Upper Reef Carbonates	0.155	0.528	0.317	191	39	-7	273	348	-16
	Spherical			49	123	43	225	3	74
				3	317	46	10	79	-4
Lower Reef Carbonates	0.450	0.335	0.215	51	31	38	321	135	5
	Spherical			23	315	-17	272	11	81
				7	244	47	15	46	-8
South Reef Carbonates	0.400	0.262	0.338	66	354	51	768	133	-3
	Spherical			52	140	34	82	165	87
				4	242	17	15	43	2
Phyllites	0.250	0.627	0.123	17	311	0	289	347	75
	Spherical			12	221	84	186	159	15
				7	221	-6	12	70	-2
2% Cu Probability Shell	0.519	0.247	0.234	86	0	0	58	0	90
	Spherical			86	90	0	46	0	0
				8	0	90	46	90	0

Note: Correlogram generated from 2 m composited sample data using elevations relative to trend plane of mineralization.

14.8 MODEL SETUP AND LIMITS

A block model was initialized with the dimensions shown in Table 14.8. A nominal block size of 5 x 5 x 5 m is considered appropriate, based on current drill hole spacing, for a project at this stage of evaluation.

Because the deposit contains both underground and open pit potential mineral resources, the 5 x 5 x 5 m selective mining unit (SMU) is driven primarily by the underground extraction potential of the deposit. Evaluations of the open pit extraction potential of the mineral resource may require that these blocks are combined into a larger SMU size.

Further engineering studies are required to evaluate the viability of the Bornite deposits. The limits of the block model are represented by the purple rectangle shown in the previous isometric views (Figures 14-1, 14-2, 14-3 and 14-8).

TABLE 14.8: BLOCK MODEL LIMITS

Direction	Minimum (m)	Maximum (m)	Block Size (m)	Number of Blocks
X-axis (W-E)	588800	591000	5	440
Y-axis (N-S)	7439300	7441500	5	440
Elevation	-900	450	5	270

Using the domain wireframes, blocks in the model are assigned estimation domain code values on a majority basis. Blocks with more than 50% of their volume inside a wireframe domain are assigned a zone code value of that domain.

14.9 INTERPOLATION PARAMETERS

Copper and cobalt grades in model blocks were estimated using ordinary kriging. The ordinary kriging models were evaluated using a series of validation approaches as described in Section 14.10 of this report. The interpolation parameters were adjusted until the appropriate results were achieved. In general, the ordinary kriging models were generated using a relatively limited number of composited sample data. This approach reduces the amount of smoothing (also known as averaging) in the model, and while there may be some uncertainty on a localized scale, this approach produces reliable estimates of the potentially recoverable grade and tonnage for the overall deposit. Interpolation parameters for copper and cobalt in the various estimation domains are summarized in Tables 14.9 and 14.10.

TABLE 14.9: COPPER INTERPOLATION PARAMETERS

Domain	Search Ellipse Range (m)			Number of Composites (2 m)			Other
	X	Y	Z [(1)]	Min/block	Max/block	Max/hole	
Upper Reef Carbonates	500	500	3	1	9	3	1DH per Octant
Lower Reef Carbonates	500	500	3	1	12	3	1DH per Octant
South Reef Carbonates	500	500	3	1	9	3	1DH per Octant
Phyllite	500	500	4	1	15	5	1DH per Octant
2% Cu Shell	500	500	5	1	15	5	1DH per Octant
Specific Gravity	500	500	7	1	21	7	ID^2

1) Vertical range relative to distances from trend plane of mineralization

TABLE 14.10: COBALT INTERPOLATION PARAMETERS

Domain	Search Ellipse Range (m)			Number of Composites (2 m)			Other
	X	Y	Z (1)	Min/block	Max/block	Max/hole	
Upper Reef Carbonates	500	500	5	1	12	4	1DH per Octant
Lower Reef Carbonates	500	500	5	1	12	4	1DH per Octant
South Reef Carbonates	500	500	5	1	12	4	1DH per Octant
Phyllite	500	500	5	1	12	4	1DH per Octant
2% Cu Shell	500	500	5	1	15	5	1DH per Octant

1) Vertical range relative to distances from trend plane of mineralization

During grade and SG estimation, search orientations were designed to follow the mineralization trend surfaces interpreted to represent the general trend of the mineralization in the deposit. Although the maximum XY range is set at 500 m, block grades are generally estimated using data limited to the nearest three or four drill holes; this criterion is often met within a maximum distance of less than 100 m. For example, the average distance-to-data used in block-grade estimates inside the mineral resource limiting pit shell is 64 m. In areas where drill holes are spaced at 200 m intervals, at depth or on the fringes of the deposit, the search range is large enough so that multiple drill holes are captured and, guided by the variogram, used in the block-grade estimates. It should be noted that although actual search ranges may extend for more than 200 m in some areas, only blocks within a maximum distance of 100 m from a drill hole are included in the Inferred category.

The inverse distance-squared (ID^2) interpolation method was used to calculate block estimates of specific gravity, and all estimation domains were recognized as hard boundaries.

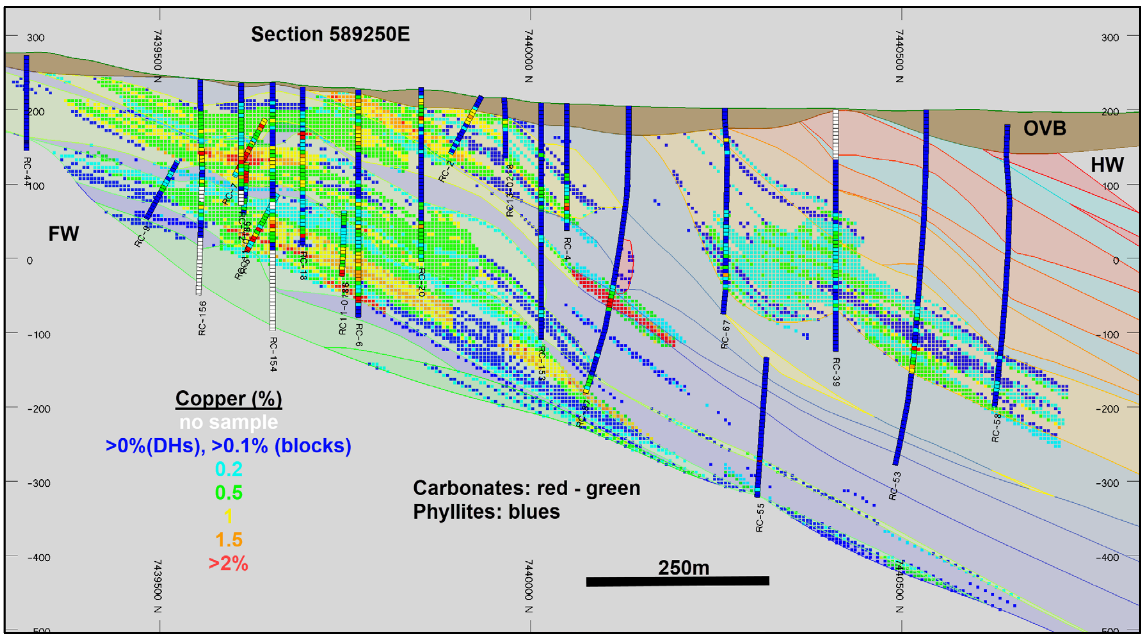
14.10 BLOCK MODEL VALIDATION

The block models were validated using the following methods: a thorough visual review of the model grades in relation to the underlying drill hole sample grades; comparisons with the change of support model; comparisons with other estimation methods; and grade distribution comparisons using swath plots.

14.10.1 Visual Inspection

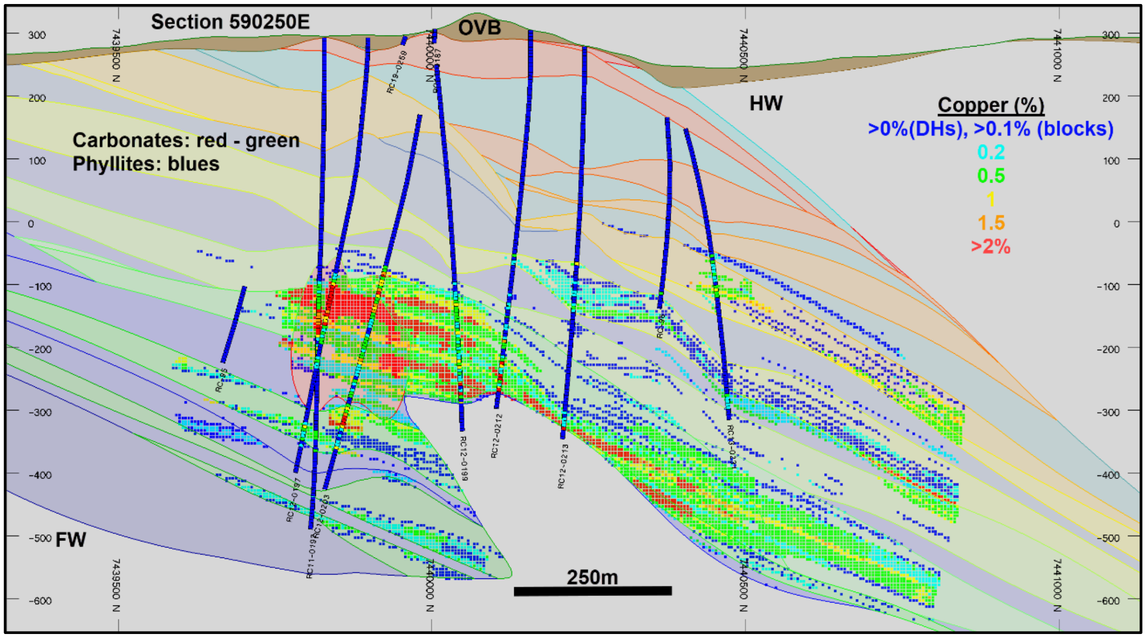
Detailed visual inspection of the block model was conducted in both section and plan to compare estimated grades against underlying sample data. This included confirmation of the proper coding of blocks within the respective zone domains. Examples of the distribution of copper grades in the block model are shown in cross section in Figures 14-21 and 14-22. Examples showing the cobalt grades are shown in cross section for the Ruby Zone in Figure 14-23 and the South Reef area in Figure 14-24.

Figure 14-21: North-South Vertical Section of Copper Estimates in the Block Model in the Ruby Zone



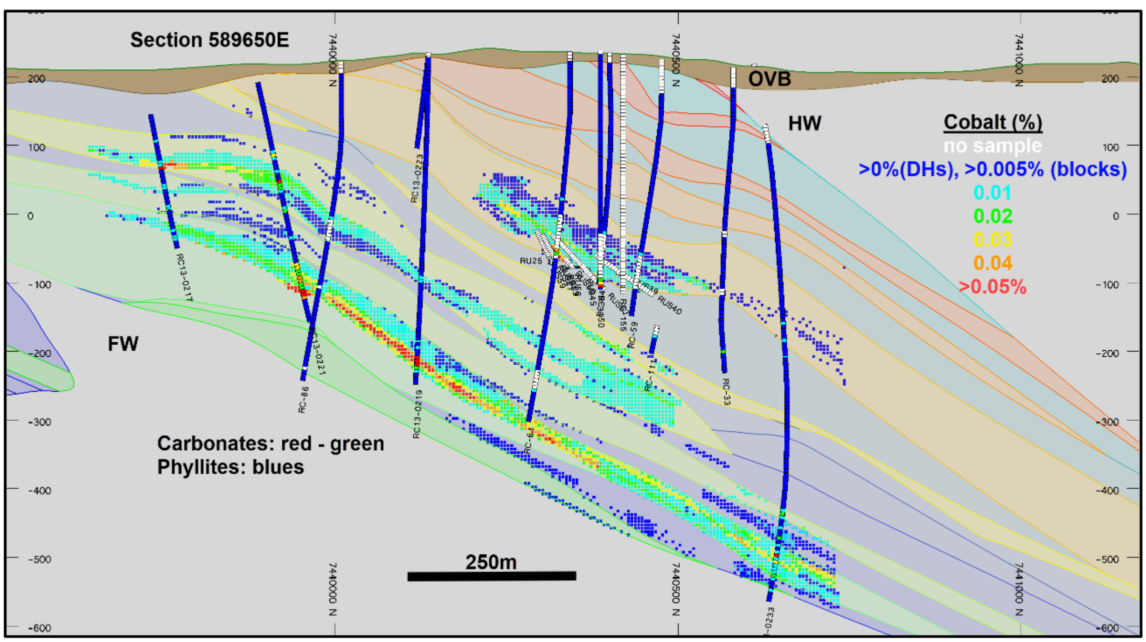
(Source: SIM, November 2021)

FIGURE 14-22: NORTH-SOUTH VERTICAL SECTION OF COPPER ESTIMATES IN THE BLOCK MODEL IN THE SOUTH REEF AREA



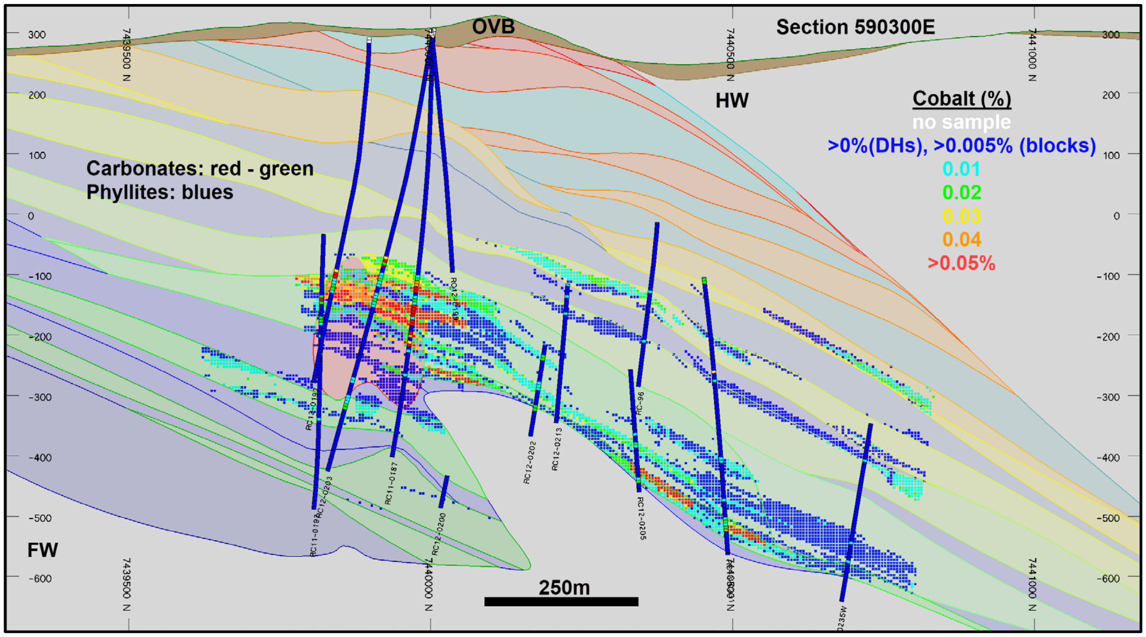
(Source: SIM, November 2021)

FIGURE 14-23: NORTH-SOUTH VERTICAL SECTION OF COBALT ESTIMATES IN THE BLOCK MODEL IN THE RUBY ZONE



(Source: SIM, November 2021)

FIGURE 14-24: NORTH-SOUTH VERTICAL SECTION OF COBALT ESTIMATES IN THE BLOCK MODEL IN THE SOUTH REEF AREA



(Source: SIM, November 2021)

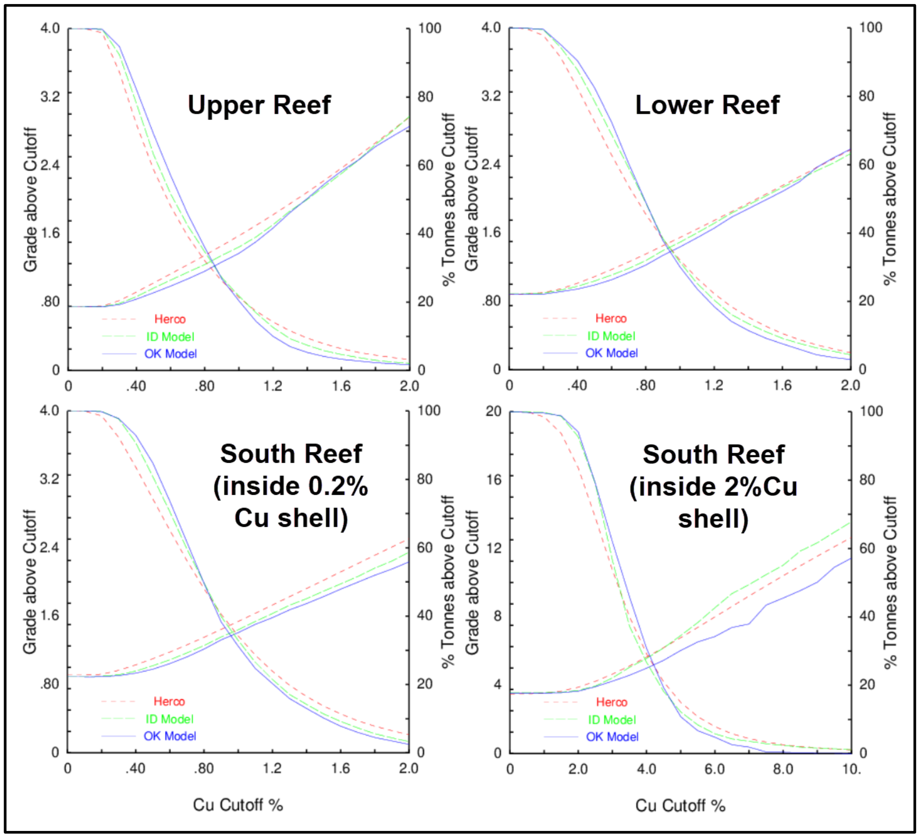
14.10.2 Model Checks for Change of Support

The relative degree of smoothing in the block estimates was evaluated using the Discrete Gaussian or Hermitian Polynomial Change of Support method (described by Rossi and Deutsch, Mineral Resource Estimation, 2014). With this method, the distribution of the hypothetical block grades can be directly compared to the estimated ordinary kriging model through the use of pseudo-grade/tonnage curves. Adjustments are made to the block model interpolation parameters until an acceptable match is made with the Herco (*Her*mitian *Co*rrection) distribution. In general, the estimated model should be slightly higher in tonnage and slightly lower in grade when compared to the Herco distribution at the projected cut-off grade. These differences account for selectivity and other potential ore-handling issues which commonly occur during mining.

The Herco distribution is derived from the declustered composite grades which were adjusted to account for the change in support moving from smaller drill hole composite samples to the larger blocks in the model. The transformation results in a less skewed distribution, but with the same mean as the original declustered samples.

At this stage of project evaluation, copper is the main economic contributor at Bornite, and it can be assumed that cobalt will act as a secondary metal or byproduct. Therefore, the change of support calculations are directed primarily at the copper content in the deposit. The available cobalt is reported based on a copper cut-off grade threshold. Examples of Herco change of support grade/tonnage plots for copper are shown in Figure 14-25; they are calculated for each reef formation limited to blocks inside the copper probability shells.

FIGURE 14-25: HERCO AND MODEL GRADE / TONNAGE PLOTS FOR COPPER INSIDE PROBABILITY SHELLS



(Source: SIM, November 2021)

Overall, the desired degree of correlation between models has been achieved. It should be noted that the change of support model is a theoretical tool intended to direct model estimation. There is uncertainty associated with the change of support model, and its results should not be viewed as a final or correct value.

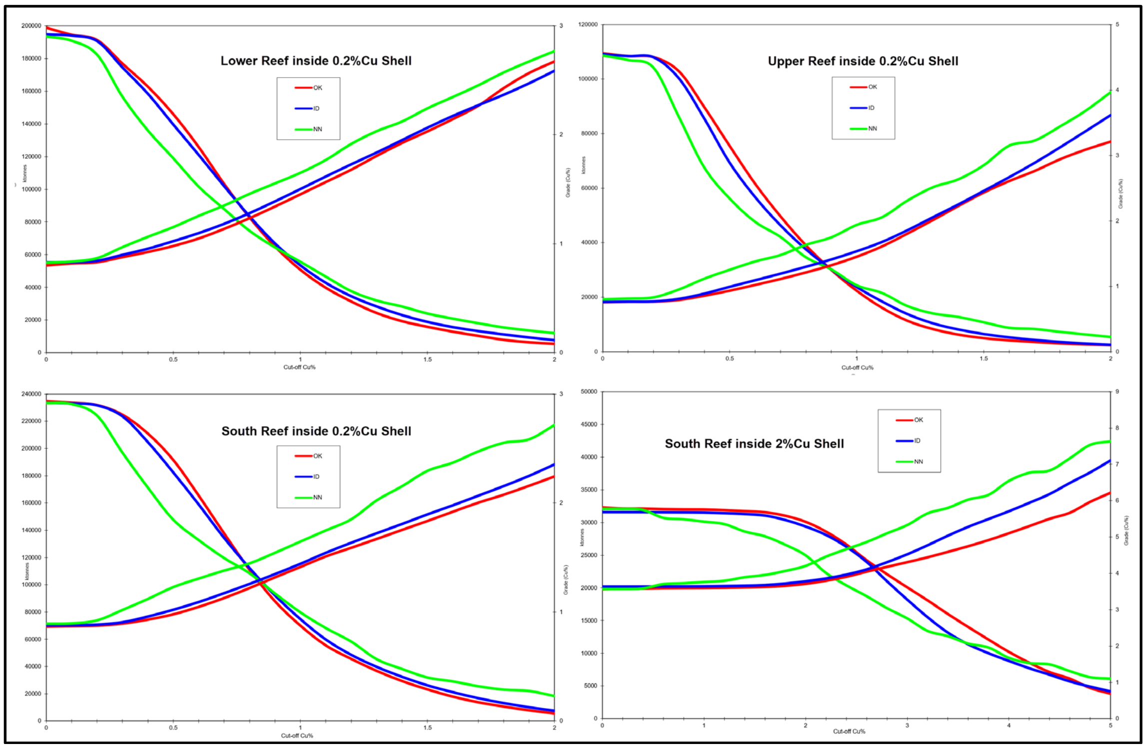
14.10.3 COMPARISON OF INTERPOLATION METHODS

For comparison purposes, additional grade models were generated using the inverse distance weighted (ID^2) and nearest neighbour (NN) interpolation methods. The NN model was created using data composited to 5 m lengths to ensure all sample data are used in the model. The results of these models were compared to the ordinary kriging (OK) models at various cut-off grades using a grade/tonnage graph. The example shown in Figure 14-26 compares copper models within the combined 2% Cu and in the 0.2% Cu shells for the Upper, Lower and South Reefs. There is good correlation between model types.

The correspondence among the grade tonnage curves is typical for the compared interpolation methods. The NN grades and tonnages above cut-off are correct assuming that the perfect selection of material above and below the cut-off can be executed at the scale of the composite samples. It is included to show the results of the averaging that occurs in the other two methods.

The ordinary kriging curves show the lowest grades and highest tonnages. The correct amount of averaging for the chosen block size is ensured for the ordinary kriging by the change of support calculation described in the preceding section. Similar relationships among the interpolation methods were achieved with the cobalt models; however, the cobalt content in the mineral resource will be based on copper cut-off grades, not cobalt cut-off grades.

FIGURE 14-26: COMPARISON OF COPPER MODEL TYPES IN CARBONATES INSIDE GRADE SHELL DOMAINS



(Source: SIM, November 2021)

14.10.4 SWATH PLOTS (DRIFT ANALYSIS)

A swath plot is a graphical display of the grade distribution derived from a series of bands, or swaths, generated in several directions throughout the deposit. Using the swath plot, grade variations from the ordinary kriging model are compared to the distribution derived from the declustered nearest neighbour grade model.

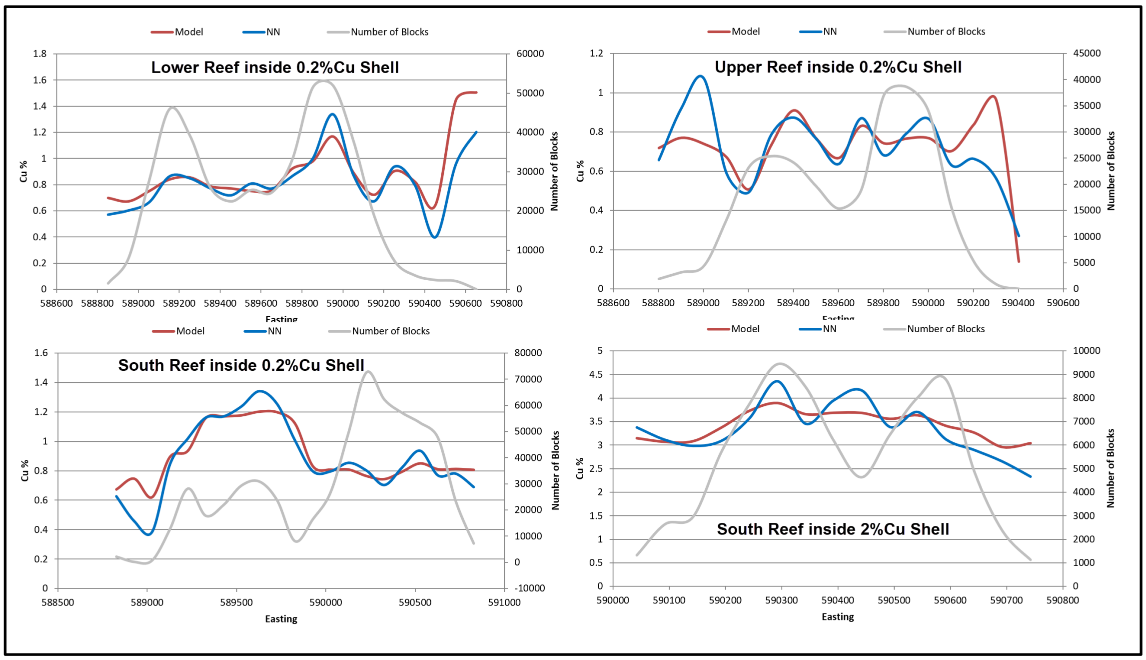
On a local scale, the nearest neighbour model does not provide reliable estimations of grade, but on a much larger scale, it represents an unbiased estimation of the grade distribution based on the underlying data. Therefore, if the ordinary kriging model is unbiased, the grade trends may show local fluctuations on a swath plot, but the overall trend should be similar to the nearest neighbour distribution of grade.

Swath plots were generated in three orthogonal directions that compare the ordinary kriging and nearest neighbour estimates for copper and cobalt in each of the estimation domains.

Examples from each of the three reefs, limited to blocks inside the 0.2% Cu probability shell, together with the 2% Cu shells for copper are shown in Figure 14-27.

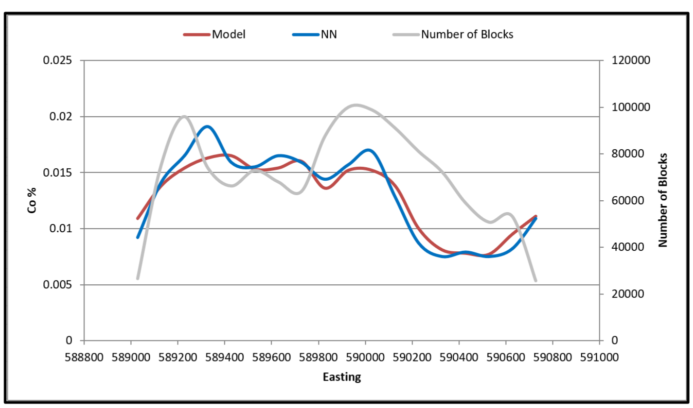
Figure 14-28 shows the cobalt swaths for all (combined) carbonate units inside the 0.2% Cu probability shell. There is good correlation between models and the degree of smoothing in the OK models (shown in red) is evident in the swaths. Areas where there are large differences between the models tend to be the result of “edge” effects, where there are less available data to support a comparison. The validation results indicate that the OK copper and OK cobalt models are reasonable reflections of the underlying sample data.

FIGURE 14-27: SWATH PLOTS OF COPPER IN CARBONATES INSIDE GRADE SHELL DOMAINS



(Source: SIM, November 2021)

FIGURE 14-28: SWATH PLOTS OF COBALT IN CARBONATES INSIDE THE GRADE SHELL DOMAINS



(Source: SIM, November 2021)

14.11 Mineral Resource Classification

The mineral resources were classified in accordance with the CIM *Definition Standards for Mineral Resources and Mineral Reserves* (May 2014). The classification parameters are defined relative to the distance between sample data and are intended to encompass zones of reasonably continuous mineralization that exhibit the desired degree of confidence in the estimate.

Classification parameters are generally linked to the scale of a deposit: a large and relatively low-grade porphyry-type deposit would likely be mined at a much higher daily rate than a narrow high-grade deposit. The scale of selectivity of these two examples differs significantly, and this is reflected in the drill-hole spacing required to achieve the desired level of confidence to define a volume of material that represents, for example, a year of production.

At this stage of evaluation for the Bornite deposit, it is becoming apparent that it may be amenable to a combination of open pit and underground extraction methods. The actual scale of extraction is unknown at this time, and further engineering work is required to gain a better understanding of these concepts. However, most of the significant copper mineralization in the (western) Ruby Zone occurs at depths generally less than about 500 m below surface, and these mineral resources are considered to be potentially amenable to open pit extraction methods. Below the pit shell at the Ruby Zone, there remains some additional copper mineralization that is of sufficient thickness and tenor to be considered amenable to underground extraction methods. Essentially all of the copper mineralization in the (eastern) South Reef area occurs at depths that exceed 400 m below surface, and as a result, it is assumed that these mineral resources would likely be amenable to only underground extraction methods.

Copper and cobalt grade and indicator variograms were evaluated to provide information regarding the range of continuity of mineralization. This was combined with visual observations regarding the nature of the deposits with respect to the distribution of available sample information.

A portion of the copper-only mineral resources in the Ruby Zone are included in the Indicated category because this part of the deposit is potentially amenable to open pit extraction methods. And current drill-hole distribution, at 75 m spacing, provides a sufficient level of confidence in the grade and continuity of mineralization. None of the cobalt mineral resources can be classified in the Indicated category due to the wider spatial distribution of sample data for cobalt. All of the cobalt mineral resources in the Ruby Zone and South Reef area are classified in the Inferred category. The current drill hole spacing in the South Reef area is insufficient to define any of the copper mineral resources in the Indicated category because it appears that this part of the Bornite deposit is likely amenable to underground extraction methods. Delineation of mineral resources in the Indicated category for underground extraction purposes requires delineation drilling with holes spaced at distances much less than 75 m.

The following classification criteria are defined for the Bornite deposit:

Indicated Mineral Resources include blocks in the model that are potentially amenable to open pit extraction methods, delineated by drilling with holes spaced at a maximum distance of 75 m, and exhibit a relatively high degree of confidence in the grade and continuity of mineralization.

Inferred Mineral Resources require a minimum of one drill hole within a maximum distance of 100 m and exhibit reasonable confidence in the grade and continuity of mineralization.

Some manual "smoothing" of these criteria was conducted that includes areas where the drill hole spacing locally exceeds the desired grid spacing, but still retains continuity of mineralization or, conversely, excludes areas where the mineralization does not exhibit the required degree of confidence. This process resulted in two areas in the Ruby Zone that contain mineral resources in the Indicated category. Some manual "smoothing" has also been used to define a continuous zone of Inferred class mineral resources along the northern, down-dip part of the deposit, where the spacing of these deep drill holes is somewhat more variable.

14.12 MINERAL RESOURCE ESTIMATE

CIM *Definition Standards for Mineral Resources and Mineral Reserves* (May 2014) defines a mineral resource as:

"A mineral resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade or quality, continuity and other geological characteristics of a mineral resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling".

The "reasonable prospects for eventual economic extraction" requirement generally implies that quantity and grade estimates meet certain economic thresholds and that mineral resources are reported at an appropriate cut-off grade which takes into account the extraction scenarios and the processing recovery.

At this stage of project evaluation, copper is the main economic contributor at Bornite, and it can be assumed that cobalt will act as a secondary metal or byproduct. Therefore, reasonable prospects for eventual economic extraction only address the copper content in the deposit, and the available cobalt is reported based on a copper cut-off grade threshold. It is very rare that appreciable cobalt grades occur where there is no associated copper mineralization.

The Bornite deposit comprises several zones of relatively continuous moderate- to high-grade copper mineralization that extends from surface to depths of more than 800 m below surface. The deposit is potentially amenable to a combination of open pit and underground extraction methods. The "reasonable prospects for eventual economic extraction" requirement was tested using a pit shell based on a series of technical and economic assumptions considered appropriate for a deposit of this type, scale and location. The resource constraining pit shell was generated with the assistance of Gordon Zurowski, P.Eng. of AGP Mining Consultants Inc. located in Barrie, Ontario. The parameters used to produce the pit shell are summarized in Table 14.11.

TABLE 14.11: PARAMETERS USED TO GENERATE A MINERAL RESOURCE LIMITING PIT SHELL

Optimization Parameters	
Open Pit Mining Cost	US$3/tonne
Milling Cost	US$11/tonne
G&A	US$5/tonne
Pit Slope	43 degrees
Metallurgical Recovery	87%
Copper Price	US$3.50/lb

(No adjustments for mining recovery or dilution)

It is important to recognize that these discussions of underground and surface mining parameters are used solely for the purpose of testing the "reasonable prospects for economic extraction" and do not represent an attempt to estimate mineral reserves. No mineral reserves were calculated for the Bornite Project. These preliminary evaluations are used to assist with the preparation of a Mineral Resource Statement and to select appropriate reporting assumptions.

Using the parameters defined in Table 14.11, a pit shell was generated in the area of the Ruby Zone that extends to a depth of approximately 500 m below surface and contains, including the mineral resources stated below, a total of 1.01 billion tonnes. Tables 14.12 and 14.13 list the copper and cobalt mineral resources contained within and below the pit shell, respectively. Estimates of mineral resources are stated separately because, although the copper data supports estimates of mineral resources in both the Indicated and Inferred categories, the distribution of cobalt sample data is sufficient to support estimates in only the Inferred category. As stated previously, it is assumed that extraction from the Bornite deposit is based on the copper content in the rocks and that cobalt would be a secondary contributor to the potential economic viability of the deposit. As a result, both copper and cobalt mineral resource estimates are defined based on a copper cut-off grade threshold. Mineral resource estimates are reported based at two cut-off grades: 0.5% Cu for material that is amenable to open pit extraction and 1.5% Cu for mineral resources that occur below the pit shell. The cut-off grade of mineral resources amenable to underground extraction is based on an underground mining cost of US$65/tonne. Mineral resources below the open pit shell are separated into two separate areas to highlight that the underground mineral resources in the South Reef area are much thicker and higher grade than those present in the area of the Ruby Zone. The distribution of mineral resources is presented with a series of isometric views in Figure 14-29.

Based on the drilling information to date, the South Reef underground resource occurs in a relatively continuous zone, measuring approximately 1,100 m north-south by 400 m east-west, that dips at about -25 degrees to the north and is located between 400 m and 1,000 m below surface. The true thickness of the underground mineral resource at South Reef is variable from 5 m to more than 40 m in some areas and averages about 15 m to 20 m thick. The underground resources at the Ruby Zone tend to be lower grade, narrower and more patchy or discontinuous in nature, with average true thicknesses typically ranging from 5 m to 10 m in most areas. Mineral resources located below the open pit shell exclude zones of mineralization that are above the base case cut-off grade of 1.5% Cu but are considered too small and/or isolated to be considered economically viable. The resulting continuity of grade and thickness of mineralization included in the estimate of mineral resources below the pit shell exhibits reasonable prospects of eventual economic extraction using underground mining methods such as a combination of longhole stoping and cut-and-fill mining. The underground mineral resources for the South Reef area and the Ruby Zone are presented separately in Tables 14.12 and 14.13 to show the differences in average copper and cobalt grades in these two deposit areas.

There are no known factors related to environmental, permitting, legal, title, taxation, socio-economic, marketing, or political issues which could materially affect the mineral resource.

TABLE 14.12: ESTIMATE OF COPPER MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type/Area	Cut-off (Cu %)	Tonnes (million)	Average Grade Cu (%)	Contained Metal Cu (Mlbs)
Indicated	In-Pit(1)	0.5	41.7	1.04	955
Inferred	In-Pit(1)	0.5	93.9	0.98	2,034
	Below-Pit South Reef	1.5	35.3	3.39	2,639
	Below-Pit Ruby Zone	1.5	15.0	1.98	653
	Total Inferred		144.1	1.68	5,326

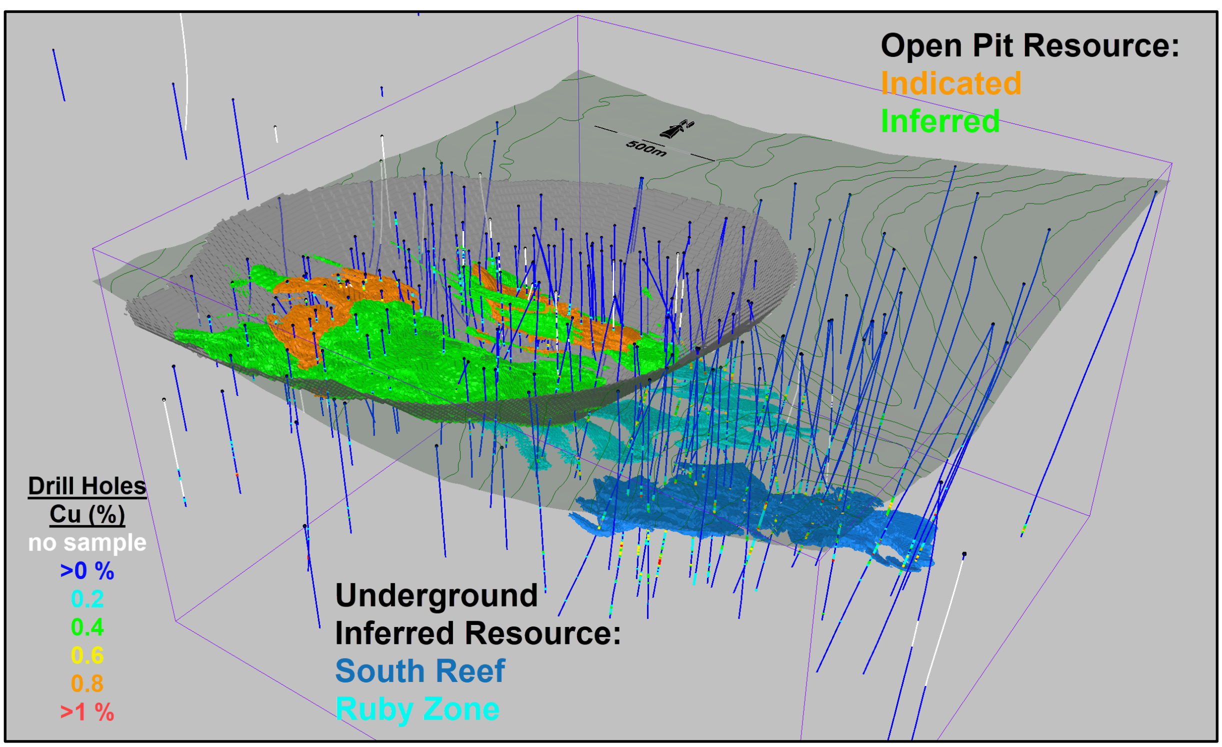
1) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3/tonne, milling costs of US$11/tonne, G&A cost of US$5/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees. Underground mining cost is US$65/tonne.
2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

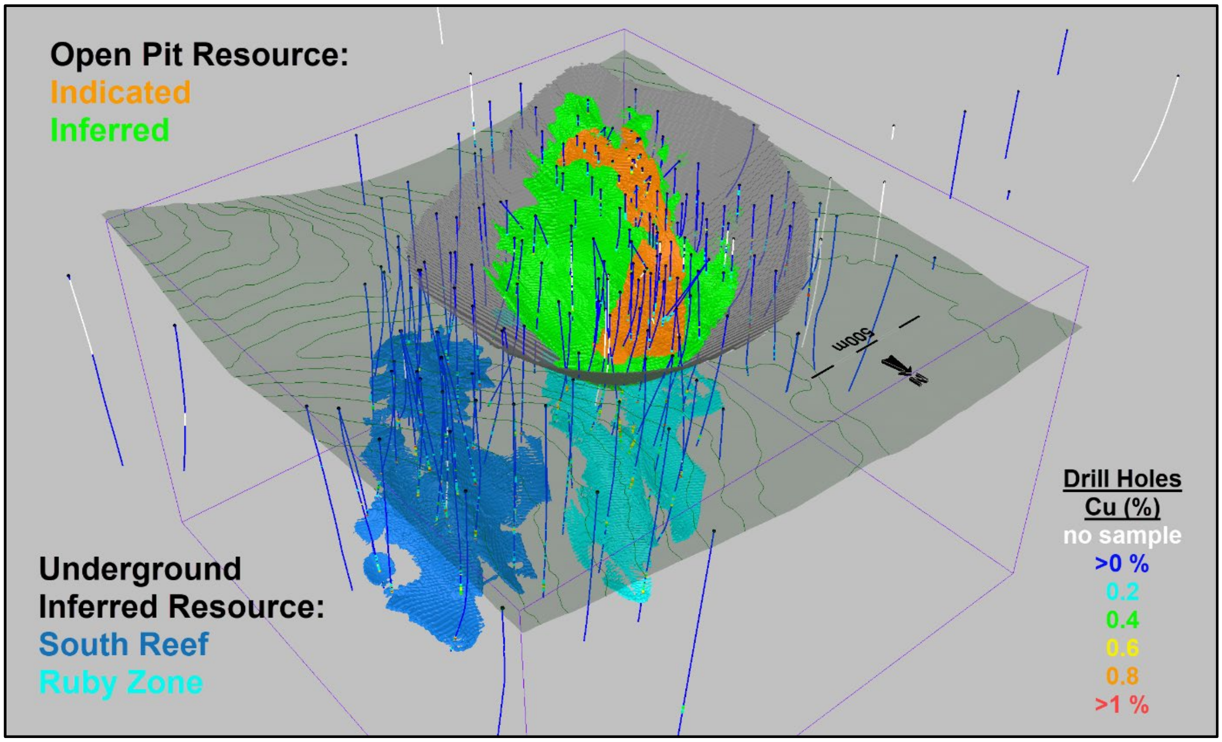
TABLE 14.13: ESTIMATE OF COBALT MINERAL RESOURCES FOR THE BORNITE PROJECT

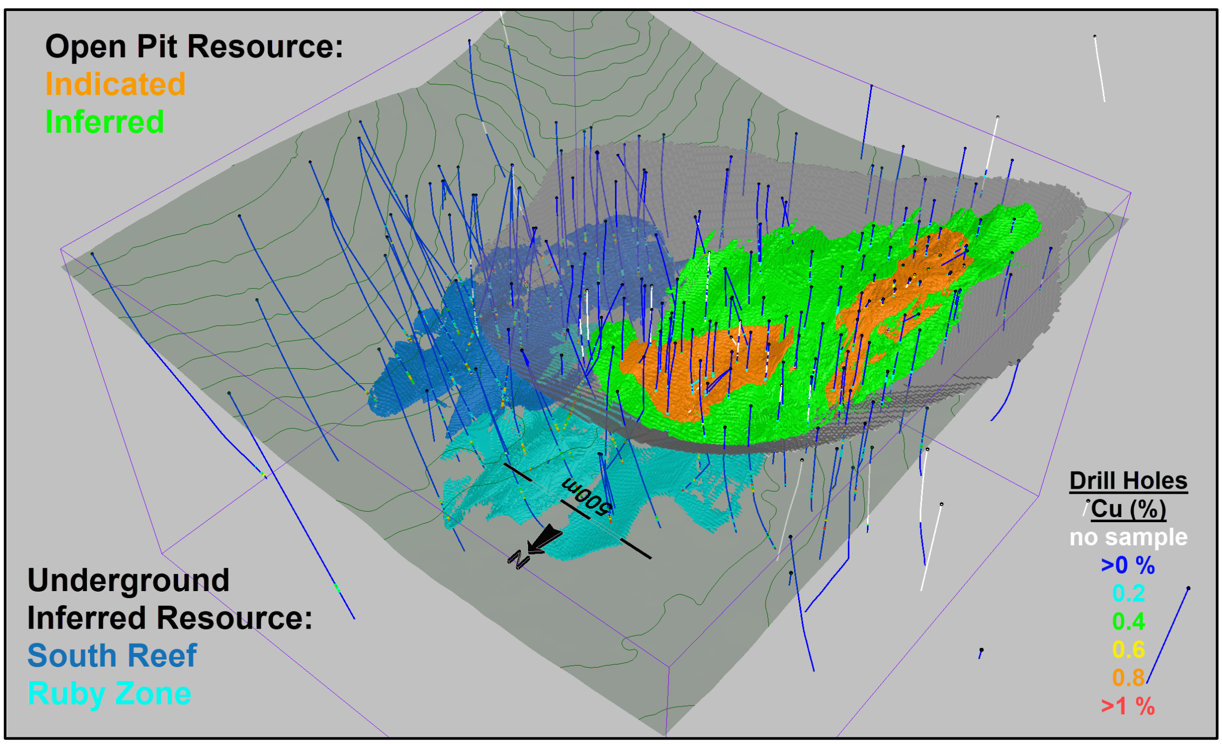
Class	Type/Area	Cut-off (Cu %)	Tonnes (million)	Average Grade Co (%)	Contained Metal Co (Mlbs)
Inferred	In-Pit(1)	0.5	135.6	0.017	51
	Below-Pit South Reef	1.5	35.3	0.039	30
	Below-Pit Ruby Zone	1.5	15.0	0.021	7
	Total Inferred		185.8	0.021	88

1) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3/tonne, milling costs of US$11/tonne, G&A cost of US$5/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees. Underground mining cost is US$65/tonne.
2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.
4) Due to limited sample data, none of the cobalt mineral resource meets the confidence level for Indicated-class mineral resources. All cobalt mineral resources are considered to be in the Inferred category.

FIGURE 14-29: ISOMETRIC VIEWS OF BORNITE MINERAL RESOURCE







(Source: SIM, November 2021)

14.13 GRADE SENSITIVITY ANALYSIS

For information purposes, mineral resources are summarized at a series of cut-off thresholds within the base case pit shell in Tables 14.14 and 14.15, and for mineral resources below the pit shell in the South Reef area and the Ruby Zone in Tables 14.16 and 14.17. The base case cut-off limit, about which the mineral resource statement was derived, is shown in bold. The reader is cautioned that the values presented in these tables should not be misconstrued with a Mineral Resource Statement. The values are only presented to show the sensitivity of the block model estimates to the selection of the cut-off grade.

TABLE 14.14: SENSITIVITY TO CUT-OFF GRADE OF COPPER MINERAL RESOURCES INSIDE THE BASE CASE PIT SHELL

Cut-off (Cu %)	Indicated			Inferred		
	Tonnes (million)	Cu (%)	Contained Cu (Mlbs)	Tonnes (million)	Cu (%)	Contained Cu (Mlbs)
0.20	53.1	0.90	1,050	127.2	0.82	2,295
0.25	52.0	0.91	1,044	121.7	0.85	2,268
0.30	50.8	0.93	1,036	117.0	0.87	2,242
0.35	49.2	0.95	1,026	112.4	0.89	2,207
0.40	47.3	0.97	1,010	107.2	0.92	2,164
0.45	44.6	1.00	985	101.1	0.95	2,109
0.50	**41.7**	**1.04**	**955**	**93.9**	**0.98**	**2,034**
0.55	38.6	1.08	920	86.5	1.02	1,949
0.60	35.4	1.13	879	79.5	1.06	1,861
0.65	32.1	1.18	834	72.6	1.10	1,767
0.70	28.7	1.24	784	65.8	1.15	1,667

1) Base Case cut-off grade of 0.50% Cu is shown in bold in the table.
2) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3.00/tonne, milling costs of US$11/tonne, G&A cost of US$5.00/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees.
3) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
4) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

TABLE 14.15: SENSITIVITY TO CUT-OFF GRADE OF COBALT INFERRED MINERAL RESOURCES INSIDE THE BASE CASE PIT SHELL

Cut-off (Cu %)	Tonnes (million)	Co (%)	Contained Co (Mlbs)
0.20	180.3	0.015	60
0.25	173.7	0.016	60
0.30	167.8	0.016	59
0.35	161.6	0.016	58
0.40	154.5	0.016	56
0.45	145.7	0.017	54
0.50	**135.6**	**0.017**	**51**
0.55	125.1	0.018	48
0.60	114.9	0.018	46
0.65	104.7	0.019	43
0.70	94.6	0.019	40

1) Base Case cut-off grade of 0.50% Cu is shown in bold in the table.
2) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3.00/tonne, milling costs of US$11/tonne, G&A cost of US$5.00/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees.
3) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
4) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

TABLE 14.16: SENSITIVITY TO CUT-OFF GRADE OF INFERRED MINERAL RESOURCES BELOW THE BASE CASE PIT SHELL IN THE SOUTH REEF AREA

Inferred					
Cut-off (Cu %)	Tonnes (million)	Average Grade		Contained Metal	
		Cu %	Co %	Cu (Mlbs)	Co (Mlbs)
1.00	60.3	2.51	0.028	3,339	37
1.25	42.2	3.07	0.035	2,861	32
1.50	**35.3**	**3.39**	**0.039**	**2,639**	**30**
1.75	31.8	3.57	0.041	2,499	29
2.00	29.8	3.67	0.043	2,413	28

1) Base Case cut-off grade of 1.50% Cu is shown in bold in the table.

2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.

3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

TABLE 14.17: SENSITIVITY TO CUT-OFF GRADE OF INFERRED MINERAL RESOURCES BELOW THE BASE CASE PIT SHELL IN THE RUBY ZONE

Inferred					
Cut-off (Cu %)	Tonnes (million)	Average Grade		Contained Metal	
		Cu %	Co %	Cu (Mlbs)	Co (Mlbs)
1.00	48.7	1.50	0.019	1,604	20.6
1.25	26.8	1.75	0.020	1,033	12.0
1.50	**15.0**	**1.98**	**0.021**	**653**	**6.8**
1.75	7.8	2.20	0.022	378	3.7
2.00	3.1	2.41	0.022	165	1.5

1) Base Case cut-off grade of 1.50% Cu is shown in bold in the table.

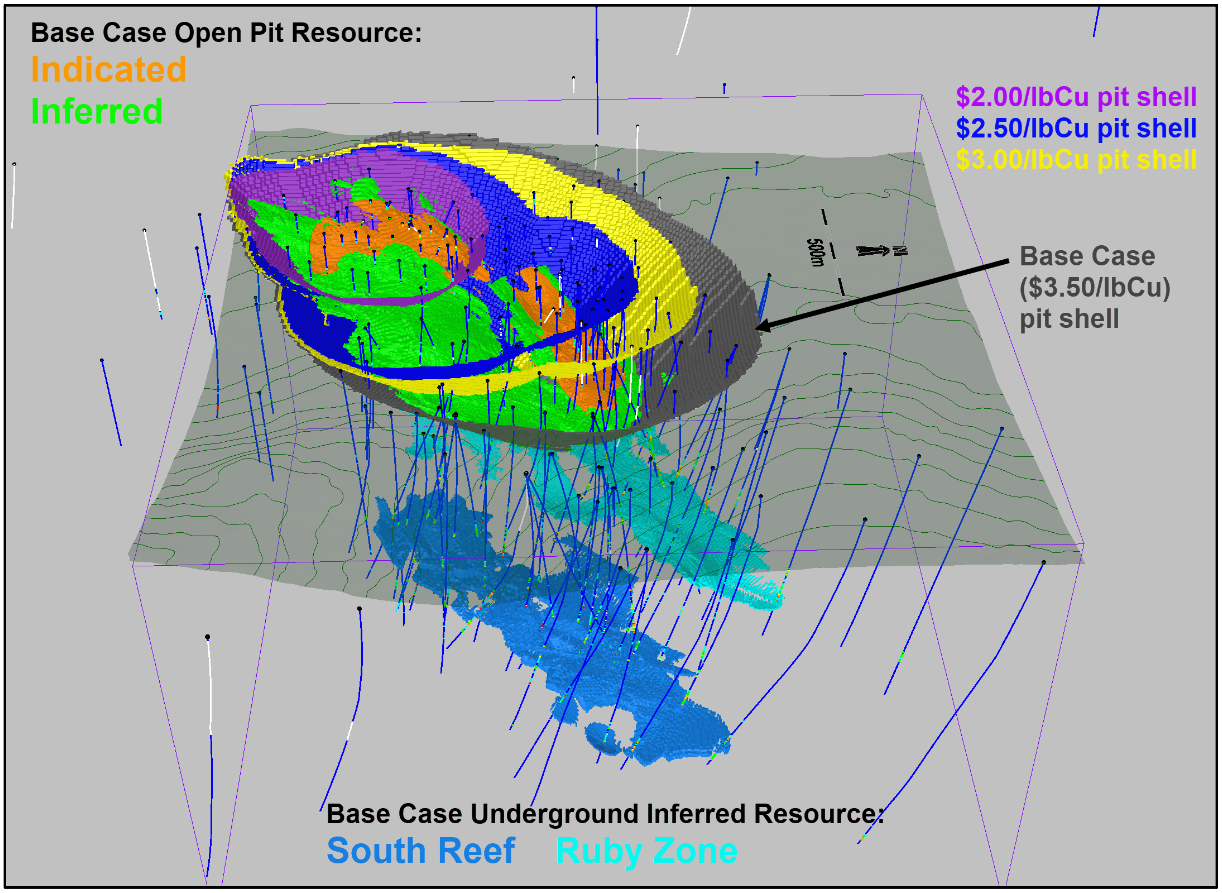
2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.

3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

The sensitivity of the open pit resources to copper price was further tested by generating additional pit shells at copper prices of $2.00/lb, $2.50/lb and $3.00/lb. The extents of these additional (smaller) pit shells, in relation to the base case mineral resources, are shown in Figure 14-30. The mineral resources contained in each shell are compared, using the base case cut-off grade of 0.5%Cu, in Table 14.18. The total tonnage in each pit shell, including the mineral resources listed in Table 14.14, is 119Mt inside the $2.00/lb Cu pit shell, 394Mt in the $2.50/lb Cu shell, 606Mt in the $3.00/lb Cu shell compared to 1,010Mt in the base case ($3.50/lb Cu) shell.

The reader is cautioned that the values presented in Table 14.18 should not be misconstrued with a Mineral Resource Statement. The values in Table 14.18 are only presented to show the sensitivity of the block model estimates when the constraining pit shells are generated using lower metal prices.

FIGURE 14-30: ISOMETRIC VIEW OF PIT SHELLS GENERATED AT LOWER COPPER PRICES RELATIVE TO THE BASE CASE MINERAL RESOURCE



(Source: SIM, November 2021)

TABLE 14.18: RESOURCES CONTAINED IN PIT SHELLS GENERATED AT VARYING COPPER PRICES (0.5%CU CUT-OFF)

Copper Price	Indicated			Inferred		
	Tonnes (million)	Cu %	Contained Cu (Mlbs)	Tonnes (million)	Cu (%)	Contained Cu (Mlbs)
$2.00/lb	19.4	0.96	411	18.0	0.93	369
$2.50/lb	29.3	1.00	647	50.8	0.96	1,078
$3.00/lb	36.8	1.03	835	65.9	0.97	1,402
$3.50/lb Base Case	**41.7**	**1.04**	**955**	**93.9**	**0.98**	**2,034**

14.14 COMPARISON TO PREVIOUS ESTIMATE OF MINERAL RESOURCES

The previous estimate of mineral resources for the Bornite deposit was summarized in a technical report with an effective date of June 5, 2018. As stated previously in this report, in the summer of 2017, seven holes were drilled to test the down-dip continuity of the northern part of the Bornite deposit. The spacing of these holes was considered too far apart to support the generation of additional mineral resource estimates at that time, and as a result, the estimate of copper mineral resources remained unchanged in the June 2018 report from those reported in the previous technical report dated April 2016. However, the June 2018 technical report did include, for the first time, an estimate of cobalt mineral resources for the Bornite Project.

In the summer of 2018, Trilogy Metals conducted a drilling program on the Bornite deposit that included the completion of 12 holes that, in part, filled the gaps in previous drilling in the northern, down-dip part of the deposit.

In the summer of 2019, another drilling program was conducted on the Property comprising eight holes that tested the continuity of the mineralization within the Bornite deposit and two holes that tested exploration targets located about 1 km south and southeast of the deposit.

Tables 14.19 and 14.20 show comparisons of the previous estimates with the new mineral resource estimates for copper and cobalt.

TABLE 14.19: COMPARISON WITH THE PREVIOUS ESTIMATE OF COPPER MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type	Cut-off (Cu %)	December 2021			June 2018		
			Tonnes (million)	Average Grade Cu (%)	Contained Metal Cu (Mlbs)	Tonnes (million)	Average Grade Cu (%)	Contained Metal Cu (Mlbs)
Indicated	In-Pit(1)	0.5	41.7	1.04	955	40.5	1.02	913
Inferred	In-Pit(1)	0.5	93.9	0.98	2,034	84.1	0.95	1,768
Inferred	Below-Pit	1.5	50.3	2.97	3,292	57.8	2.89	3,683
Inferred	Total Inferred		144.1	1.68	5,326	141.9	1.74	5,450

TABLE 14.20: COMPARISON WITH THE PREVIOUS ESTIMATE OF COBALT MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type	Cut-off (Cu %)	December 2021			June 2018		
			Tonnes (million)	Average Grade Co (%)	Contained Metal Co (Mlbs)	Tonnes (million)	Average Grade Co (%)	Contained Metal Co (Mlbs)
Inferred	In-Pit(1)	0.5	135.6	0.017	51	124.6	0.017	45
Inferred	Below-Pit	1.5	50.3	0.033	37	57.8	0.025	32
Inferred	Total		185.8	0.021	88	182.4	0.019	77

Compared to the previous estimate of mineral resources (effective date June 5, 2018), the current mineral resource estimate shows slightly more mineral resources that are considered amenable to open pit extraction and slightly fewer mineral resources that are located below the pit shell. The overall amount of copper contained in each of these two estimates of mineral resources remains within about 1% of each other.

There is a slight increase in the cobalt mineral resource that is amenable to open pit extraction methods compared to the previous estimate. This is primarily due to the slightly larger size of the newer constraining pit shell. The additional holes drilled at depth (below the open pit) since the previous mineral resource estimate show better continuity of higher grade intervals of cobalt mineralization, and this is reflected in an increase in the average grade of the cobalt mineral resource below the pit shell.

Factors that contribute to the changes in mineral resources are summarized as follows:

- The current mineral resource estimate includes the results of drilling that was conducted in 2017, 2018, and 2019, but as stated previously, the 2017 drill holes were too widely spaced to support updated mineral resources on the northern (down-dip) part of the deposit at that time. The additional drilling had no impact on the distribution of mineral resources in the Indicated category located inside the resource pit shell. Most of the new drilling was located along the northern, down-dip side of the deposit, or in the vicinity of the South Reef area. These additional drill holes generally resulted in a slight reduction in the volume (tonnage) of mineral resources but with a corresponding increase in both copper and cobalt grades.
- The interpretations of geologic domains and trend planes were updated based on all available drilling information. The differences in these interpretations compared to the previous resource estimate are relatively minor.
- The projected operating costs and metal prices used to generate the resource constraining pit shell were updated to reflect the current mining environment. The mining cost was increased from $2/t to $3/t and the copper price was increased from $3.00/lb to $3.50/lb. These changes have resulted in a slightly larger resource constraining pit shell, which generally increased the volume of open pit mineral resources and decreased the amount of underground mineral resources.
- The new mineral resource estimate was subjected to a more critical review of the continuity of grade and thickness of mineralization below the pit shell; this was completed to ensure that the mineral resource exhibits reasonable prospects for eventual economic extraction using underground mining methods. This process has eliminated some of the more isolated mineralized areas that were present in the previous mineral resource estimate.

15 MINERAL RESERVE ESTIMATES

The Bornite Project is an early exploration project; there are presently no mineral reserves at the Project.

16 MINING METHODS

The Bornite Project is an early exploration project, and generalized mining methods were considered but none have been investigated for the Project. Based on the current information, the mineral resource would be extracted using a combination of open pit and underground mining methods. The generally thicker and higher grade mineral resources in the South Reef area are thought to be amenable to long-hole open stoping, and the narrower zones of mineralization would be mined using conventional cut-and-fill mining.

17 RECOVERY METHODS

The Bornite Project is an early exploration project, and process design remains to be conceptually based on limited metallurgical test work results. Nonetheless, the Bornite Project has been shown to respond well to traditional process test work, and a traditional process design is expected for the Project. This will include the following key unit operations:

1) Primary crushing
2) SAG milling and ball milling to approximately 100 microns
3) Rougher copper flotation
4) Rough concentrate re-grinding to approximately 10 to 20 microns
5) Flotation cleaning to produce final copper concentrates
6) Concentrate de-watering
7) Deposition of tailings solids

Results of copper recovery test work are detailed in Section 13 of this technical report and is based on the use of a proposed flowsheet which is shown in Figure 13-2. There has been no work completed that evaluates the potential recovery of cobalt.

18 PROJECT INFRASTRUCTURE

18.1 ROAD

The projects in the Ambler Mining District are at an exploration or early development stage, including Trilogy Metals' Bornite Project. Trilogy Metals and NANA are supporting the State of Alaska's efforts to develop infrastructure in the region, specifically AMDIAP, under the *Alaska Roads to Resources* program.

Between 2009 and 2012, the State of Alaska funded over $10 million to study access to the Ambler Mining District. During that period, a working group consisting of ADOT, the Governor's office, AIDEA, NANA, and Trilogy Metals was developed to advance AMDIAP. An additional $8.5 million was funded by the Alaskan government for permitting activities during the 2013–2014 fiscal year.

Efforts from 2009 to 2011 focused on identifying optimal access routes and, after input from local communities and a review of a series of options, the Brooks East Access Route was chosen for further assessment. In 2012, the Alaska State Legislature approved an additional $4 million to allow the ADOT to initiate environmental baseline studies on the Brooks East Access Route connecting the Ambler Mining District with the Dalton Highway 322 km to the east. In the fall of 2012, a project description for AMDIAP was prepared by AIDEA; it was the project proponent to finalize the proposed action and identify the lead federal agency for impact analysis and determine the state and federal cooperating agencies to assure permit coordination. Also, initial meetings between all of the permitting and licensing agencies and initial community engagement meetings were held in August 2013. On October 21, 2015, the Governor of the State of Alaska authorized AIDEA to begin the EIS process. In 2015, AIDEA completed a Consolidated Right-of-Way Application (form SF-299) to the relevant federal permitting agencies, including the National Park Service (NPS); US Army Corps of Engineers (ACE), and Bureau of Land Management (BLM).

In August 2016, the Consolidated Right-of-Way Application (SF-299) application was reviewed and deemed Complete and Compliant by the NPS, ACE, and the BLM. In February 2017, the BLM as Lead Federal Agency issued the Notice of Intent (NOI) and thereby initiated an Environmental Impact Study.

In July 2020, the US BLM signed a Record of Decision for the Ambler Mining District Industrial Access Project (AMDIAP) that approved the development of the northern route, a 211-mile gravel private-access road in the southern Brooks Range foothills that would provide access to the Ambler Mining District.

On August 3, 2020, a coalition of national and Alaska environmental non-government organizations ("ENGO") filed the first of two lawsuits against the federal agencies responsible for issuing the JROD. A second similar lawsuit was filed in October 2020. The ENGO's main position is that due process was not carried out during the permitting of the AMDIAP. Subsequently, AIDEA, Ambler Metals, the State of Alaska and NANA have filed for and received intervenor status in each of the lawsuits and will be defending the issuance of the JROD and the permits.

More information for permitting the AMDIAP is available on the BLM's website at http://eplanning.blm.gov.

Figure 18-1 shows the Brooks East Access Route in orange with respect to the existing Dalton Highway in black and the Alaska Railroad in blue. Figure 18-2 shows the preferred access option (Brooks East Access Route) in yellow.

In the first half of 2020, the name of the Ambler Mining District Industrial Access Project (AMDIAP) was changed to the Ambler Access Project (AAP). Additional information can be found at https://ambleraccess.org.

In June 2020, the Board of Directors of the Alaska Industrial Development and Export Authority (AIDEA), approved a Memorandum of Understanding (MOU) with Ambler Metals which specified how the parties would jointly establish a plan regarding the permitting, feasibility, engineering and design, construction and operation, financing, and closure of the AMDIAP. Ambler Metals has committed to contribute up to $35 million to match AIDEA's contribution of $35 million for these activities.

In January 2021, the BLM, NPS, and the AIDEA signed the documents granting a 50-year right-of-way for the future construction of the Ambler Mining District Industrial Access Road.

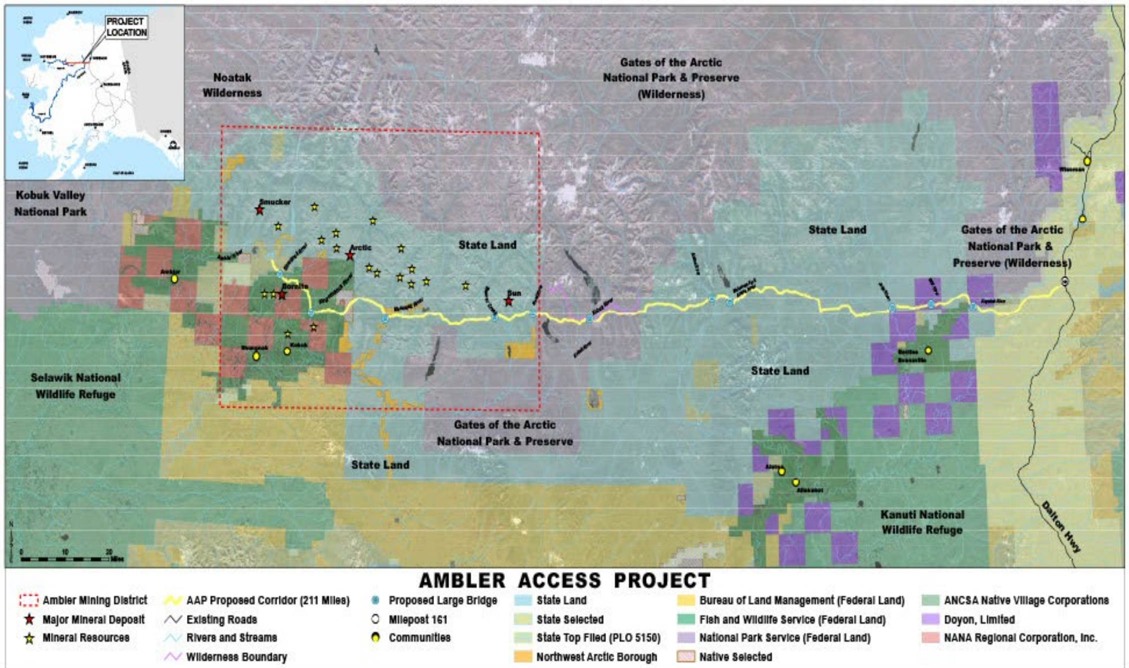
During the summer of 2021, the field work required to advance the cultural resources information and design of the road was initiated. Additional work is scheduled for 2022 and 2023.

In October 2021, the Ambler Access Project announced the Subsistence Advisory Committee (SAC) Working Group. The seven-member SAC Working Group comprises five Alaska Native Elders and two representatives from the two Alaska Native landowner regions along the approved route.

FIGURE 18-1: BROOKS EAST ROUTE ACCESS TO THE UKMP

(Source: Trilogy Metals, 2017)

FIGURE 18-2: PREFERRED OPTION BROOKS EAST ROUTE ACCESS TO THE UKMP



(Source: Trilogy Metals, 2021)

18.2 POWER

Remote projects typically use diesel fuel for power generation. In July 2013, AIDEA published a feasibility study to investigate the viability of trucking LNG to Fairbanks to supply local utilities which would use the LNG to fuel their power generation plants. The feasibility study estimated that the use of LNG could significantly lower electrical power generation costs in Fairbanks.

19 MARKET STUDIES AND CONTRACTS

The Bornite Project is an early exploration project; no market studies have been completed.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

This section characterizes the existing and ongoing environmental baseline data collection for the Bornite Project area, suggests additional studies that could provide a basis for the eventual mine permitting efforts, describes the major environmental permits that will likely be required for the Bornite Project, and identifies potential significant social or community impacts.

20.1 ENVIRONMENTAL STUDIES

The Bornite Project area includes NANA's Bornite and ANCSA lands, the Ruby Creek drainage (a tributary of the Shungnak River), the Shungnak River drainage, and portions of the Ambler Lowlands. Since 2008, baseline environmental data collection has occurred in the area, including archaeology, aquatic life surveys, sediment sampling, wetlands mapping, surface water-quality sampling, hydrology, meteorological monitoring, and subsistence. The existing data are summarized in Sections 20.1.1 to 20.1.7.

A summary of existing environmental baseline studies is shown in Table 20.1.

20.1.1 ARCHAEOLOGY

Limited work was done in 2008 by Northern Land Use Research Inc. (NLUR) to identify sites that could have potential cultural significance within the Bornite Project area. NLUR concluded "No Historic Properties Affected" with regards to the 2008 work plan. Additional archaeological assessment work was completed near Bornite in 2018 and 2019 by Kuna Engineering to determine whether archaeological resources were impacted by development of the proposed Dahl Creek to Artic Mine Road. A comprehensive archaeological survey will be completed at Bornite prior to permitting.

20.1.2 AQUATIC LIFE AND FISHERIES

Aquatic life and fisheries sampling efforts were conducted in 2010 by TetraTech Inc. Tetra Tech's sampling efforts included baseline aquatic life surveys in the area along the proposed road alternatives between the Bornite airstrip and the Arctic airstrip, and along the Arctic airstrip to the Arctic Deposit road in Subarctic Creek. The purpose of this study was to characterize the aquatic life within the Shungnak River and determine potentially impacted tributaries. Opportunities were also observed along the Kogoluktuk River.

The Alaska Department of Fish and Game conducted aquatic surveys on Ruby Creek near Bornite in 2016, 2017, 2018, 2019 and 2021, including both fish and macroinvertebrates abundance and diversity. Metals analysis of fish tissues was also performed and compared to background water quality results.

20.1.3 Ecosystem and Soils

Soil sampling was completed in 2011 to determine the presence of naturally occurring asbestos (NOA). Sampling was completed at the Bornite Camp, Bornite Airstrip, and along the Kobuk to Bornite Road. Analysis of the samples was conducted using a Polarized Light Microscopy (PLM) detection method. No asbestos was found during this sampling program.

In 2010, TetraTech completed wetlands delineation for the road corridor between the Bornite Airstrip and the Arctic Airstrip using the standard three-parameter approach required by the US ACE. Thirty-three sampling locations were evaluated reflecting the fourteen vegetation communities observed in the field. Vegetation communities were characterized using the Alaska Vegetation Classification system. A wetlands map for the Bornite Project area was produced in 2011 using aerial photography and extrapolating data collected during the 2010 wetlands study.

In 2015, 2016 and 2018, DOWL completed a project-wide wetlands delineation, including the Bornite Lands and the area from Dahl Creek to the Arctic Deposit and possible facilities locations.

20.1.4 Hydrology

Since 2010, surface water-quality sampling has been conducted within the Bornite Project area, with the exception of 2011 and 2020. Samples were analyzed for dissolved metals, total metals, and common environmentally significant parameters, including pH, conductivity, dissolved oxygen and nitrates. Velocity, depth, width and discharge (cubic feet per second) were measured using a Marsh McBirney sensor, and then later a Doppler current meter.

Two hydrologic gauging stations have been installed within the Bornite Project area: one on Ruby Creek and one on the Shungnak River. These stations measure the depth of the water, pH, and conductivity. The depth of the water in conjunction with frequent instantaneous discharge measurements taken with a SonTek 2 Acoustic Doppler were used to generate a rating curve for both Ruby Creek and the Shungnak River.

20.1.5 Meteorology, Air Quality, and Noise

Since September 2011, meteorological data have been collected year-round. Site data have been collected hourly for humidity, barometric pressure, precipitation, solar radiation, temperature, wind speed, and wind direction.

In 2018, a new meteorological station was installed near the proposed Arctic Project and data, approved by the Alaska Department of Environmental Conservation (ADEC), have been collected since that time.

In 2021, three Geonor precipitation gauges were installed by Boreal Environmental Services to accurately characterize the precipitation at the Arctic deposit, which is located near Bornite.

20.1.6 Subsistence

In 2012, Stephen R. Braund & Associates completed a subsistence data gap analysis under contract to the Alaska Department of Transportation and Public Facilities as part of the baseline studies associated with a proposed road to the Ambler Mining District. The purpose of this analysis was to identify what subsistence research had been conducted for the communities potentially affected and to determine whether subsistence uses and use areas overlapped with or may be affected by the project. The gap analysis attempted to identify additional information (i.e., data gaps) needed to accurately assess potential effects to subsistence.

The Alaska Department of Fish and Game conducted a comprehensive survey of subsistence usage in the three Upper Kobuk Villages of Ambler, Shungnak and Kobuk in 2015 (Braem et al., 2015).

20.1.7 Avian

In 2016 and 2017, ABR Inc. conducted an avian survey of the Bornite area and Ambler Lowlands. The survey included a spring survey to determine nest locations, followed by a summer study to determine species and fledging rate.

Table 20.1: Summary of Existing Environmental Baseline Studies Reports

Discipline	Year	Report Title	Author
Archaeology	2008	Assessment of Cultural Resources and Site Potential of Proposed Geologic Exploration Drill Areas	Neely, Burr and Proue, Molly (NLUR Inc.)
Aquatic Life and Fisheries	2010	Arctic Deposit Access Environmental Baseline Data Collection Aquatics	TetraTech Inc.
	2016	Aquatic Biomonitoring at the Arctic-Bornite Prospect, 2016	Alaska Department of Fish and Game
	2017	Aquatic Biomonitoring at the Arctic-Bornite Prospect, 2017	Alaska Department of Fish and Game
	2018	Aquatic Biomonitoring at the Arctic-Bornite Prospect, 2018	Alaska Department of Fish and Game
	2019	Aquatic Biomonitoring at the Arctic-Bornite Prospect, 2019	Alaska Department of Fish and Game
Ecosystem and Soils	2010	Arctic Deposit Access Environmental Baseline Data Collection Wetlands & Vegetation	TetraTech Inc.
	2011	Ambler Project Asbestos Soil Sampling Report	Craig, Cal (Trilogy Metals)
	2015	NovaCopper Wetlands Assessment	DOWL
	2016	Trilogy Wetland Assessment	DOWL

Discipline	Year	Report Title	Author
	2018	Trilogy Wetland Assessment	DOWL
Hydrology and Water Quality	2008	Trip Report-Arctic Deposit and Bornite August 13-18, 2008	Bergstrom, Frank (Amerikanuak Inc.)
	2010	Arctic Deposit Access Environmental Baseline Data Collection Hydrology	TetraTech Inc.
	2012	Stream Gauge Install	DOWL HKM
		Water Quality Monitoring Report: Fall 2012	Craig, Cal (NovaCopper)
		NovaCopper Weather Station and Streamflow Gauging Data Collection Year-End Report	DOWL HKM
	2013	Water Quality Monitoring Report: First Quarter 2013 Water Quality Monitoring Report: Second Quarter 2013	Craig, Cal (NovaCopper)
	2014	Water Quality Monitoring Report: Third Quarter 2014	Craig, Cal (NovaCopper)
	2015	Water Quality Monitoring Report: Third Quarter 2015	Craig, Cal (NovaCopper)
	2016	Water Quality Monitoring Report: Third Quarter 2016 Water Quality Monitoring Report: Fourth Quarter 2016	Craig, Cal (Trilogy Metals)
	2017	Water Quality Monitoring Report: April 2017 Water Quality Monitoring Report: May 2017 Water Quality Monitoring Report: July 2017 Water Quality Monitoring Report: August 2017 Water Quality Monitoring Report: September 2017 Water Quality Monitoring Report: December 2017	Craig, Cal (Trilogy Metals)
	2018	Water Quality Monitoring Report: March 2018 Water Quality Monitoring Report: June 2018 Water Quality Monitoring Report: Aug 2018 Water Quality Monitoring Report: Dec 2018	Craig, Cal Doherty, Jonathon (Trilogy Metals)
		Review of Hydrogeological Conditions and Preliminary Estimate of Dewatering Rates for the Bornite Deposit, Alaska UPDATED DRAFT	SRK

Discipline	Year	Report Title	Author
	2019	Water Quality Monitoring Report: March/April 2019 Water Quality Monitoring Report: June 2019 Water Quality Monitoring Report: Aug., Sept., Oct. 2019 Water Quality Monitoring Report: December 2019	Craig, Cal Stockert, Kelsey (Trilogy Metals)
		2012-2018 Hydrologic Summary: Upper Kobuk Mineral Projects	Owl Ridge Natural Resource Consultants
	2021	Water Quality Monitoring Report: January 2021 Water Quality Monitoring Report: March 2021 Water Quality Monitoring Report: Aug., Sept., June-July 2021 Water Quality Monitoring Report: August 2021 Water Quality Monitoring Report: September-October 2021	Craig, Cal Stockert, Kelsey (Trilogy Metals)
Meteorology, Air Quality, and Noise	2012	NovaCopper Weather Station and Streamflow Gauging Data Collection Year-End Report	DOWL HKM
	2018	2018 Arctic Deposit Baseline Weather Data Report	Doherty, Jonathon (Trilogy Metals)
	2019	Arctic Baseline Weather Data Report 2018-2019	Stockert, Kelsey (Trilogy Metals)
Subsistence	2012	Ambler Mining District Access Project Subsistence Data Gap Memo	Braund, Stephen (Stephen R. Braund and Associates)
	2015	Wild Food Harvests in 3 Upper Kobuk River Communities: Ambler, Shungnak, and Kobuk 2012–2013	ADF&G
Avian	2016	Upper Kobuk Raptors Final Report 2016	ABR Inc.
	2017	Upper Kobuk Raptors Final Report 2017	ABR Inc.

20.1.8 ADDITIONAL BASELINE DATA REQUIREMENTS

Additional baseline environmental data in NANA's Bornite and ANCSA lands, Ruby Creek drainage, Shungnak River drainage, portions of the Ambler Lowlands, and downstream receiving environments will be required to support future mine design, development of an EIS, permitting, construction and operations. Trilogy Metals will consult with state, local and federal regulatory agencies and their consultants to further develop a comprehensive environmental baseline program. Due to the long lead-time to collect data (years), it is important that the comprehensive environmental baseline program generates adequate data in terms of type, quality and quantity for each of the disciplines of interest. Recommendations for additional baseline studies are included in Table 20.2.

TABLE 20.2: ADDITIONAL RECOMMENDED ENVIRONMENTAL BASELINE STUDIES

Discipline	Recommended Studies
Acid-Base Accounting	Static test work of waste domains within and adjacent to the proposed open pit, potential underground resources, and static investigation of borrow sources and tailings followed by kinetic test work.
Archaeology	Assessment of cultural resources, cultural site clearance
Aquatic Life	Expanded aquatic surveys
Ecosystem and Soils	Permafrost and wetlands delineation mapping; vegetation surveys
Fisheries	Expanded fisheries surveys
Hydrogeology	Installation and monitoring of groundwater wells in the Ruby Creek drainage areas near the site of, and down gradient of, any proposed pit, any proposed tailings and waste rock storage facilities and alternative sites for tailings and waste rock disposal locations. A large-scale pump down test will also be needed to understand the connectivity of the aquifers.
Hydrology	Additional streamflow measurements, hydrological modelling and snow survey data collection.
Meteorology, Air Quality, and Noise	Expansion of the meteorological program to additional locations to be determined; air quality monitoring
Visual Impacts	A survey of potentially impacted visual resources and mitigation
Wildlife	Avian survey, large mammal survey, analysis of subsistence resources

All the data are important to the development of an accurate environmental baseline and water balance model for the Bornite Project area. These studies would need to be completed in sufficient detail to cover all reasonably foreseeable baseline work that may be requested by the regulatory agencies. The inherent risks of insufficient baseline data include delays in the permitting process, poorly constrained pre-mining characterizations, inappropriate trigger levels in permits, and inaccurate water balance models that can negatively affect operations and otherwise result in unforeseen and potentially costly circumstances during permitting or mine operations and closure.

20.2 PERMITTING

Development of the Bornite Project will require a significant number of permits and authorizations from state, federal, and regional organizations. Much of the groundwork to support a successful permitting effort must be conducted before permit applications are submitted so that issues can be identified and resolved, baseline data can be acquired, and regulators and stakeholders can become familiar with the proposed project.

The comprehensive permitting process for the Bornite Project can be divided into three categories:

- Exploration state and regional permitting phase: required to obtain approval for drilling, camp operations, engineering, and environmental baseline studies.
- Pre-application phase: conducted in conjunction with engineering feasibility studies. This stage includes the collection of environmental baseline data and interaction with stakeholders and regulators to facilitate the development of a project that can be successfully permitted.
- The National Environmental Policy Act (NEPA) phase: formal agency review of the Federal and State requirements for public and agency participation to determine if and how the Project can be done in an acceptable manner.

Table 20.3 lists the typical permits that may be required for the Project.

TABLE 20.3: PERMITS THAT MAY BE REQUIRED FOR THE BORNITE PROJECT

Authority	Permit
FEDERAL	
Environmental Protection Agency (EPA)	Spill Prevention Containment and Contingency (SPCC) Plan
U.S. Army Corps of Engineers (USACE)	CWA Section 404 Permit (wetlands dredge and fill)
	River and Harbors Act (RHA) Section 10 (structures in navigable waters)
	RHA Section 9 (dams and dykes in navigable waters-interstate commerce)
U.S. Coast Guard	RHA Section 9 Construction Permit (bridge across navigable waters)
Bureau of Alcohol, Tobacco, and Firearms	License to Transport Explosives
	Permit and License for Use of Explosives
Federal Aviation Administration	Notice of Landing Area Proposal (existing airstrip)
	Notice of Controlled Firing Area for Blasting
U.S. Department of Transportation	Hazardous Materials Registration
U.S. Fish and Wildlife Service	Section 7 of the Endangered Species Act, Consultation requiring a Biological Assessment or Biological Opinion
STATE	
Division of Mining, Land, and Water	Plan of Operations
	Reclamation Plan Approval
	Mining License
	Land Use Permits and Leases
	Right-of-Ways, Easements, Material Sales, etc.
	Certificate of Approval to Construct a Dam
	Certificate of Approval to Operate a Dam
	Temporary Water Use Permit
	Water Rights Permit/Certificate to Appropriate Water
State Historic Preservation Office	Section 106 Historical and Cultural Resources Protection Act clearance
Department of Fish and Game	Fish Habitat Permit
	Wildlife Hazing Permit
	Culvert/Bridge Installation Permit

Authority	Permit
Division of Water	Section 401 Water Quality Certification (CWA 402 permit)
	Wastewater Disposal Permits
	Non-Domestic Wastewater Disposal Permit
	Storm Water Discharge Pollution Prevention Plan
	Domestic Wastewater Disposal Permit
	Approval to Construct and Operate a Public Water Supply System
Division of Environmental Health	Solid Waste Disposal Permits
	Food Sanitation Permit
	Class III Municipal Solid Waste Landfill Permit
Division of Air Quality	Air Quality Construction Permit (first 12 months)
	Air Quality PSD Title V Operating Permit (after 12 months)
	Air Quality permit to Open Burn
REGIONAL	
Northwest Arctic Borough	Title 9 Land Use Permit
	Fuel Storage Permit
	Commercial Transporter Authorization
	Master Plan of Operations

The permit review process will determine the number of management plans required to address all aspects of the Project to ensure compliance with environmental design and permit criteria. Each plan will describe the appropriate environmental engineering standard and the applicable operations requirements, maintenance protocols, and response actions.

20.3 Social or Community Considerations

The Bornite Project is located approximately 19 km north of the village of Kobuk, 23 km northeast of the village of Shungnak, and 40 km east of the village of Ambler. The populations in these villages are approximately 191 in Kobuk (2020 US Census), 272 in Shungnak (2020 US Census) and 274 in Ambler (2020 US Census). Residents live a largely subsistence lifestyle with incomes supplemented by trapping, guiding, local development projects, government aid and other work in and outside of the villages.

The Bornite Project has the potential to significantly improve work opportunities for village residents in the region. Ambler Metals is working directly with the villages to employ residents in the ongoing exploration program as geo-technicians, drill helpers, environmental technicians, and many other camp-support positions. Trilogy Metals and NANA have established a Workforce

Development Subcommittee to assist with developing a local workforce. In addition, Ambler Metals works with native-affiliated companies (such as NANA Management Services and Kuna Engineering, formerly WHPacific Inc.) that provide camp catering and environmental services for the project.

In October 2011, Trilogy Metals signed an agreement with NANA which has now been transferred to Ambler Metals. In addition to consolidating landholdings in the Ambler Mining District and Bornite, the agreement includes language establishing native hiring preferences and preferential use of NANA subsidiaries for contract work. Furthermore, the agreement formalized an Oversight Committee, with equal representation from Ambler Metals and NANA, to regularly review project plans and activities. The agreement also includes a scholarship funded annually by Ambler Metals that promotes education opportunities for shareholders in the region. Ambler Metals meets periodically during the field season with the residents of Kobuk, Shungnak and Ambler, the three villages closest to the project area. They also meet occasionally with eight other NANA region villages, including Noatak, Kivalina, Kotzebue, Kiana, Deering, Buckland, Selawik and Noorvik, to update residents on project plans and address any questions and concerns. Trilogy Metals and now Ambler Metals have also developed a good working relationship with the NWAB government.

In general terms, rural Alaska residents are often concerned about potential mining impacts to wildlife and fish for those projects within their traditional use areas. Trilogy Metals and Ambler Metals acknowledge these views and concerns and are taking substantive steps to address them during the current exploration stage of the Bornite Project.

Local community concerns will also be formally recognized during the scoping stage at the beginning of the NEPA process. At that time, the lead federal agency (likely the USACE) will hold scoping meetings in rural villages to hear and record the concerns of the local communities so that they can be addressed during the development of the EIS. In addition, the USACE would have government-to-government consultations with the Tribal Councils in each of the villages, as part of the NEPA process, to discuss the project and discuss Council concerns.

Characterizing the level of support or opposition to the Bornite Project would be speculative at this time. A poll conducted by Dittman Research for the 2011 NANA Shareholder opinion survey asked if shareholders supported or opposed road projects on NANA-land to assist in economic and potential mineral development. Eighty-three percent supported the concept and fifteen percent opposed. Similar surveys show a broad support for infrastructure and mineral development in the region as long as regional interests are met. Regional engagement has also encountered a strong desire for the economic benefits that come with mining projects. However, like most mining projects, there will likely be some opposition to this project.

20.4 RECLAMATION

20.4.1 BORNITE MINE LEGACY CLEANUP

Under the NANA Agreement signed on October 19th, 2011, NANA is required to complete a baseline environmental report following completion of cleanup of the former mining camp on the Bornite Lands, to the standards required by the ADEC and "to the reasonable satisfaction of Trilogy Metals". This includes "*removal and disposal as required by law of all hazardous substances present on the Bornite Lands. NANA has indemnified and will hold Trilogy Metals harmless for any loss, cost, expense, or damage suffered or incurred attributable to the environmental condition of the Bornite Lands at the date of the baseline report which relate to any activities prior to the date of the agreement.*"

Travis/Peterson Environmental Consulting Inc. completed a site characterization for Bornite in 2007. The report identified several safety and environmental issues and possible mitigation solutions. Identified in the report are asbestos-containing structures, petroleum ground contamination, an open shaft which presents a safety hazard, and environmental liabilities due to out of service vehicles. Full results are available in the report, *Bornite Mine Camp Site Characterization Report* (Travis/Peterson Environmental Consulting, Inc., 2007).

NANA has completed all of the planned work and is believed to have satisfied the requirements laid out in the Agreement. NANA delivered the final baseline environmental report in 2014 for review by Trilogy Metals. If the work has been done satisfactorily and the report is complete, Trilogy Metals and Ambler Metals will sign off on it, thereby releasing NANA from legacy environmental obligations at the Bornite Site.

20.4.2 RECLAMATION OF EXPLORATION ACTIVITIES

Reclamation of mineral exploration activities at the Bornite Project is completed under the guidelines presented by the State of Alaska in the Multi-Year Hardrock Exploration Permit #2183 issued by the Department of Natural Resources Division of Mining, Land, and Water. Key components include the following:

- Topsoil will be stockpiled.
- The area will be reshaped to blend with surrounding topography.
- Organic material will be spread over the site to prevent erosion.
- Reclamation will be done in the same season as disturbance.
- Drill casing will be removed or cut off at ground level.
- Drill holes will be plugged with bentonite clay or equivalent.
- Reseeding will be done as necessary.
- Disturbance will be held to a minimum.

21 CAPITAL AND OPERATING COSTS

The Bornite Project is an early exploration project; no capital or operating costs have been estimated.

22 ECONOMIC ANALYSIS

The Bornite Project is an early exploration project; no economic analysis has been completed.

23 ADJACENT PROPERTIES

There are no data from any adjacent properties that have been used in the estimation of mineral resources for the Bornite Project.

24 OTHER RELEVANT DATA AND INFORMATION

There are no additional data or information that are relevant to the Bornite Project

25 INTERPRETATION AND CONCLUSIONS

The level of understanding of the geologic controls that influence the distribution of copper mineralization at the Bornite Deposit is relatively good. The drilling, sampling and validation practices used by Trilogy Metals during the various campaigns have been conducted in a professional manner and adhere to accepted industry standards. The confidence in older, historical, drilling conducted by Kennecott has been demonstrated through a series of validation checks and, overall, the underlying database is considered sufficient for the estimation of copper resources in the Indicated and Inferred categories and cobalt mineral resources in the Inferred category. Estimates of mineral resources that are amenable to a combination of open pit and underground extraction methods are summarized in Tables 25.1 and 25.2.

TABLE 25.1: ESTIMATE OF COPPER MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type/Area	Cut-off (Cu %)	Tonnes (million)	Average Grade Cu (%)	Contained Metal Cu (Mlbs)
Indicated	In-Pit(1)	0.5	41.7	1.04	955
Inferred	In-Pit(1)	0.5	93.9	0.98	2,034
	Below-Pit South Reef	1.5	35.3	3.39	2,639
	Below-Pit Ruby Zone	1.5	15.0	1.98	653
	Total Inferred		144.1	1.68	5,326

1) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3/tonne, milling costs of US$11/tonne, G&A cost of US$5/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees. Underground mining cost is US$65/tonne.

2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.

3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.

TABLE 25.2: ESTIMATE OF COBALT MINERAL RESOURCES FOR THE BORNITE PROJECT

Class	Type/Area	Cut-off (Cu %)	Tonnes (million)	Average Grade Co (%)	Contained Metal Co (Mlbs)
Inferred	In-Pit(1)	0.5	135.6	0.017	51
	Below-Pit South Reef	1.5	35.3	0.039	30
	Below-Pit Ruby Zone	1.5	15.0	0.021	7
	Total Inferred		185.8	0.021	88

1) Mineral resources stated as contained within a pit shell developed using a metal price of US$3.50/lb Cu, mining costs of US$3/tonne, milling costs of US$11/tonne, G&A cost of US$5/tonne, 87% metallurgical recoveries and an average pit slope of 43 degrees. Underground mining cost is US$65/tonne.
2) Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the Mineral Resources will be converted into Mineral Reserves.
3) It is reasonably expected that the majority of Inferred mineral resources could be upgraded to Indicated mineral resources with additional exploration.
4) Due to limited sample data, none of the cobalt mineral resource meets the confidence level for Indicated-class mineral resources. All cobalt mineral resources are considered to be in the Inferred category.

The deposit remains “open” to potential expansion near-surface toward the south, and at depth toward the north, northeast and east. Further drilling is warranted to test these assumptions.

Metallurgical test work to date indicates that the Bornite Project can be treated using standard grinding and flotation methods to produce copper concentrates. Initial testing indicates copper recoveries of approximately 87% resulting in concentrate grades of approximately 28% Cu with very low potential penalty elements. Further metallurgical test work is warranted to test these assumptions. There has been essentially no metallurgical test work that evaluates the extraction of cobalt. This work is recommended.

Based on the information to date, the Bornite Project hosts a relatively large copper resource with associated cobalt that is potentially amenable to a combination of open pit and underground extraction methods. It is recommended that Trilogy Metals continue to advance the Project through continued exploration, metallurgical studies, preliminary engineering studies, and environmental baseline analyses, and it should consider the generation of a preliminary economic analysis in the near future.

A significant proportion of the current mineral resource occurs in the Inferred category, which, by definition, has a high degree of uncertainty whether it is economically viable. Significant changes to the estimate of mineral resources could result from further drilling or studies related to engineering, metallurgy or environmental issues. It is expected that the majority of resources in the Inferred category could be upgraded to the Indicated mineral resources with continued exploration.

26 RECOMMENDATIONS

The author's recommendations for this project are summarized in Table 26.1. There is no specific order to these recommendations, and none are dependent on the success or completion of any of the others in order to proceed.

TABLE 26.1: RECOMMENDATIONS FOR THE BORNITE PROJECT

Recommended Program	Description	Estimated Budget
Baseline Studies	Maintain environmental baseline studies and permitting activities	50,000
Acid Base Accounting Study	Implement an initial acid base accounting waste-rock study	50,000
Exploration	Continue exploration in the vicinity of Bornite looking for satellite deposits through an integrated program, including geologic mapping, relogging of existing drill holes, lithogeochemistry and geophysical surveys.	250,000
Metallurgical Testing	Conduct additional metallurgical testing, including the collection of bulk samples for grinding and flotation tests as well as a suite of samples that test the variability of mineralization throughput the Bornite deposit. This proposal includes drilling of 3 holes in the open pit area of the Ruby Zone and 3 holes into the South Reef area to obtain fresh sample material for testing. Metallurgical testing will evaluate optimal processes for recovering copper and cobalt. Studies will also look at grinding, concentrating, filtering and possible options for tailings management. Includes 4,000 m drilling @ \$300/m = \$1,200,000 plus \$300,000 for metallurgical testing.	1,500,000
Hydrogeological and Geotechnical Testing	Initiate hydrogeological and geotechnical programs to better understand the groundwater regime and the stability characteristics of the rocks at Bornite.	500,000
Preliminary Economic Assessment	Proceed with a preliminary economic assessment of the Bornite project.	500,000
Total		**\$2,850,000**

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28 CERTIFICATES OF QUALIFIED PERSONS

CERTIFICATE of QUALIFIED PERSON

Bruce M. Davis, FAusIMM

I, Bruce M. Davis, FAusIMM, do hereby certify that:

1. I am an independent consultant at:

   589 Williams Drive

   Cedarburg, WI USA 53012
2. I graduated from the University of Wyoming with a Doctor of Philosophy (Geostatistics) in 1978.
3. I am a Fellow of the Australasian Institute of Mining and Metallurgy, Number 211185.
4. I have practiced my profession continuously for 40 years and have been involved in mineral resource and reserve estimations and feasibility studies on numerous underground and open pit base metal and gold deposits in Canada, the United States, Central and South America, Europe, Asia, Africa and Australia.
5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
6. I am a co-author of the technical report titled NI 43-101 Technical Report on the Bornite Project, Northwest Alaska, USA dated February 11, 2022, with an effective date of December 31, 2021 (the "Technical Report"). I am responsible for Sections 11 and 12 and portions of 1, 14 (14.4, 14.7, 14.10.2 and 14.10.4), 25 and 26.
7. I visited the Bornite Property on 26-27 July 2011, 25 September 2012, 10-12 August 2015 and 28-29 August, 2019.
8. I have had prior involvement with the Property that is the subject of the Technical Report. I was a co-author of four previous Technical Reports dated February 8, 2013, April 1, 2014, October 12, 2017 and July 20, 2018.
9. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
10. I am independent of Trilogy Metals Inc. and the Property applying all of the tests in Section 1.5 of NI 43-101.
11. I have read NI 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
12. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on websites accessible by the public, of the Technical Report

Dated this 11th day of February, 2022.

"original signed and sealed"

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Bruce M. Davis, FAusIMM

CERTIFICATE of QUALIFIED PERSON

Robert Sim, P.Geo, SIM Geological Inc.

I, Robert Sim, P.Geo, do hereby certify that:

1. I am an independent consultant of:

   SIM Geological Inc.
   508 – 1950 Robson St., Vancouver
   British Columbia, Canada V6G 1E8

2. I graduated from Lakehead University with an Honours Bachelor of Science (Geology) in 1984.
3. I am a member, in good standing, of Engineers & Geoscientists British Columbia, License Number 24076.
4. I have practiced my profession continuously for 36 years and have been involved in mineral exploration, mine site geology and operations, mineral resource and reserve estimations and feasibility studies on numerous underground and open pit base metal and gold deposits in Canada, the United States, Central and South America, Europe, Asia, Africa and Australia.
5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
6. I am a co-author of the technical report titled NI 43-101 Technical Report on the Bornite Project, Northwest Alaska, USA dated February 11, 2022, with an effective date of December 31, 2021 (the "Technical Report"), and accept professional responsibility for Sections 2 to 10, 14 to 24 and portions of 1, 25 and 26.
7. I have visited the Bornite Property on September 20-22, 2018.
8. I have had prior involvement with the Property that is the subject of the Technical Report. I was a co-author of four previous Technical Reports dated February 8, 2013, April 1, 2014, October 12, 2017 and July 20, 2018.
9. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
10. I am independent of Trilogy Metals Inc. and the Property applying all of the tests in Section 1.5 of NI 43-101.
11. I have read NI 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
12. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on websites accessible by the public, of the Technical Report

Dated this 11th day of February, 2022.
"original signed and sealed"

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Robert Sim, P.Geo

CERTIFICATE of QUALIFIED PERSON

Jeffrey B. Austin, P.Eng., International Metallurgical & Environmental Inc.

I, Jeffrey B. Austin, P.Eng., do hereby certify that:

1. I am employed as President of International Metallurgical & Environmental Inc., located at 906 Fairway Crescent, Kelowna, B.C. V1X 7L4, Canada.
2. I graduated with a Bachelor of Applied Science specializing in Mineral Process Engineering from the University of British Columbia in 1984.
3. I am a member, in good standing, of the Association of Professional Engineers and Geoscientists of British Columbia, License Number 15708.
4. I have practiced my profession continuously for 34 years and have been involved in the design, evaluation and operation of mineral processing facilities during that time. A majority of my professional practice has been the completion of test work and test work supervision related to feasibility and pre-feasibility studies of projects involving flotation technologies.
5. I have read the definition of “qualified person” set out in National Instrument 43-101 (“NI 43-101”) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a “qualified person” for the purposes of NI 43-101.
6. I am responsible for the preparation of Section 13 of the Technical Report titled “NI 43-101 Technical Report on the Bornite Project, Northwest Alaska, USA” dated February 11, 2022, with an effective date of December 31, 2021 (the “Technical Report”).
7. I have not visited the Bornite Property.
8. I have had prior involvement with the Property that is the subject of the Technical Report. I was a co-author of three previous Technical Reports dated April 1, 2014, October 12, 2017, and July 20, 2018.
9. As of the date of this certificate, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to make the Technical Report not misleading.
10. I am independent of Trilogy Metals Inc. and the Property applying all of the tests in Section 1.5 of NI 43-101.
11. I have read NI 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
12. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on websites accessible by the public, of the Technical Report.

Dated this 11th day of February, 2022.
“original signed and sealed”

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Jeffrey B. Austin, P.Eng.