Oyu Tolgoi Operations Technical Report Summary

In accordance with Subpart 1300 of Regulation S-K under the U.S. Securities Act of 1933 and Item 601(b)(96) thereunder

31 December 2022

Date and signature page

Qualified Persons	Signature	Date
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1. Executive summary

This report is prepared as a Feasibility Study-level Technical Report Summary (TRS) in accordance with the United States Securities and Exchange Commission's (SEC) Modernized Property Disclosure Requirements for Mining Registrants as described in Subpart 229.1300 of Regulation S-K, Disclosure by Registrants Engaged in Mining Operations (Regulation S-K 1300) and Item 601(b)(96) Technical Report Summary on the Oyu Tolgoi property (Oyu Tolgoi Property or Property).

1.1 Property description and ownership

The Oyu Tolgoi Property containing the Oyu Tolgoi Project (Oyu Tolgoi or the Project) is located in the South Gobi region of Mongolia, approximately 645 km by road south of the capital, Ulaanbaatar. The Project is being developed by Oyu Tolgoi LLC and consists of a series of deposits containing copper, gold, and silver.

Rio Tinto International Holdings Limited (Rio Tinto) holds a 66% interest in Oyu Tolgoi LLC following the acquisition of the minority shareholding of Turquoise Hill Resources Ltd[1] (TRQ) in 2022. The remaining 34% interest is held by the Government of Mongolia through Erdenes Oyu Tolgoi LLC.

Oyu Tolgoi's legal title to the Shivee Tolgoi and Javkhlant licences is subject to an equity participation and earn-in agreement between Entrée LLC and Oyu Tolgoi.

1.2 Geology and mineralisation

The mineral deposits at Oyu Tolgoi lie in a structural corridor where mineralisation has been discovered over a 26 km strike length. Four deposits hosting Mineral Resources have been identified: Oyut, Hugo North, Hugo South, and Heruga.

The Oyu Tolgoi copper-gold porphyry deposits are distributed along a 12 km north-northeast striking corridor. From north to south, the deposits comprise Hugo North, Hugo South, Oyut, and Heruga.

These deposits lie within the Gurvansayhan island-arc terrane, a fault bounded segment of the broader Silurian to Carboniferous Kazakh-Mongol arc, located towards the southern margin of the Central Asian Orogenic Belt.

Mineralisation is associated with multiple, overlapping, intrusions of late Devonian quartz-monzodiorite intruding Devonian (or older) juvenile, probably intra-oceanic arc-related, basaltic lavas and lesser volcaniclastic rocks, unconformably overlain by late Devonian basaltic to dacitic pyroclastic and volcano sedimentary rocks. These quartz-monzodiorite intrusions range from early-mineral porphyritic dykes, to larger, linear, syn-, late- and post-mineral dykes and stocks.

1.3 Exploration

Exploration on the mine leases is undertaken by Oyu Tolgoi LLC's site technical services team. The current exploration strategy is focused on developing a project pipeline prioritised in areas that can impact the current development of the Oyu Tolgoi deposits, seeking low cost development options and continuing the assessment of legacy datasets to enable future discovery. Exploration targets, based on identified medium or high priority have had exploration work completed in 2022, and some targets will be investigated in the future. Development of the known Mineral Resources is a key objective of stakeholders and over

[1] formerly known as Ivanhoe Mines Ltd

the life of Oyu Tolgoi. Oyu Tolgoi LLC will continue to progress its understanding of these resources and ultimately make decisions on their development.

1.4 Mineral Resources estimate

Rio Tinto's share of the individual Mineral Resources for Oyu Tolgoi by deposit and in total are outlined in Table 1.1. The 2022 Mineral Resources reported in the Annual Report on Form 20-F for the year ended 31 December 2022 have been prepared using industry accepted practice and conforms to the disclosure requirements of the Regulation S-K 1300.

The Mineral Resources for the Hugo North deposit reported in this 2022 TRS have been updated from the Mineral Resources reported for the deposit in the 2021 Rio Tinto Annual Report on Form 20-F for the year ended 31 December 2021, the update reflects changes in depletions to Oyut Open Pit and Hugo North and adds the Hugo North Stockpile. There has been no update to the Mineral Resource estimates for the Oyut, Hugo North, Hugo South, or Heruga deposits.

Rio Tinto's share of the Oyu Tolgoi deposits in total contain estimated Measured and Indicated Mineral Resources of 5.4 Mt (11.9 billion pounds) of contained copper, 5.9 Moz of contained gold, and estimated Inferred Mineral Resources of 13.6 Mt (30 billion pounds) of contained copper and 20.4 Moz of contained gold.

Table 1-1: Oyu Tolgoi Property Rio Tinto Ownership Basis Mineral Resources summary, as at 31 December 2022

	Likely mining method[1]	Measured Mineral Resources as at 31 December 2022					Indicated Mineral Resources as at 31 December 2022					Total Measured and Indicated Mineral Resources as at 31 December 2022				
		Tonnage	Grade				Tonnage	Grade				Tonnage	Grade			
Copper[2]		Mt	% Cu	g/t Au	g/t Ag	% Mo	Mt	% Cu	g/t Au	g/t Ag	% Mo	Mt	% Cu	g/t Au	g/t Ag	% Mo
Oyu Tolgoi (Mongolia)[3]																
- Heruga ETG	U/G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Heruga OT	U/G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Hugo Dummett North[4]	U/G	38	1.90	0.50	4.30	-	251	1.39	0.35	3.24	-	289	1.46	0.37	3.38	-
- Hugo Dummett North Extension	U/G	-	-	-	-	-	48	1.62	0.55	4.21	-	48	1.62	0.55	4.21	-
- Hugo Dummett South	U/G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Oyut Open Pit	O/P	11	0.41	0.38	1.10	-	61	0.33	0.30	1.13	-	72	0.34	0.31	1.12	-
- Oyut Underground	U/G	6	0.48	0.91	1.31	-	33	0.38	0.61	1.18	-	39	0.40	0.66	1.20	-
Total		**55**	**1.44**	**0.53**	**3.33**	**-**	**393**	**1.17**	**0.39**	**2.86**	**-**	**448**	**1.20**	**0.41**	**2.91**	**-**

	Inferred Mineral Resources as at 31 December 2022					**Total Mineral Resources as at 31 December 2022**					Rio Tinto Interest[5]	Total Mineral Resources as at 31 December 2021				
	Tonnage	Grade				**Tonnage**	**Grade**					Tonnage	Grade			
Copper[2]	Mt	% Cu	g/t Au	g/t Ag	% Mo	**Mt**	**% Cu**	**g/t Au**	**g/t Ag**	**% Mo**	%	Mt	% Cu	g/t Au	g/t Ag	% Mo
Oyu Tolgoi (Mongolia)[3]																
- Heruga ETG	841	0.41	0.40	1.44	0.012	841	0.41	0.40	1.44	0.012	56.0	442	0.41	0.40	1.44	0.012
- Heruga OT	71	0.42	0.30	1.58	0.011	71	0.42	0.30	1.58	0.011	66.0	36	0.42	0.30	1.58	0.011
- Hugo Dummett North[4]	474	0.83	0.29	2.47	-	763	1.07	0.32	2.82	-	66.0	388	1.06	0.32	2.80	-
- Hugo Dummett North Extension	90	1.05	0.37	2.85	-	137	1.25	0.43	3.32	-	56.0	72	1.24	0.43	3.31	-
- Hugo Dummett South	483	0.83	0.07	1.87	-	483	0.83	0.07	1.87	-	66.0	245	0.83	0.07	1.87	-
- Oyut Open Pit	215	0.29	0.19	1.01	-	287	0.30	0.22	1.04	-	66.0	149	0.30	0.22	1.05	-
- Oyut Underground	95	0.41	0.42	1.25	-	135	0.40	0.49	1.23	-	66.0	68	0.40	0.49	1.23	-
Total	**2,269**	**0.60**	**0.28**	**1.76**	**0.005**	**2,716**	**0.70**	**0.30**	**1.95**	**0.004**		1,401	0.69	0.30	1.94	0.004

(1) Likely mining method: O/P = open pit/surface; U/G = underground.

(2) Mineral Resources are stated on an in situ dry weight basis and Mineral Resources are reported EXCLUSIVE of Mineral Reserves.

(3) Oyu Tolgoi Mineral Resource valuations are based on commodity prices of US c 320.30 /lb for copper, US$ 1,479.82 /oz for gold, US$ 19.23 /oz for silver and US$ 9.29 /lb for molybdenum. These represent July 2021 consensus prices sourced from the average forecasts from ten brokers/banks (Barclays, BoAML, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, JP Morgan, Macquarie, Morgan Stanley and UBS) and two analysts (CRU and Woodmac).

(4) The Hugo Dummett North Mineral Resources include approximately 0.9 million tonnes of stockpiled material at a grade of 0.35% copper, 0.11 g/t gold and 0.85 g/t silver. The Hugo Dummett North underground mine is currently under construction.

(5) As reported to the market on 16th December 2022, Rio Tinto completed its acquisition of Turquoise Hill Resources Ltd and the Rio Tinto Interest % reflects this change. 2021 figures are reported using the previous ownership %.

1.5 Mineral Reserves estimate

The Mineral Reserves estimates are based on a Life of Mine (LoM) plan that has been developed according to Regulation S-K 1300 and has been developed using industry accepted strategic planning approaches which defined the life of the mines on the Oyu Tolgoi Property. Inferred Mineral Resources have been treated as waste. The final reserves plan is the outcome of the application of appropriate modifying factors in order to establish an economically viable and operational mine plan. At the Oyu Tolgoi property, a variable cut-off grade strategy is applied to develop the mine plan. The Mineral Reserves estimate includes both the Oyut and Hugo North deposits.

Table 1-2: Oyu Tolgoi Property Rio Tinto Ownership Basis Mineral Reserves summary, as at 31 December 2022

	Type of mine[1]	Proven Mineral Reserves as at 31 December 2022					Probable Mineral Reserves as at 31 December 2022					**Total Mineral Reserves as at 31 December 2022**				
		Tonnage	Grade				Tonnage	Grade				**Tonnage**	**Grade**			
Copper[2]		Mt	% Cu	g/t Au	g/t Ag	% Mo	Mt	% Cu	g/t Au	g/t Ag	% Mo	**Mt**	**% Cu**	**g/t Au**	**g/t Ag**	**% Mo**
Oyu Tolgoi (Mongolia)[3]																
- Hugo Dummett North[4]	U/G	-	-	-	-	-	271	1.54	0.30	3.18	-	**271**	**1.54**	**0.30**	**3.18**	**-**
- Hugo Dummett North Extension	U/G	-	-	-	-	-	21	1.61	0.56	3.82	-	**21**	**1.61**	**0.56**	**3.82**	**-**
- Oyut open pit	O/P	163	0.53	0.39	1.30	-	265	0.41	0.25	1.14	-	**427**	**0.45**	**0.30**	**1.20**	**-**
- Oyut stockpiles	S/P	-	-	-	-	-	36	0.32	0.12	1.04	-	**36**	**0.32**	**0.12**	**1.04**	**-**
Total		**163**	**0.53**	**0.39**	**1.30**	**-**	**592**	**0.96**	**0.28**	**2.16**	**-**	**755**	**0.87**	**0.30**	**1.98**	-

	Average mill recovery %				Rio Tinto Interest[5]	**Rio Tinto share Recoverable Metal**				Total Mineral Reserves as at 31 December 2021				
										Tonnage	Grade			
Copper[2]	Cu	Au	Ag	Mo	%	**Mt Cu**	**Moz Au**	**Moz Ag**	**Mt Mo**	Mt	% Cu	g/t Au	g/t Ag	% Mo
Oyu Tolgoi (Mongolia)[3]														
- Hugo Dummett North[4]	92	79	81	-	66.0	**3.856**	**2.077**	**22.296**	**-**	138	1.55	0.30	3.19	-
- Hugo Dummett North Extension	92	81	83	-	56.0	**0.311**	**0.306**	**2.132**	**-**	12	1.55	0.54	3.68	-
- Oyut open pit	78	67	53	-	66.0	**1.507**	**2.747**	**8.771**	**-**	238	0.44	0.29	1.19	-
- Oyut stockpiles	71	52	51	-	66.0	**0.082**	**0.074**	**0.616**	**-**	17	0.31	0.13	0.96	-
Total						**5.755**	**5.204**	**33.815**	**-**	405	0.84	0.29	1.93	-

(1) Type of mine: O/P = open pit, S/P = stockpile, U/G = underground.

(2) Copper Mineral Reserves are reported as dry mill tonnes.

(3) Oyu Tolgoi Mineral Reserve valuations are based on commodity prices of US c 350.80/lb for copper, US$ 1,496.75/oz for gold and US$20.43/oz for silver. These represent January 2022 consensus prices sourced from the average forecasts from ten brokers/banks (Barclays, BoAML, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, JP Morgan, Macquarie, Morgan Stanley and UBS) and two analysts (CRU and Woodmac).

(4) The Hugo Dummett North Mineral Reserves include approximately 1.4 million tonnes of stockpiled material at a grade of 0.51% copper, 0.16 g/t gold and 1.25 g/t silver. The Hugo Dummett North underground mine is currently under construction.

(5) As reported to the market on 16 December 2022, Rio Tinto completed its acquisition of Turquoise Hill Resources Ltd and the Rio Tinto Interest % reflects this change. 2021 figures are reported using the previous ownership %.

1.6 Capital and operating costs

The capital costs presented in this report include costs for Phase 1 of the Oyu Tolgoi mine development, which involved development of the Oyut open pit mine, the concentrator and associated infrastructure and for Phase 2, which involves development of the Hugo North underground mine, conversion or modification of the concentrator and expansion of the site infrastructure. Phase 1 development was completed in 2011 and Phase 2 development is in progress.

Sustaining capital costs are also covered in this report and are presented separately from the capital expenditure required for development of the mine. Sustaining capital cost estimates include replacement of major equipment, replacement of major equipment components, planned growth of the mine, the construction of the tailings storage facility and other projects to maintain and improve efficiency and productivity of the operations. For the Hugo North mine, sustaining capital costs include all lateral development, undercut, and drawbell construction activities over and above capital expenditure, required to increase capacity to nameplate and sustain it. Additional Panel 1 and Panel 2 development completed prior to first drawbell is included in sustaining capital. Capital costs are summarized in Table 1-3 and Table 1-4 below.

Table 1-3: Summary of total Phase 2 capital costs[2] by major area (US$M nominal, 100% basis)

WBS	Description	Total (US$M)
Direct Cost		
1000	Underground Mine	3,005
2000	Site Development	0
3000	Concentrator Conversion	167
5000	Utilities & Ancillaries	149
6000	Offsite Facilities	159
	Subtotal	3,480
Indirect Cost		
7000	Indirect Costs	1,563
8000	Owner's Costs	2,135
9000	Escalation, Growth & Contingency & Forex	179
	Subtotal	3,877
Total		7,358

Table 1-4: Estimated sustaining capital for the Property (from 2021 and onwards)

Area	First 5 Years	First 10 Years	Life of Mine
Open Pit	99	233	820
Underground	1,365	2,231	2,739
Concentrator	33	61	149
Tailings	159	299	829
Infrastructure	93	110	255
General and Administration, Other	84	118	212
Total Sustaining Capital (before tax)	**1,832**	**3,151**	**5,004**
Value Added Tax, Custom Duties	193	340	539

Operating costs include costs associated with mining, processing, support, and other costs such as those associated with community relationships.

[2] This amount includes $6,852 million of project costs and $505 million for pre-restart of the Phase 2 development for a total of $7.4 billion from the OTFS20. Subsequently, an updated cost and schedule reforecast was finalised in June 2022 incorporating further Covid-19 impacts to June 2022, cost price escalation and impacts of revised Mongolian labour laws ("2022 Reforecast" or "22RF"). The 2022 Reforecast remains the latest estimate, where the total capital cost for Phase 2 remains at $7.06 billion not including pre-restart costs (nominal – including escalation).

Across the supply chain, operating costs include both internal and external contract labour, diesel and energy, materials, corporate costs and other expenditure required in day-to-day operations.

1.7 Permitting requirements

The following key agreements relating to the development and operation of the Project have been entered into by Rio Tinto, the Government of Mongolia, and other entities and have an impact on Rio Tinto's interest in, and obligations relating to the Oyu Tolgoi Property:

- Investment Agreement dated 6 October 2009, between the Government of Mongolia, Ivanhoe Mines Mongolia LLC (now Oyu Tolgoi LLC), Ivanhoe Mines Ltd (now Turquoise Hill Resources Ltd), and Rio Tinto in respect of Oyu Tolgoi (Investment Agreement or IA);
- Amended and Restated Shareholders Agreement (ARSHA) dated 8 June 2011 among Oyu Tolgoi LLC, THR Oyu Tolgoi Ltd. (formerly Ivanhoe Oyu Tolgoi (BVI) Ltd.), Oyu Tolgoi Netherlands B.V. and Erdenes MGL LLC. Erdenes MGL LLC subsequently transferred its shares in Oyu Tolgoi LLC and its rights and obligations under the ARSHA to its subsidiary, Erdenes Oyu Tolgoi LLC;
- Oyu Tolgoi Underground Mine Development and Financing Plan (Underground Development Plan) dated 18 May 2015, between TRQ, the Government of Mongolia, Erdenes Oyu Tolgoi LLC, THR Oyu Tolgoi Ltd., Oyu Tolgoi Netherlands B.V., Rio Tinto and Oyu Tolgoi LLC. The Underground Development Plan was terminated in 2022; and
- Power Source Framework Agreement (PSFA) dated 31 December 2018, between the Government of Mongolia and Oyu Tolgoi LLC, including the amendment to the PSFA dated 26 June 2020.

These agreements establish obligations and commitments of the involved parties, including the Government of Mongolia, providing clarity and certainty in respect of the development and operation of Oyu Tolgoi. The Investment Agreement also includes a dispute resolution clause that requires the parties to resolve disputes through international commercial arbitration procedures. Copies of each agreement are available at Agreements (ot.mn).

Activities related to the Project must be carried out in accordance with these agreements and the laws of Mongolia. As of the date of this 2022 Technical Report Summary, material permits and authorizations necessary to develop and operate the Project have been obtained.

1.8 Qualified Persons' conclusions and recommendations

Oyu Tolgoi has Mineral Resources and Mineral Reserves supported by drilling programmes, all within the boundaries of Oyu Tolgoi's mining concessions and surface rights and close to existing infrastructure. The vertically integrated nature of the mining and processing facilities, located proximal to the orebody, provides the flexibility to add and optimise growth tonnes to existing infrastructure.

Mineral Resources confidence is reflected in the applied classifications in accordance with the Regulation S-K 1300 with factors influencing classification including but not limited to data density, data quality, geological continuity and/or complexity, estimation quality and weathering zones. Reconciliation data from the existing operation supports the confidence of resource estimates. There has been over 10 years of production history at the Oyu Tolgoi Property that has been used to validate and calibrate the Mineral Resources estimates and modifying factors employed. The high proportion of Indicated/Measured Mineral Resources and the reconciliation history give high confidence in the estimation and reporting of the Mineral Resources. The Qualified Person (QP) is of the opinion that the Mineral Resource estimates are supported by adequate technical data and assumptions.

Future work planned within the annual planning cycle is expected to continue to acquire data to both improve the local estimate within all Mineral Resources categories and extend this level of understanding to new volumes for the deposit as required.

Confidence in the Mineral Reserves is reflected in the applied Mineral Reserves classifications in accordance with the Regulation S-K 1300 with factors influencing classification including but not limited to mining methods, processing methods, economic assessment and other life of asset and closure assessments. Reconciliation data from the existing operation supports the confidence of Mineral Reserves estimate. Uncertainties that affect the reliability or confidence in the Mineral Reserves estimate include but are not limited to:

- Future macro-economic environment, including metal prices and foreign exchange rate.
- Changes to operating cost assumptions, including labour costs.
- Ability to continue sourcing water.
- Changes to mining, hydrological, geotechnical parameters, and assumptions.
- Ability to maintain environmental and social licence to operate.
- Metallurgical recovery assumptions.

Economic value is most sensitive to the commodity price however it still remains positively economic for the life of Mineral Reserves. Based on the confidence in the modifying factors and the information presented in this TRS, the QPs is of the opinion that the Mineral Reserves estimate is supported by adequate technical data and assumptions.

2. Introduction

The Oyu Tolgoi Project is located in the South Gobi region of Mongolia, approximately 645 km by road south of the capital, Ulaanbaatar. The Project is being developed by Oyu Tolgoi LLC and consists of a series of deposits containing copper, gold, and silver.

Rio Tinto International Holdings Ltd. (Rio Tinto) holds a 66% interest in Oyu Tolgoi LLC (the Property). The remaining 34% interest is held by the Government of Mongolia through Erdenes Oyu Tolgoi LLC. Rio Tinto, with other Rio Tinto affiliates, provides strategic and operational management services and support to Oyu Tolgoi LLC in respect of its operations and activities.

In October 2020, Turquoise Resources Limited (TRQ) filed a Canadian National Instrument 43-101 on Standards of Disclosure for Mineral Projects (NI43-101) Technical Report (2020 Technical Report) to provide updated scientific and technical information in respect of Oyu Tolgoi. This TRS has been prepared in accordance with Regulation S-K 1300 and Item 601(b)(96) Technical Report Summary on the Oyu Tolgoi Property to provide a record of scientific and technical information in respect of the Project due to the Property being material to Rio Tinto.

The mineral deposits at Oyu Tolgoi lie in a structural corridor where mineralisation has been discovered over a 26 km strike length. Four deposits hosting Mineral Resources have been identified: Oyut, Hugo North, Hugo South, and Heruga.

Mineral Reserves have been reported at the Oyut and Hugo North Deposits. The Oyut deposit is currently being mined as an open pit using conventional drill, blast, load, and haul methods. The Hugo North deposit is currently in operation as an underground mine using the block caving mining method. A staged approach is envisaged for developing the Hugo North deposit, involving mining two block cave lifts (Lift 1 and potentially Lift 2). Mineral Reserves have been estimated for Lift 1, which comprises three panels (Panel 0, Panel 1, and Panel 2).

All forward looking schedules and cost estimates presented in this 2022 TRS are subject to any delays arising from the COVID-19 pandemic and are subject to further study and assessment as part of Oyu Tolgoi LLC's cost and schedule estimation update which is expected later in 2023 and subject to further study and analysis on Panels 1 and 2.

2.1 Registrant information

This 2022 TRS for the Property, located in Mongolia, is prepared by Rio Tinto. The Rio Tinto Group consists of Rio Tinto plc (registered in England and Wales as company number 719885 under the UK Companies Act 2006 and listed on the London Stock Exchange), and Rio Tinto Limited (registered in Australia as ABN 96 004 458 404 under the Australian Corporations Act 2001 and listed on the Australian Securities Exchange). Rio Tinto plc and Rio Tinto Limited operate together and are referred to in this report as Rio Tinto, the Rio Tinto Group or the Group.

As noted on the Date and Signature Page, several QPs were involved in the technical work summarised in this TRS.

The Property consists of a copper-gold asset comprising an open pit and underground block cave mine and related infrastructure.

Rio Tinto tested each of its properties to determine which are material to the Group based on the previous financial year reporting in accordance with the definition of material Property in the SEC's regulations.

Based on the medium term value (>10% of Group Ore Reserves) and qualitative value tests, the Oyu Tolgoi Property is considered material to the Group and hence requires submission of a TRS.

For SEC reporting purposes, the Oyu Tolgoi Property is considered a production stage Property.

2.2 Terms of reference and purpose

The purpose of this TRS is to report Mineral Resources and Mineral Reserves for the Property effective as at 31 December 2022. The report utilises:

- Australian English spelling.
- Metric units of measure.
- Grades are presented in weight percent (wt.% and grams per tonne (g/t)).

- Coordinate system is using Geodetic Universal Trans Mercator (UTM) stated in metres east and north of the UTM zone 48N datum. Mine grid coordinates correspond to the UTM coordinates.
- Geographic coordinates are stated in degrees, minutes and seconds of longitude and latitude are relative to the World Geodetic System (WGS) 1984 datum.
- Real US Dollars.
- Summary Mineral Resources and Mineral Reserves in Table 11-3 and Table 12-1 are presented based on Rio Tinto equity ownership.
- All other information in the TRS is presented on a 100% basis for the Property.[3]

Key acronyms and definitions used in this TRS include those items listed in Table 2-1.

Table 2-1: List of acronyms and abbreviations used in this TRS

Acronym/Abbreviation	Definition
AAS	Atomic Absorption Spectroscopy
AEP	Annual Exceedance Probability
ALS	Australian Laboratory Services Limited
ARD	Acid Rock Drainage
ARSHA	Amended and Restated Shareholders Agreement
AusIMM	Australasian Institute of Mining and Metallurgy
BEng	Batchelor of Engineering
BSc	Batchelor of Science
BWI	Bond Work Index
Ci	Minnovex Crushing Index
COG	Cut-Off Grade
CuEq	Copper equivalent (grade)
DAC	Design Acceptance Criteria
DDH	Diamond Drillhole
DGPS	Differential Global Positioning System
DICL	Ductile Iron Concrete Lined
FIFO	Fly-In-Fly-Out
g	Gram/mes
G&A	General and administration (costs)

[3] In this TRS, 100 percent basis for the Property means the Property (including the volume of Mineral Reserves within the Property and all economic analysis related to the Mineral Reserves) is presented on the basis of 100% ownership of the Property as a whole, without regard for any joint venture or other ownership structures that may exist between Rio Tinto and third parties in respect of the Property. This approach differs from external guidance in other Rio Tinto reporting, which is presented on an equity basis. As such, certain figures presented in this TRS may deviate from figures published by Rio Tinto elsewhere.

Acronym/Abbreviation	Definition
GHG	Greenhouse Gas
GPS	Global Positioning System
GIS	Geographical Information System
ha	Hectare/s
HME	Heavy Mobile Equipment
HR	Hydraulic Radius
HSEC	Health, Safety, Environment and Community
ICMM	International Council on Mining and Metals
IFC	International Finance Corporation
IMMI	Ivanhoe Mines Mongolia Inc. LLC
IMPIC	Inner Mongolia Power International Cooperation Co. Ltd.
IP	Induced Polarisation
IRR	Internal Rate of Return
InSAR	Interferometric Synthetic Aperture Radar
ISO	International Organization for Standardization
kg	Kilogramme/s
km	Kilometre/s
km^2	Square kilometre/s
KOH	Potassium Hydroxide
kV	Kilovolt
kWh/t	Kilowatt Hours per tonne
lb	Pound
LECO	LECO Corporation (infrared absorption and thermal conductivity measurement for Sulphur and Carbon)
LiDAR	Light Detection and Ranging
LLC	Limited Liability Company
LOM	Life of Mine
LTE	Long-Term Evolution
m	Metre/s
Ma	Million Years
MAusIMM	Member of the Australasian Institute of Mining and Metallurgy
MBI	Modified Bond Index
mm	Millimetre/s
MNS	Mongolian National Standard

Acronym/Abbreviation	Definition
MRMR	Mining rock mass rating
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Megawatt
µm	Micron/micrometre
NAF	Non- Acid Forming
NGO	Non-Government Organisation
NPV	Net Present Value
NN	Nearest Neighbour (estimation method)
NPTG	National Power Transmission Grid
NSR	Net Smelter Return
ODBC	Open Database Connectivity
OECD	Organisation for Economic Co-operation and Development
OK	Ordinary Kriging
OTFS20	Oyu Tolgoi Feasibility Study 2020
QA/QC	Quality Assurance/Quality Control
QP	Qualified Person
PAF	Potentially Acid Forming
PCD	Polycrystalline Drillhole
PEA	Preliminary Economic Evaluation
PIMA	Portable Infrared Mineral Analyzer
PRC	Production Rate Curve
PSFA	Power Source Framework Agreement
QEMSCAN	Quantitative Evaluation by Scanning Electron Microscope
RC	Reverse Circulation
RCD	RC pre-collared DDH
RQD	Rock Quality Designation
RTDB	Rio Tinto acQuire™ Database
SAG	Semi-Autogenous Grinding
SGS	Société Générale de Surveillance
SK	Simple Kriging
SME	Society for Mining, Metallurgy and Exploration
SMU	Selective Mining Unit
SPI	SAG Mill Power Index

Acronym/Abbreviation	Definition
SRM	Standard reference material
SWIR	Short Wave Infrared
t	Tonne/s
TEC	Trace Element Composites
TMM	Total material movement
TRS	Technical Report Summary
TRQ	Turquoise Hill Resources Ltd
TSF	Tailings Storage Facility
TTPP	Tavan Tolgoi Power Plant
UCS	Unconfined Compressive Strength
UTM	Universal Transverse Mercator
WGS	World Geodetic System
WRS	Waste Rock Storage

2.3 Sources of information

Sources of exploration and geological data supporting the modelling and Mineral Resource estimates presented in this TRS include data and observations collected by Rio Tinto during the various exploration campaigns completed across the Property, and the various Mineral Resource estimate reports prepared by Rio Tinto and dated 31 December 2019 (and in some cases updated to 30 June 2020).

General regional and local geological interpretation and information for the Property is sourced from various geological reports prepared by or on behalf of Rio Tinto tenement holders as well as from publicly available peer-reviewed geological papers; these geological reports and papers are referenced throughout this TRS where relied upon. This TRS also utilises relevant external technical reports and data available to Rio Tinto providing input to location, setting, geology, project history, exploration activities, methodology, quality assurance and interpretations.

Sources of data and information supporting the Mineral Reserves estimates presented in this TRS are the various Mineral Reserve estimate reports prepared by Rio Tinto and dated 31 December 2019 (and in some cases updated to 30 June 2020).

Observations and interpretations of geostatistics, geology and mineralised trends, grade estimation, and Mineral Resources and Mineral Reserves estimates have been generated by Rio Tinto personnel.

The following software was utilised:

- acQuire™ for the drill hole database.
- Leapfrog Geo™ for geological interpretation and 3D modelling.
- Vulcan™ for block model development and grade estimation.
- Datamine Supervisor for variography and statistical analysis.

- GEOVIA Whittle™ for definition of economic pit limits.
- GEOVIA PCBC™ for the planning and scheduling of block and panel cave mines.
- Vulcan™ for pit design.
- Minemax Scheduler™ for mine scheduling.
- ArcGIS™ for multi-purpose 2D data visualisation, and map generation.

A detailed list of references is provided in Section 25 of this TRS.

2.4 QPs and site visits

Information in this TRS has been prepared under the supervision of the following QPs:

- Oyunjargal Dendev – Information in this TRS has been prepared under the supervision of Oyunjargal Dendev, Member of the Australian Institute of Mining and Metallurgy (MAusIMM, Member Number 313230) and Member of the Society for Mining, Metallurgy and Exploration (SME, Member Number 04148761), Principal Geologist Resources. Oyunjargal is responsible for Mineral Resources for Oyu Tolgoi group deposits including Hugo Dummett, Oyut and Heruga. Visits to Oyu Tolgoi mine site occur each year as often as possible, and the last visit was in October 2022.
- Nathan Robinson – Information in this TRS has been prepared under the supervision of Nathan Robinson, Member of the Australian Institute of Mining and Metallurgy (MAusIMM, Member Number 202085), Principal Mining Engineer. Nathan is responsible for Oyut open pit Mineral Reserves. Visits to Oyu Tolgoi Oyut open pit occur each year, except for 2021-2022 due to COVID-19. The last visit was September 2020.
- Barry Ndlovu – Information in this TRS has been prepared under the supervision of Barry Ndlovu, Member of the Australasian Institute of Mining and Metallurgy (MAusIMM, Member Number 336347), Principal Engineer Caving. Barry is responsible for underground Mineral Reserves. Visits to Oyu Tolgoi occur each year, except for 2021 due to COVID-19 travel restrictions. The last site visit was in May 2022.

Table 2-2 presents a tabulation of the QPs and their areas of responsibility.

Table 2-2: List of QPs

QP	Qualifications	Site Visit	Area of Responsibility[1]
Nathan Robinson	BEng (Mining Engineering), Member of AusIMM (CP)	September 2020	Sections 1, 2, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 22, 24, 25
Barry Ndlovu	Bachelor's Degree (Mining Engineering), Member of AusIMM	May 2022	Section 1, 2, 9, 12, 13, 22, 23, 24
Oyunjargal Dendev	BSc (Geology), Member of AusIMM and SME	October 2022	Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 20, 21, 22, 24

[1]QPs have relied on information provided by the registrant for preparing findings and conclusions relating to aspects of modifying factors. This information and the portions of the TRS relating to its use can be seen in Section 25.

2.5 Previously filed technical report summaries

This is the first TRS filed for the Property.

3. Property description

The Oyu Tolgoi Property is approximately 645 km by road south of the capital of Mongolia, Ulaanbaatar. The location of the Property and its proximity to major national infrastructure is illustrated in Figure 3-1: Property location map.

The mineral deposits at the Oyu Tolgoi Property lie in a structural corridor where mineralisation has been discovered over a 26 km strike length. Four deposits hosting Mineral Resources have been identified within the Property: Hugo North, Hugo South, Oyut and Heruga.

Hugo North and Hugo South are the fault-separated parts of the Hugo Dummett deposit. The Oyut deposit, formerly known as Southern Oyu Tolgoi, is currently mined as an open pit using a conventional drill, blast, load, and haul method. The Hugo North deposit is currently being developed as an underground mine.

3.1 Property location

The Oyu Tolgoi Project is located in the South Gobi region of Mongolia, approximately 645 km by road south of the capital, Ulaanbaatar. The Project is being developed by Oyu Tolgoi LLC and consists of a series of deposits containing copper, gold, and silver. The Project is centred at approximately latitude 43°00'45"N, longitude 106°51'15"E (Figure 3-1).

Details of the tenure are shown in Table 3-1 and locations shown in Figure 3-2.

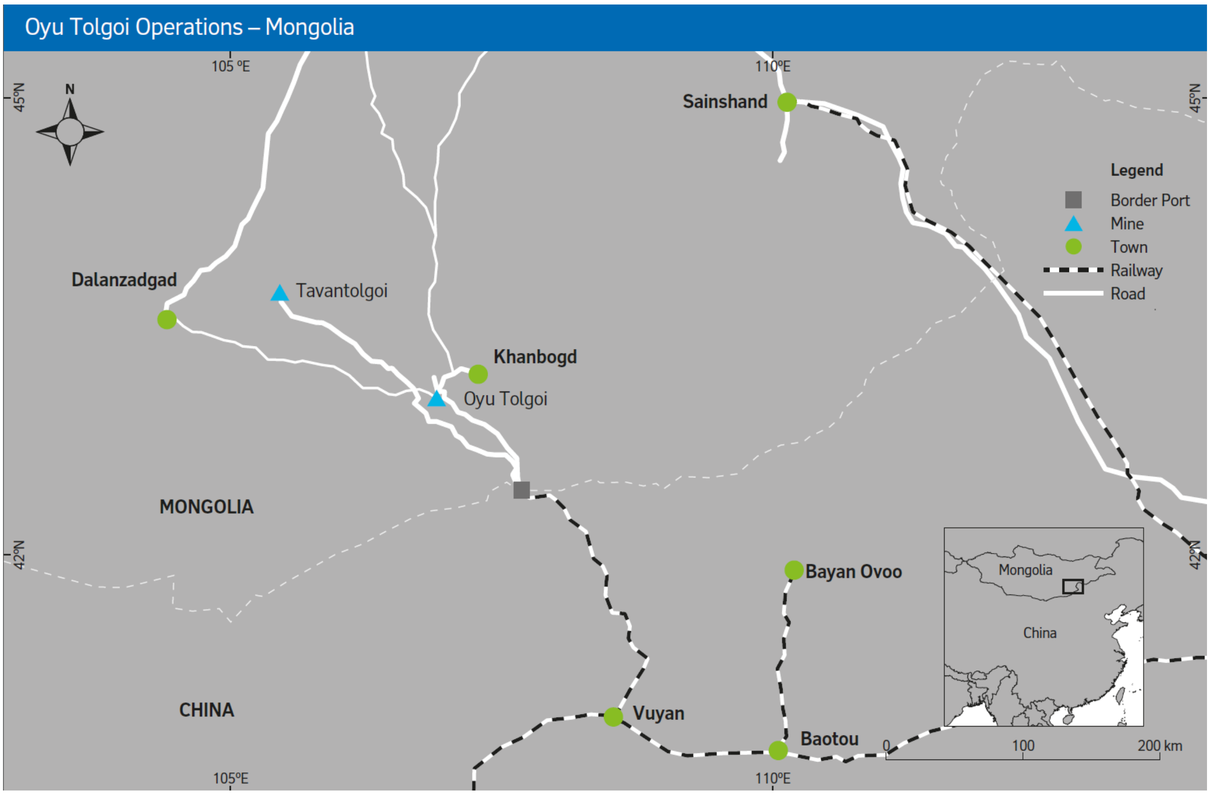

Figure 3-1: Property location map

Table 3-1: Rio Tinto tenure containing the Mineral Resources and Mineral Reserves

Tenure Number	Tenure Name	Tenure Type	Holder Group	Oyu Tolgoi's Interest	Tenure Status	Expiry Date	Current Area (ha)
MV-006708	Manakht	Mining Licence	Oyu Tolgoi LLC	100%	Live	23 Dec 2033	4,533
MV-006709	Oyu Tolgoi	Mining Licence	Oyu Tolgoi LLC	100%	Live	23 Dec 2033	8,490
MV-006710	Khukh Khad	Mining Licence	Oyu Tolgoi LLC	100%	Live	23 Dec 2033	1,763
MV-015225	Javkhlant	Mining Licence	Entrée Resources Ltd.	70% from the surface to 560 m below the surface; and 80% from below 560 m	Live	27 Oct 2039	20,327
MV-015226	Shivee Tolgoi	Mining Licence	Entrée Resources Ltd.	70% from the surface to 560 m below the surface; and 80% from below 560 m	Live	27 Oct 2039	42,593

Figure 3-2 presents a tenement map of the Property.

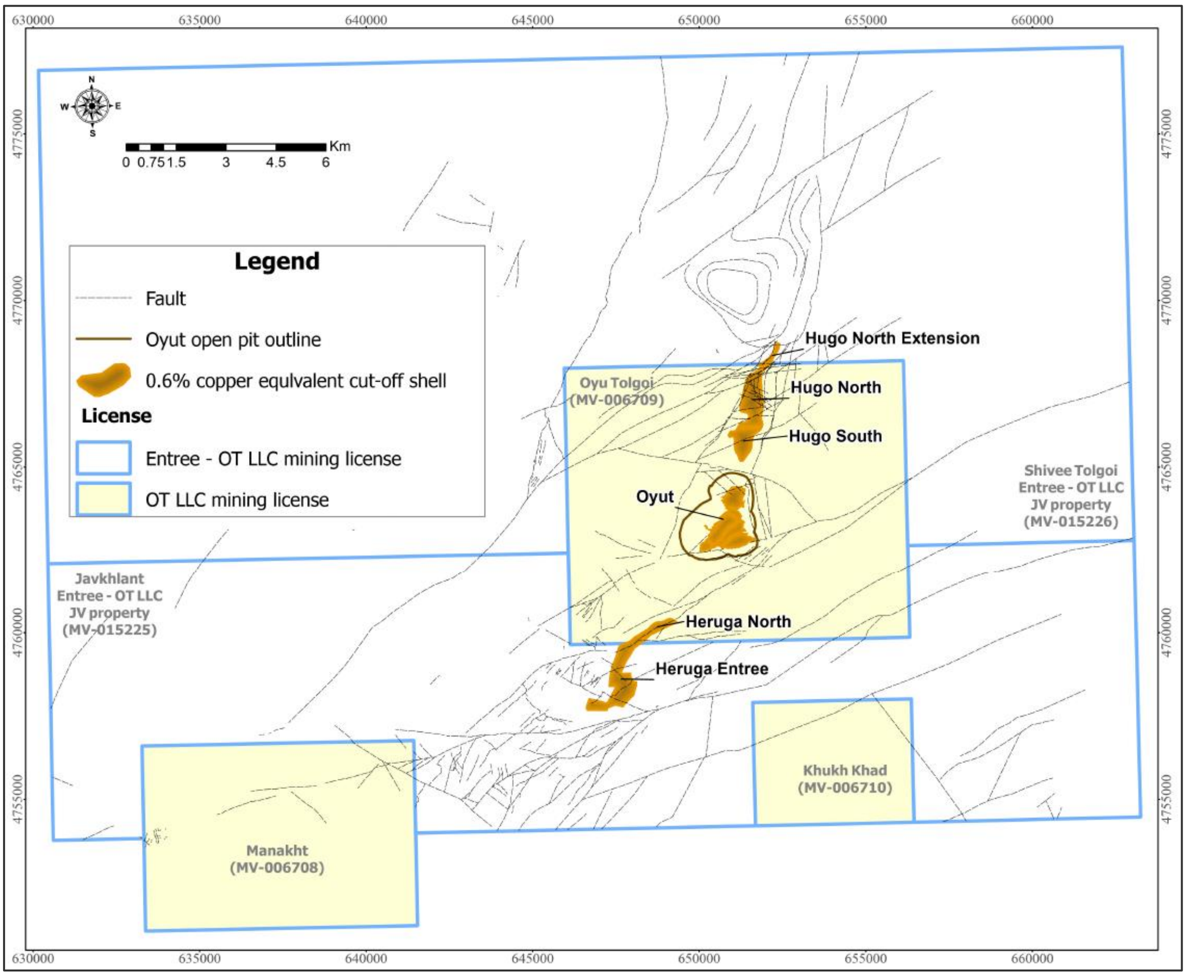

Figure 3-2: Property tenement map

3.2 Title details and rights

Oyu Tolgoi's legal title to the Shivee Tolgoi and Javkhlant licences is subject to the equity participation and earn-in agreement dated 15 October 2004, as amended on 9 November 2004, between Entrée Resources Ltd. and Oyu Tolgoi LLC (the Earn-In Agreement), which established a joint venture arrangement between Oyu Tolgoi LLC and Entrée Resources Ltd., which provides for Oyu Tolgoi LLC to hold legal title in the licences, subject to the terms of the agreement, and to Oyu Tolgoi LLC meeting prescribed earn-in expenditures. Although a formal joint venture agreement has not been signed, the earn-in requirements have been met. Both the Shivee Tolgoi and Javkhlant licences are operated by Oyu Tolgoi LLC.

Under the Earn-in Agreement, Oyu Tolgoi LLC's participating interest in the joint venture arrangements (including the licences) consists of:

- 70 percent of the proceeds from mining from the surface to 560 m below the surface
- 80 percent of the proceeds from mining from depths below 560 m.

Most of the identified mineralisation at Oyu Tolgoi occurs at the Hugo North and Oyut deposits within the Oyu Tolgoi Licence MV006709. The northernmost extension of the Hugo North deposit extends onto the Shivee Tolgoi Licence and is subject to the terms of the Earn-In Agreement.

3.3 Encumbrances

There are no known significant encumbrances to the Mineral Resources or Mineral Reserves on the Property.

3.4 Risks to access, title or right to perform work

The risks to access, title, and the right to perform work are associated with approvals that consider heritage; environment (including water); communities and other stakeholders; cumulative impacts; and state and federal legislation in relation to the deposits and surrounds. Work programs to understand and manage the risks for these aspects are completed before and during exploration and studies; and continued through to operation and closure. Mine and infrastructure designs are adjusted where areas of specific significance or risk are identified and need to be avoided or specially managed, which may be through monitoring and management plans or via the delineation of restricted areas or Mining Exclusion Zones.

3.5 Agreements and royalties

The following agreements relating to the Project have been entered into by Rio Tinto, the Government of Mongolia, and other entities and have an impact on Rio Tinto's interest in, and obligations relating to the Oyu Tolgoi Property:

- Investment Agreement dated 6 October 2009, between the Government of Mongolia, Oyu Tolgoi LLC, and Rio Tinto in respect of Oyu Tolgoi (Investment Agreement).
- Amended and Restated Shareholders Agreement (ARSHA) dated 8 June 2011 among Oyu Tolgoi LLC, THR Oyu Tolgoi Ltd. (formerly Ivanhoe Oyu Tolgoi (BVI) Ltd.), Oyu Tolgoi Netherlands B.V. and Erdenes MGL LLC (ARSHA). Erdenes MGL LLC since transferred its shares in Oyu Tolgoi LLC and its rights and obligations under the ARSHA to its subsidiary, Erdenes Oyu Tolgoi LLC.

- Underground Mine Development and Financing Plan (Underground Development Plan) dated 18 May 2015, between Rio Tinto, the Government of Mongolia, Erdenes Oyu Tolgoi LLC, THR Oyu Tolgoi Ltd., Oyu Tolgoi Netherlands B.V., and Oyu Tolgoi LLC. The Underground Development Plan was terminated in 2022.
- PSFA dated 31 December 2018, between the Government of Mongolia and Oyu Tolgoi LLC, including the amendment to the PSFA dated 26 June 2020.

These agreements establish obligations and commitments of the involved parties, including the Government of Mongolia, providing clarity and certainty in respect of the development and operation of Oyu Tolgoi. The Investment Agreement also includes a dispute resolution clause that requires the parties to resolve disputes through international commercial arbitration procedures. Copies of each agreement are available at Agreements (ot.mn).

3.5.1 Investment Agreement

The Investment Agreement provides for, among other things, a framework for undertaking mining activities in compliance with all laws relating to the environment and human health, the rehabilitation of the environment, the social and economic development of the Southern Gobi region, and the creation of new jobs in Mongolia.

The Investment Agreement became effective on 31 March 2010 and has an initial term of 30 years (until 31 March 2040). Oyu Tolgoi LLC has the right, by giving notice not less than 12 months prior to the expiry of the initial term and subject to the fulfilment of certain conditions, to extend the initial term of the Investment Agreement for an additional term of 20 years.

To exercise its right to extend the initial term, Oyu Tolgoi LLC must have performed certain obligations during the initial 30-year term, including, among others:

- Having demonstrated that Oyu Tolgoi has been operated to industry best practice in terms of national and community benefits, environmental health and safety practices.
- Having made capital expenditures in respect of Oyu Tolgoi of at least $9 billion.
- Having complied in all material respects with its obligations to pay taxes under the laws of Mongolia, as stabilized under the terms of the Investment Agreement.
- If Oyu Tolgoi LLC constructs a smelter as part of the development of the Oyu Tolgoi Project, it must be located in Mongolia.
- If the development and operation of Oyu Tolgoi has caused any unanticipated and irreversible ecological damage to natural resources in Mongolia, then Oyu Tolgoi LLC must pay compensation based on the value of any such permanently damaged natural resources in accordance with the applicable laws of Mongolia.
- Having secured the total power requirements for Oyu Tolgoi from sources within the territory of Mongolia within four years of commencement of production. This obligation has been subsequently amended and restated through a Power Sector Cooperation Agreement, which was in turn superseded by the PSFA, amended in 2020. Please see Power discussion below.

Sale of mineral products

The Investment Agreement confirms Oyu Tolgoi LLC’s rights to market sell and export mineral products from Oyu Tolgoi at international market prices and to freely expend and repatriate its sale proceeds in Mongolian Togrogs and foreign currencies. It also conveys legal protection on capital, property and assets of Oyu Tolgoi LLC and its affiliates, and the requirement that any expropriation action must be in accordance with due process of law on a non-discriminatory basis and with the condition of full compensation by the Government of Mongolia to the affected party.

Taxes royalties and fees

Throughout the term of the Investment Agreement, if any, all taxes as set out in Section 2.1 of the Investment Agreement payable by Oyu Tolgoi LLC will remain stabilized including the corporate income tax rate, customs duties, value-added tax, excise tax (except on gasoline and diesel fuel purchases), royalties, mineral exploration and mining licence payments, and immovable property tax and/or real estate tax. Non-stabilized taxes will apply to Oyu Tolgoi LLC on a non-discriminatory basis. Examples of non-stabilized taxes are social security obligations, work placement fees, royalties on the use of sand and gravel and water levies, some of which are paid locally.

Infrastructure, roads, and water

The Investment Agreement permits Oyu Tolgoi LLC to construct a road between the Oyu Tolgoi site and the Gashuun Sukhait border crossing with China. Oyu Tolgoi LLC may deduct the road construction expenses from its annual taxable income.

Oyu Tolgoi LLC has the right to access and use self-discovered water resources for any purpose connected with Oyu Tolgoi during the life of the Project. Oyu Tolgoi LLC is required to pay fees for its water use, but such fees must be no less favourable than those payable from time to time by other domestic and international users, must take into account the quantity and quality of the water removed and consumed, and are treated as a deductible expense from Oyu Tolgoi LLC’s taxable income.

Power Source Framework Agreement Amendment

Oyu Tolgoi LLC currently sources power for the Oyu Tolgoi mine from China’s Inner Mongolian Western Grid, via overhead power line, pursuant to back-to-back power purchase arrangements with Mongolia’s National Power Transmission Grid JSC (NPTG), the relevant Mongolian power authority, and Inner Mongolia Power International Cooperation Co., Ltd (IMPIC), the Chinese power generation company.

Oyu Tolgoi LLC is obliged under the 2009 Oyu Tolgoi Investment Agreement to secure a long-term domestic source of power for the Oyu Tolgoi mine. The PSFA entered into between Oyu Tolgoi LLC and the Government of Mongolia on 31 December 2018 provides a binding framework and pathway for long-term power supply to the Oyu Tolgoi mine. The PSFA originally contemplated the construction of a coal-fired power plant at Tavan Tolgoi (TTPP), which would be majority-owned by Oyu Tolgoi LLC and situated close to the Tavan Tolgoi coal mining district located approximately 150 km from the Oyu Tolgoi mine. In April 2020, the Government of Mongolia advised that it was unwilling to support Oyu Tolgoi LLC’s proposal to develop the TTPP and announced its intention to fund and construct a state-owned power plant at Tavan Tolgoi.

On 26 June 2020, Oyu Tolgoi LLC and the Government of Mongolia amended the PSFA (the PSFA Amendment) to reflect their agreement to jointly prioritise and progress the state-owned power plant, in accordance with and subject to agreed milestones, as the domestic source of power for the Oyu Tolgoi mine. The milestones include: signing an Electricity Purchase and Sale Agreement (Power Purchase Agreement) for the supply of power to the

Rio Tinto

Oyu Tolgoi mine by 31 March 2021, commencing construction of a state owned power plant by no later than 1 July 2021, commissioning the state-owned power plant within four years thereafter, and reaching agreement with IMPIC on an extension to the existing power import arrangements by 1 March 2021 in order to ensure there is no disruption to the power supply required to safeguard the Oyu Tolgoi mine's ongoing operations and development pending start of the supply from the state-owned power plant.

The PSFA Amendment provides that if certain agreed milestones are not met in a timely manner (subject to extension for defined delay events) then Oyu Tolgoi LLC will be entitled to select from, and implement, the alternative power solutions specified in the PSFA Amendment, including an Oyu Tolgoi LLC led coal-fired power plant and a primary renewables solution, and the Government of Mongolia would be obliged to support such decision.

Local communities and employment

The Investment Agreement requires that at least 90% of the employees at Oyu Tolgoi and at least 50% of Oyu Tolgoi LLC engineers at Oyu Tolgoi are Mongolian nationals. Oyu Tolgoi LLC currently meets these requirements. Oyu Tolgoi LLC must also use its best endeavours to ensure that at least 70% of its engineers are Mongolian nationals after September 2023. Oyu Tolgoi LLC must also use its best efforts to ensure that not less than 60% of its contractors' employees are Mongolian nationals for construction work and 75% of its contractors' employees are Mongolian nationals for mining and mining related work.

Oyu Tolgoi LLC will conduct, implement, and update, from time to time, socio-economic impact assessments, socio-economic risk analyses, multi-year community plans, community relations management systems, policies, procedures and guidelines, and mine closure plans, all of which shall be produced with community participation and input and be consistent with international best practices. Oyu Tolgoi LLC will also conduct community development and education programs.

Oyu Tolgoi LLC will prioritize the training, recruiting and employment of citizens from local communities for Oyu Tolgoi, giving specific preference to the citizens of Umnugobi Aimag.

Environment

The Investment Agreement requires that every three years Oyu Tolgoi LLC provides the Government of Mongolia with an independent report on its progress in implementing the environmental protection plan set out in the Detailed Environmental Impact Assessments submitted to the Government of Mongolia in 2012. The required independent report was submitted in 2016. The Detailed Environmental Impact Assessment will be reviewed and any amendments submitted during 2021. The report is subject to periodic review on 5-year cycles or when there are significant changes to the description of the Project.

4. Accessibility, climate, local resources, infrastructure, and physiography

4.1 Topography, elevation, and vegetation

The topography of the Oyu Tolgoi Property largely consists of gravel-covered plains, with low hills along the northern and western borders of the licence areas. Small, scattered rock outcrops and colluvial talus are widespread within the northern, western, and southern parts of the Property. The elevations of the central portion of the Property range from approximately 1,140 m to 1,215 m above sea level.

The surrounding mountains (Khanbogd, Dalain Duulga, and Javkhlant Khairkhan) are relatively high and considered places of worship and of other cultural and religious significance. The Gunii Hooloi basin is a hilly area in the east and south of the valley. The concentrate transportation corridor or the Oyu Tolgoi to Gashuun Sukhait paved road (Figure 4-1) transects the Galbyn Gobi lowlands, and the lowest lying area is depression called Khuurai Nuur.

The Undai River is one of the key elements within the Oyu Tolgoi Property in terms of surface features. Although there are no special protected areas within the Oyu Tolgoi Property, the surrounding hills are considered of high importance. There are no significant places within the Gunii Hooloi valley and along the transport corridor.

There is limited vegetation in Oyu Tolgoi area, which lies in the desert steppe, semi-desert and desert zone of the South Gobi ecosystem.

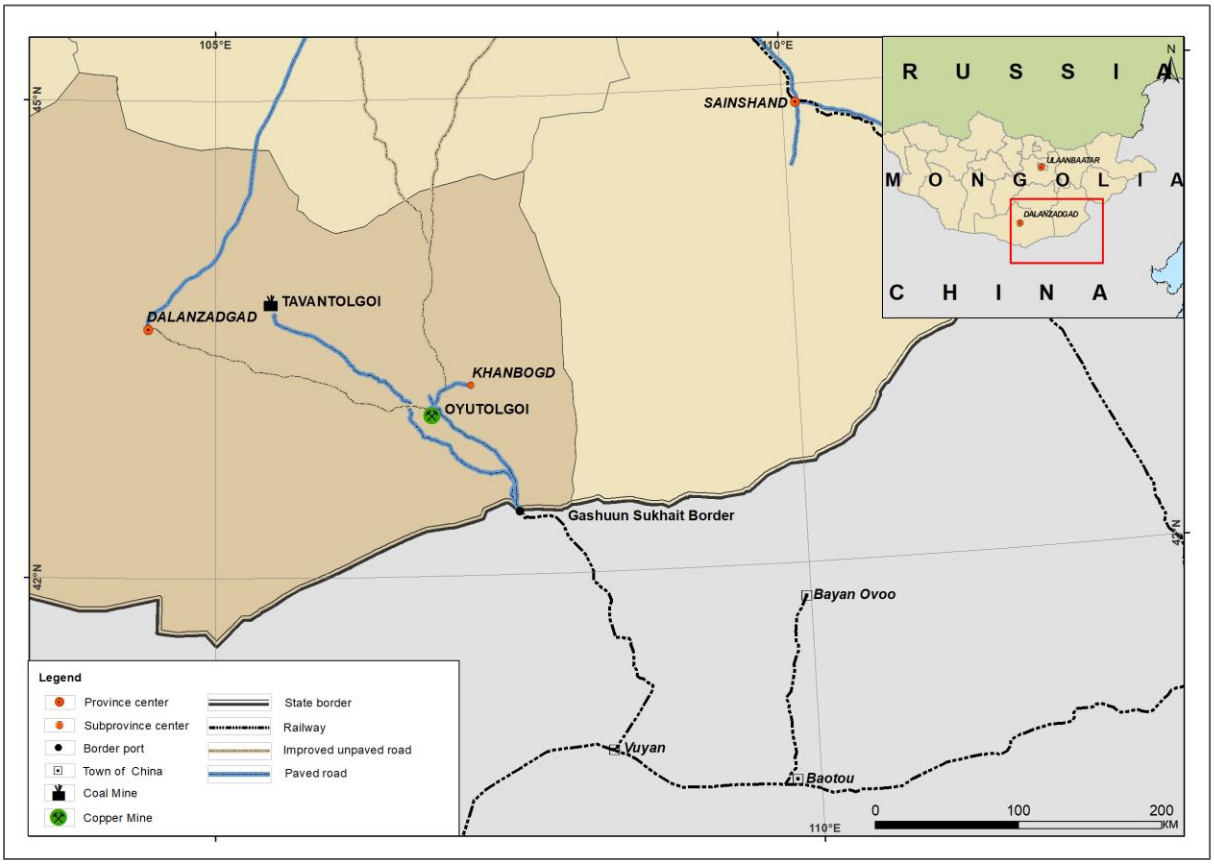

Figure 4-1: Oyu Tolgoi location and regional infrastructure

4.2 Access

Road access to the Oyu Tolgoi Property from Ulaanbaatar is currently by an unpaved road, via Mandalgovi. The Chinese Government has upgraded 226 km of road from Ganqimaodao to Wuyuan, providing a direct road link between the Mongolian border crossing at Gashuun Sukhait, 80 km south of Oyu Tolgoi, and the Trans-China railway system. A 105 km long sealed road has been constructed from Oyu Tolgoi to the Mongolian-Chinese border crossing at Gashuun Sukhait.

A permanent domestic airport designed to accommodate commercial aircraft up to the Boeing 737-800 series has been constructed 11 km north of the Oyu Tolgoi camp area. The flight time from Ulaanbaatar is just over one hour. The airport also serves as the regional airport for the town of Khanbogd.

4.3 Climate

The South Gobi region has a continental, semi-desert climate. The spring and autumn seasons are cool, summers are hot, and winters are cold. The climatic conditions are such that normal operations can continue throughout the year. Minor weather-related operational disruptions are expected to occur.

Temperatures range from a maximum of about 42 °C to a minimum of –31 °C. Typical air temperature in winter fluctuates between 6 °C and –21 °C. In the coldest month, January, the average temperature is –13 °C. The ground surface can freeze to a depth of 2.5 m in some soil types.

Average annual precipitation is 97 mm, 90% of which falls as rain and the rest as snow. Snowfall accumulations rarely exceed 50 mm. Maximum rainfall events of up to 44 mm/h for a 1-in-10 year, 10-minute storm event have been recorded. In an average year, rainfalls occur on only 19 days, and snow falls on 10 to 15 days.

4.4 Local resources and infrastructure

4.4.1 Power supply

Oyu Tolgoi LLC has secured the power requirements for Oyu Tolgoi through the terms of the Investment Agreement and the subsequent agreements described in Section 4.4.2. Power for the Project is currently supplied with electricity from China in accordance with three agreements:

- Power Purchase Agreement for the Project between Oyu Tolgoi LLC, the IMPIC, and the NPTG of Mongolia;
- Operation and Maintenance Agreement (O&M Agreement) between Oyu Tolgoi LLC and the IMPIC; and
- Dispatch Agreement between Oyu Tolgoi LLC and the IMPIC.

Power is supplied via a 220 kV double-circuit transmission line from Inner Mongolia. Either circuit can supply approximately 400 MW, thus Oyu Tolgoi’s load can be met entirely from one circuit. To date, the reliability of the electricity supply from IMPC has been very good, with no recorded full outage of the transmission line.

4.4.2 Water supply

Water resource development in the South Gobi Region is part of the Mongolian national water resources strategy, and its management is embedded in national legislation and the institutional framework. Oyu Tolgoi LLC fully understands the importance of water in the South Gobi Region and has implemented a wide range of measures to promote water conservation and to minimize the amount of water used by the Project.

4.4.3 Personnel

Personnel are engaged on either a residential or Fly-In-Fly-Out (FIFO) basis, sourced from capital and regional centres in Mongolia.

4.4.4 Supplies

Supplies are transported to site by road or by air, utilising major highways and an Oyu Tolgoi owned airport.

5. History

5.1 Project history

5.1.1 Early history

The existence of copper in the Oyu Tolgoi area has been recognized since the Bronze Age, but contemporary exploration for Mineral Resources did not begin until the 1980s, when a joint Mongolian and Russian geochemical survey team identified a molybdenum anomaly. Evidence of alteration and copper mineralisation in the area of the Oyut deposit was first noted in 1983. In September 1996, geologists from the Magma Copper Company identified a porphyry copper leached cap over what is now known as the Central zone of the Oyut deposit. The Magma Copper Company subsequently secured exploration tenements in the area. Magma Copper Company was subsequently acquired by BHP, which became BHP-Billiton (BHP).

Geophysical surveying on the Oyu Tolgoi mining licence (MV 006709) was first conducted by BHP in 1997. An airborne magnetometer survey was carried out, followed by induced polarization (IP) surveys. The surveys covered exploration targets in the area of the Oyut deposit but did not extend into the northern area that ultimately became the Hugo Dummett deposits (Hugo North and Hugo South).

Between 1997 and 1998, BHP also carried out geological, geophysical, and geochemical (stream sediment and soil) surveys, and diamond drilling programs (23 drill holes in total) in the Central and South zones of the Oyut deposit. Copper and gold values were encountered at depths from 20 m to 70 m below the surface, and a supergene-enriched, chalcocite blanket was encountered in one drill hole. Based on the results of this drilling, BHP prepared a Mineral Resource estimate in 1998, but the resulting tonnage and grade estimate was considered too small to meet BHP corporate objectives, and BHP elected to offer the property for joint venture.

In 1999, TRQ (known at the time as Ivanhoe Mines Ltd.) visited Oyu Tolgoi and agreed to acquire 100% interest in the property, subject to a 2% NSR royalty. TRQ subsequently acquired the 2% NSR royalty payable by Oyu Tolgoi LLC in November 2003, thereby removing any future obligations to BHP.

5.1.2 2000 to 2009

In 2000, Ivanhoe Mines Mongolia Inc. LLC (IMMI), completed 8,000 m of reverse circulation (RC) drilling, mostly at the Central zone, to explore the chalcocite blanket discovered earlier by BHP, and updated the BHP Mineral Resource estimate.

In 2001, IMMI continued RC drilling, mostly in the South zone area, to test for additional supergene copper mineralisation. IMMI then drilled three diamond core holes to test the deep hypogene copper-gold potential. One of these holes, drilled over the Southwest zone, intersected 508 m of chalcopyrite mineralisation from a depth of 70 m, grading 0.81% Cu and 1.17 g/t Au. This marked the discovery of the Oyut deposit.

These results encouraged Ivanhoe to mount a major follow up drilling program. In late-2002, drilling in the far northern section of the property intersected 638 m of bornite-chalcopyrite-rich mineralisation, starting at a depth of 222 m. This hole marked the discovery of the Hugo Dummett deposits (Hugo North and Hugo South).

In 2003, the Government of Mongolia granted mining licence MV-006709 to IMMI, along with mining licences for MV-006708 and MV-006710.

In 2004, a NI 43-101 Preliminary Economic Assessment (PEA) was completed on the economics of open pit mining the Oyut deposit.

In 2004, a first-time Mineral Resource estimate was reported for the Hugo South portion of the Hugo Dummett deposits.

In November 2004, following the signing of an Equity Participation and Earn-in Agreement with Entrée Resources Ltd. (refer to Section 4). IMMI initiated exploration work on the Javkhlant and Shivee Tolgoi licences. Entrée Resources Ltd. had previously undertaken soil geochemical surveys, geophysical surveys and geological mapping, but had failed to locate any mineralisation of significance.

In 2005, the Hugo Dummett Mineral Resource estimate was updated to include Hugo North.

In 2005, a PEA was prepared based on an integrated development plan for open pit mining of the Oyut deposit, two block caves on the Hugo North deposit, and one block cave on Hugo South. The integrated development plan included a processing plant with a capacity of 25.5 million tonnes per annum (Mtpa), with an expansion to 51 Mtpa.

In 2006, following further geophysical exploration and drilling, IMMI reported a first-time Mineral Resource estimate for the part of the Hugo North deposit that extends onto the Shivee Tolgoi mining licence. This area is known as the Hugo North Extension.

In 2006, a Mineral Reserve estimate for the Oyut deposit was reported, based on a feasibility study of an open pit only mining scenario.

In January 2006, Shaft 1 headframe, hoisting plant, and associated infrastructure were completed. By January 2008, the shaft had been sunk to a depth of 1,385 m enabling underground exploration development for the Hugo North deposit to commence.

In early 2007, core drilling was initiated to test IP anomalies on Entrée Resources Ltd.'s Javkhlant licence. The drilling identified the Heruga deposit in 2008.

In 2007, the Hugo North Mineral Resource estimate was updated.

In 2008 a first-time Mineral Resource estimate was reported for the Heruga deposit.

In 2009, the Investment Agreement between IMMI, Rio Tinto and the Government of Mongolia was signed (refer to Section 4) and Oyu Tolgoi LLC was formed. As part of the agreement process, Oyu Tolgoi LLC prepared a Mongolian feasibility study (MFS09) for the Government of Mongolia. MFS09 envisaged open pit mining on the Oyut deposit and underground mining by block caving on Hugo North, Hugo South, and the Heruga deposits. A processing plant capacity of 36.5 Mtpa expanding to 58 Mtpa was envisaged.

5.1.3 2010 to 2013

In 2010, a NI 43-101 Technical Report (2010 Technical Report) was released based on an integrated development plan for the Project. The 2010 Technical Report included a Mineral Reserve for the Oyut deposit based on open pit mining and a Mineral Reserve for part of the

Hugo North deposit (Lift 1) based on the block caving method. The report envisaged the same plant capacity as MFS09.

In 2010, a decision was made to construct the Oyut open pit mine and to construct a 36.5 Mtpa concentrator and supporting infrastructure.

In 2011, an updated NI 43-101 Technical Report was released that updated the 2010 Technical Report while maintaining the same concentrator feed capacity.

In 2011, sinking of Shaft 2 (the main personnel, rock hoisting, and intake ventilation shaft) commenced.

In 2012, Rio Tinto became the majority shareholder of IMMI.

In 2012, IMMI was renamed Turquoise Hill Resources Ltd. and the Detailed Integrated Development and Operating Plan was prepared examining the scenario of open pit mining on the Oyut deposit and underground block caving on Hugo North Lift 1, without a plant expansion.

In November 2012, Oyu Tolgoi LLC, IMPIC and Oyu Tolgoi LLC executed the Power Purchase Agreement to supply power to Oyu Tolgoi.

In January 2013, Oyu Tolgoi processed its first ore through the concentrator, and shortly thereafter, produced the first copper-gold concentrate.

In March 2013, Detailed Integrated Development and Operating Plan and a further Technical Report (2013 Technical report) was released based on a more detailed feasibility study of open pit mining on the Oyut deposit and underground block caving of Hugo North Lift 1.

In June 2013, more than 40,000 t of concentrate had been produced. The concentrator was reported to be running at full capacity in September 2013.

In August 2013, development of the underground mine was suspended to allow matters to be resolved between the parties to the Investment Agreement, including a tax dispute, approval of the Detailed Integrated Development and Operating Plan by Oyu Tolgoi's shareholders and by the Mongolian Minerals Council, agreement of a comprehensive funding plan, and receipt of all necessary permits.

5.1.4 2014 to 2016

In 2014, the Hugo North Mineral Resource estimate was updated, and Oyu Tolgoi LLC submitted a Statutory Feasibility Study with the Mongolian Minerals Council. The Statutory Feasibility Study envisaged open pit mining on the Oyut deposit and underground block caving on Hugo North Lift 1. In addition, the study considered the development of Mineral Resources at Hugo North Lift 2, Hugo South, and Heruga). A concentrator throughput rate of 36.5 Mtpa was envisaged.

In March 2014, TRQ announced that it was continuing to work together with Rio Tinto and the Government of Mongolia with the aim of resolving outstanding shareholder matters and finalizing Oyu Tolgoi Project financing.

In October 2014, TRQ filed a Technical Report (2014 Technical Report) for the Project. The 2014 Technical Report was based on a new feasibility study prepared by Oyu Tolgoi LLC. The study envisaged the same integrated mining concept as the 2013 Technical Report.

In 2014, Oyu Tolgoi LLC produced 148,400 t of copper and 589,000 oz of gold in concentrates.

In March 2015, Oyu Tolgoi LLC filed the Statutory Feasibility Study with the Mongolian Minerals Council and in May 2015, TRQ announced the signing of the Underground Development Plan by the Government of Mongolia, TRQ and Rio Tinto (refer to Section 4), which addressed key outstanding shareholder matters and set out an agreed basis for the funding of the Project. The Statutory Feasibility Study (updated in 2016) incorporated matters resolved between the shareholders and was approved by the Oyu Tolgoi LLC board of directors and shareholders.

In August 2015, Oyu Tolgoi LLC filed revised schedules for the Statutory Feasibility Study with the Mongolian Minerals Council. The filing aligned the Statutory Feasibility Study with the Underground Development Plan.

In 2015, Oyu Tolgoi LLC produced 202,200 t of copper and produced 653,000 oz of gold in concentrate. It recorded net revenue of approximately $1.6 billion in sales on approximately 820,000 t of concentrates. Mill throughput increased by 23.9% compared to 2014, driven by operational improvements.

In May 2016, Oyu Tolgoi LLC received the formal notice to restart underground development. Underground construction began in mid-2016.

In October 2016, TRQ released a Technical Report (2016 Technical Report), which updated and replaced the 2014 Technical Report.

5.1.5 2017 to 2020

In May 2017, Oyu Tolgoi LLC signed a new power purchase agreement with the NPTG of Mongolia. The power purchase agreement was executed in connection with the power import arrangement between NPTG of Mongolia and the IMPIC.

In January 2018, Shaft 2 shaft sinking was completed, enabling shaft equipping to commence.

In March 2018, the sinking of Shaft 5 (an exhaust ventilation shaft) was completed to its final depth of 1,178 m.

In July 2018, the Shaft 5 commissioning was completed.

In October 2018, TRQ reported that Rio Tinto in its role as manager of Oyu Tolgoi and underground construction contractor had undertaken its second annual schedule and cost re-forecast for the Project (2018 Rio Tinto Review) and had notified TRQ that, based on preliminary results, the achievement of sustainable first production from Hugo North was expected to occur by the end of the third quarter of 2021 instead of the first quarter of 2021, a delay of nine months.

In December 2018, Oyu Tolgoi LLC and the Government of Mongolia announced the signing of the PSFA, which provided a binding framework and pathway forward for the construction of the TTPP and established a basis for a long-term domestic power solution for the mine.

In March 2019, TRQ announced that, following its own independent review performed after the 2018 Rio Tinto Review, the following key risks to the development of the Project were developing:

Rio Tinto

- Shaft 2 equipping delays were occurring due to lower than expected productivity in steel and electrical installation as well as increased quality assurance measures. This was likely to impact overall underground development rate increases.
- There had been delays to development progress and productivities in key areas.
- In some areas there was a delay to the critical path activities from scope growth in mass excavation and additional ground support due to unexpectedly adverse geotechnical conditions.

TRQ announced that further delays on the Shaft 2 equipping were expected to contribute to an overall delay to sustainable first production beyond the end of the third quarter of 2021. The management team was also studying relocating the ore passes on the footprint and this may modify the initiation sequence within the first panel (Panel 0) to be mined.

In July 2019, TRQ announced that improved rock mass information and geotechnical data modelling had confirmed stability risks with components of the existing mine design. To address these risks, several mine design options were under consideration to determine the final design of Panel 0, and that this work was anticipated to continue into early 2020.

TRQ also announced that preliminary estimates indicated that sustainable first production could be delayed by 16 to 30 months compared to the schedule provided in the 2016 Technical Report. The delay included a contingency of up to eight months.

In November 2019, the equipping of Shaft 2 was completed, and the shaft was in the final stages of commissioning.

In November 2019, TRQ announced that a decision had been made to retain a mid-access drive on the apex level and remove the originally planned mid-access drives on the undercut and extraction levels of Panel 0. The mid-access drives provide easy access to the levels but increase the stress concentration on the levels during the undercutting process.

In February 2020, TRQ announced the submission of the feasibility study for the TTPP to the Government of Mongolia. TRQ also announced that Oyu Tolgoi LLC would enact the contingency arrangements under the PSFA. This commenced a negotiation process to confirm a mutually acceptable pathway to secure a domestic power supply for Oyu Tolgoi.

In April 2020, Phase One of the contingency arrangements under the PSFA concluded on 14 April 2020. The parties had not been able to agree a way forward for a TTPP. This commenced Phase Two of the contingency arrangements, which is the consideration of the alternatives specified in the PSFA, including an Oyu Tolgoi mine site-based power plant, a primary renewables solution and a grid power supply.

In May 2020, TRQ announced that the updated Panel 0 mine design was approved. The approved design is based on a block cave method and includes two pillars, one to the north and one to the south of Panel 0. As a result of the updated design, a delay was anticipated to the 2016 Feasibility Study key project milestone of Sustainable Production by 25 months (with a range of 21 to 29 months) and an increase in development capital cost of $1.5 billion (with a range of $1.3 to $1.8 billion).

In June 2020 Phase Two of the contingency arrangements under the PSFA concluded. TRQ also announced that the Government of Mongolia and Oyu Tolgoi LLC reached an agreement to amend the PSFA. This amendment would prioritise a state-owned power plant.

The agreement envisages the funding and construction of the state-owned power plant by the Government of Mongolia.

In July 2020, TRQ and Rio Tinto announced that the 2020 Feasibility Study (OTFS20) was delivered to the Government of Mongolia. The announcement included updated Mineral Resources and Mineral Reserves. The OTFS20 was submitted to the Government of Mongolia to comply with local regulatory requirements.

In August 2020, TRQ lodged an NI 43-101 Technical Report (2020 Technical Report) which was released based on an integrated development plan for the Project. The 2020 Technical Report included a Mineral Reserve for the Oyut deposit based on open pit mining and a Mineral Reserve for part of the Hugo North deposit (Lift 1) based on the block caving method. The report envisaged the same plant capacity as MFS09.

In September 2020, TRQ and Rio Tinto signed a non-binding Memorandum of Understanding concerning the long-term funding of Oyu Tolgoi.

5.1.6 2021 to 2023

In April 2021, TRQ announced that it had entered into a binding Heads of Agreement with Rio Tinto to provide an updated funding plan for the completion of the Oyu Tolgoi Underground Project in Mongolia. The funding plan is designed to address the estimated remaining funding requirement of approximately $2.3 billion and replaces the non-binding Memorandum of Understanding.

In October 2021, TRQ announced an increase in the Company's base case estimated incremental funding requirement to $3.6 billion, and deferral of some open pit metal to beyond 2024. COVID-19 restrictions impacted both open pit operations and underground development, which, through the end of the third quarter of 2021, have resulted in a cumulative increase of $140 million to the estimate of underground development capital included in the Definitive Estimate, and a delayed undercut commencement pending resolution of certain non-technical undercut criteria, including the support of all Oyu Tolgoi LLC board directors to increase the underground development capital and to commence discussions with the project finance lenders, obtaining outstanding, required regulatory approvals and to agree on a pathway to meet Oyu Tolgoi's long-term power requirements.

In January 2022, TRQ and Rio Tinto announced that they had successfully reached a mutual understanding for a renewed partnership with the Government of Mongolia and the board of directors of Oyu Tolgoi LLC had unanimously approved the commencement of the undercut, namely the commencement of blasting that would start the Oyu Tolgoi underground mine production. The decision to approve the undercut followed resolution of key outstanding issues related to the Oyu Tolgoi underground mine development Project. In addition, TRQ and Rio Tinto agreed to a comprehensive and binding, amended funding arrangement that provides a pathway forward to address TRQ's estimated funding requirements.

In May 2022, TRQ announced that TRQ and Rio Tinto had agreed to an amendment to the comprehensive funding arrangement to, among other things, obtain interim debt funding from Rio Tinto to address TRQ's near-term estimated funding requirements and to extend the date by which TRQ is required to raise additional equity capital.

On 1 September 2022, TRQ announced that it had reached an agreement in principle and entered into a binding term sheet with Rio Tinto plc and Rio Tinto International Holdings Ltd. a subsidiary of Rio Tinto, in respect of a transaction whereby, among other things, Rio Tinto International Holdings Ltd. would acquire the approximately 49% of the issued and outstanding common shares of TRQ that Rio Tinto International Holdings Ltd and its affiliates do not currently own for C$43.00 per share in cash (the Arrangement). The term sheet also contemplated an updated funding plan for the completion of the TRQ's Oyu Tolgoi Underground Project in Mongolia.

On 5 September 2022, TRQ announced that it had entered into (i) a definitive arrangement agreement with Rio Tinto plc and Rio Tinto International Holdings Ltd in respect of the Arrangement and (ii) an amendment to the amended and restated heads of agreement dated 10 May 2022, between the Company and Rio Tinto International Holdings Ltd, providing for the updated funding plan for the completion of the Underground Project.

In October 2022, TRQ announced capital expenditures on the Underground Project are expected to be $1.0 billion to $1.1 billion for 2022 compared to previous guidance of $1.1 billion to $1.3 billion as a result of improvements to construction productivity and the slower ramp-up of on-site construction resources that continued during the third quarter of 2022.

At the end of 2022, a total of 19 drawbells had been fired. Drawbell progression accelerated as a result of improvement initiatives implemented by the Oyu Tolgoi teams, bringing projected first sustainable production from Panel 0 forward to the first quarter of 2023 (previously first half of 2023).

Rio Tinto now has a 66% direct interest in Oyu Tolgoi following the successful completion of the acquisition of TRQ. This is allowing Rio Tinto to focus fully on strengthening its relationship with the Government of Mongolia and moving the Project forward with a simpler and more efficient ownership and governance structure.

Table 5-1 provides a summary of work completed by previous owners. Early work was exploratory in nature and relied on geophysical surveying and drilling of reverse circulation and diamond drilling. Post discovery of the four main deposits detailed evaluation work involving diamond drilling from surface and underground together with extensive metallurgical testwork programs has informed the studies that support the current Mineral Resources and Mineral Reserves. Construction of infrastructure and mining facilities has allowed commencement of mining and processing of ores on the Property.

A summary of drilling completed across the Property is shown in Table 7-6.

Table 5-1: Summary of Oyu Tolgoi exploration and ownership history

Deposit	Current Holders	Previous Holders/ Operators	Work completed by Previous Holders/ Operators
Oyut (also previously South Turquoise or Southern Oyu including Southwest Oyu and Central Oyu)	Rio Tinto (66%) / Erdenes Oyu Tolgoi LLC (34%)	Joint Mongolian-Russian regional geochemical surveys	1980s regional geochemistry surveys outline molybdenum anomaly
		Magma Copper/BHP	1996-97 - geological mapping, stream and soil sediment surveys, magnetic and induced polarization surveys. Diamond core drill holes (DDH) (6 holes, 1,100 m). 1998 – DDH (17 holes, 2,800 m)

Deposit	Current Holders	Previous Holders/ Operators	Work completed by Previous Holders/ Operators
		Ivanhoe Mines Mongolia Inc	2000 – Reverse Circulation (RC) drilling (109 holes, 8,828 m)
			2001 – RC drilling (x holes, X m), DDH (3 holes, X m)
			2002 - US$6 million in exploration
			2006 – IMMI and Rio Tinto form strategic partnership
			Pre-stripping work for the open pit mine of Oyut (South Turquoise) deposit started in August 2011. The first ore for Oyut was extracted from the open pit in April 2012.
Hugo Dummett (Hugo South and Hugo North)	Rio Tinto (66%) / Erdenes Oyu Tolgoi LLC (34%)	IMMI	2002 Discovery hole for Hugo Dummett
			2004 IMMI entered into Joint Venture with Entrée Resources Ltd. on Shivee Tolgoi property
Heruga	Rio Tinto (66%) / Erdenes Oyu Tolgoi LLC (34%)	IMMI	2009 Discovery hole for Heruga

5.2 Development and production history

In 2010, a decision was made to construct the Oyut open pit mine and to construct a 36.5 Mtpa concentrator and supporting infrastructure. First ore was mined in 2011 and first concentrate was processed and sold in 2013 (Table 5-2).

In 2011, sinking of Shaft 2 (the main personnel, rock hoisting, and intake ventilation shaft) commenced.

In 2019, Shaft 2 construction was completed. Shafts 3 and 4 sinking commenced. In April 2020, work on Shafts 3 and 4 halted due to COVID and in March 2022, sinking operations for Shafts 3 and 4 re-commenced.

In June 2022 the first drawbell of the Hugo North Lift 1 Panel 0 Block Cave was fired and 19 drawbells had been completed by the end of 2022.

Table 5-2: Mined production since commencement of mining at Oyu Tolgoi stated as Rio Tinto share of production.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Copper ('000 tonnes)	25.7	49.8	67.8	67.5	52.8	53.3	49.1	50.2	54.6	43.4
Gold ('000 ounces)	53.0	197.3	219.0	100.5	38.3	95.7	81.1	61.0	156.9	61.6
Silver ('000 ounces)	164	299	410	476	326	306	290	293	328	292

6. Geological setting, mineralisation, and deposit

6.1 Regional geology

The Oyu Tolgoi porphyry deposits are hosted within the Gurvansaikhan Terrane, part of the Central Asian Orogenic Belt, rocks of which now comprise the South Gobi region of Mongolia (Figure 6-1).

Development of the Central Asian Orogenic Belt consisted of Palaeozoic age accretionary episodes that assembled several island and continental margin magmatic arcs, rifted basins, accretionary wedges, and continental margins. Arc development ceased by about the Permian. During the Late Jurassic to Cretaceous, north–south extension occurred, accompanied by the intrusion of granitoid bodies, unroofing of metamorphic core complexes, and formation of extensional and transpressional sedimentary basins. Northeast–southwest shortening is superimposed on the earlier units and is associated with major strike-slip faulting and folding within the Mesozoic sedimentary basins.

The Gurvansaikhan Terrane is interpreted to be a juvenile island arc assemblage that consists of highly deformed accretionary complexes and volcanic arc assemblages dominated by imbricate thrust sheets, dismembered blocks, mélanges, and high strain zones. Lithologies identified to date in the Gurvansaikhan Terrane include Silurian to Carboniferous terrigenous sediments, volcanic-rich sediments, carbonates, and intermediate to felsic volcanic rocks.

Sedimentary and volcanic units have been intruded by Devonian granitoids and Permo-Carboniferous diorite, monzodiorite, granite, granodiorite, and syenite bodies, which can range in size from dykes to batholiths.

Major structures to the west of the Gurvansaikhan Terrane include the Gobi-Tyanshine sinistral strike-slip fault system that splits eastward into a number of splays in the Oyu Tolgoi area, and the Gobi Altai Fault system, which forms a complex zone of sedimentary basins over-thrust by basement blocks to the north and northwest of Oyu Tolgoi (Figure 6-1). To the east of the Gurvansaikhan Terrane, regional structures are dominated by the northeast striking East Mongolian Fault Zone, which forms the southeast boundary of the terrane. This regional fault may have formed as a major suture during Late Palaeozoic terrane assembly, with Mesozoic reactivation leading to the formation of north-east elongate sedimentary basins along the fault trace.

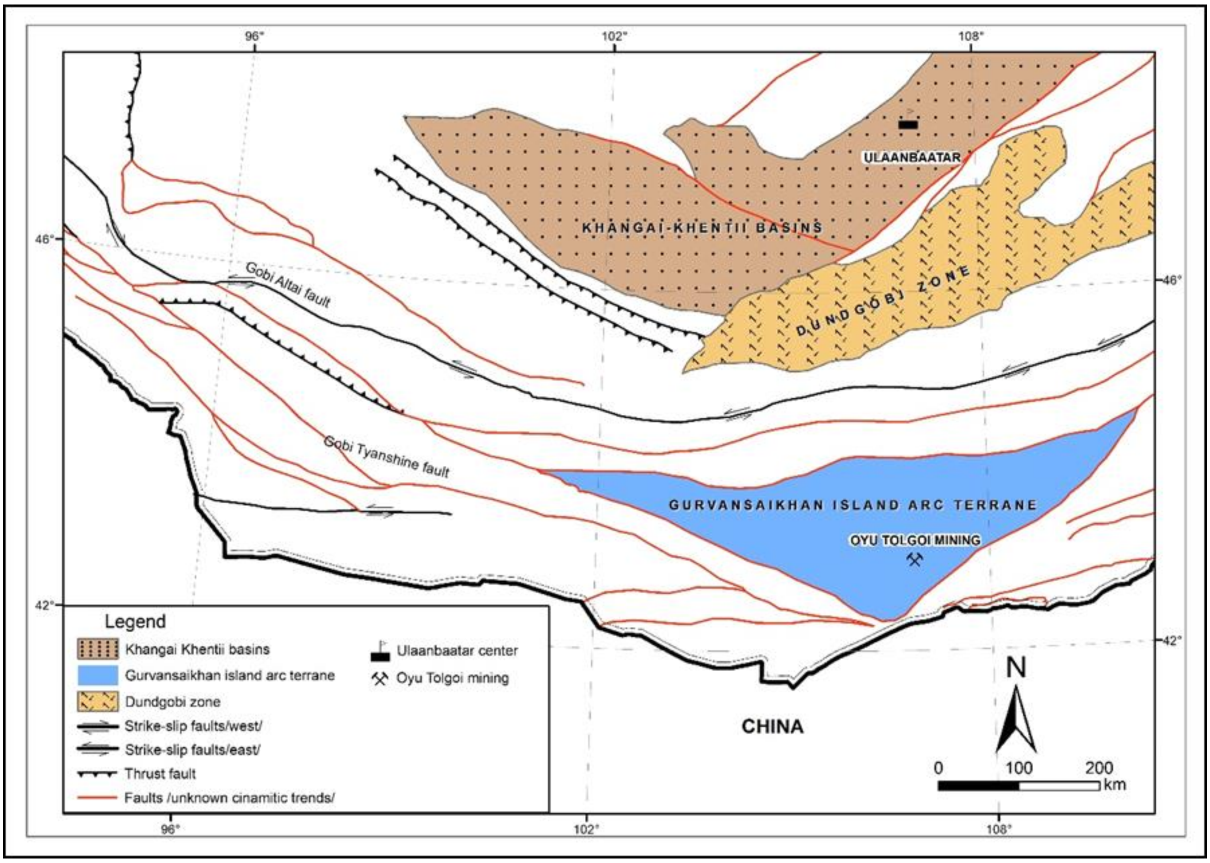

Figure 6-1: Regional geology of the Oyu Tolgoi region

6.2 District geology

6.2.1 Overview

The Oyu Tolgoi copper-gold porphyry deposits are situated in a poorly exposed inlier of Devonian mafic to intermediate volcanic, volcaniclastic, and sedimentary rocks that have been intruded by Devonian to Permian felsic plutons. These rocks are unconformably overlain by poorly consolidated Cretaceous sedimentary rocks and younger unconsolidated sedimentary deposits.

The stratigraphic sequences recognized in the Project area, from oldest to youngest, include:

- Alagbayan Group – comprising the Bulagbayan and Khalzan-Ovoo Formations that consist of tuffs, basaltic rocks, and sedimentary strata of probable island-arc affinity assigned to the Upper Devonian.
- Sainshandhudag Formation - an overlying succession containing conglomerates, fossiliferous marine siltstones, sandstones, water-lain tuffs, and basaltic to andesitic flows and volcaniclastic rocks, assigned to the Carboniferous.
- Bayanshiree Formation - overlying Upper Cretaceous clays and gravels.
- Quaternary sediments.

The Alagbayan and Sainshandhudag sequences are separated by a regional unconformity that, in the Oyu Tolgoi area, is associated with a time gap. The volcanic and sedimentary rocks are cut by several phases of intrusive rocks ranging from batholithic intrusions to narrow discontinuous dykes and sills. Compositional and textural characteristics vary.

The Project area is underlain by complex networks of poorly exposed faults, folds, and shear zones. These structures influence the distribution of mineralisation by both controlling the original position and form of mineralized bodies and modifying them during post-mineral deformation events.

The mineralized porphyry centres define a north-northeast trending corridor underlain by east-dipping panels of Upper Devonian or older layered sequences intruded by quartz-monzodiorite and granodiorite stocks and dykes (Figure 6-2).

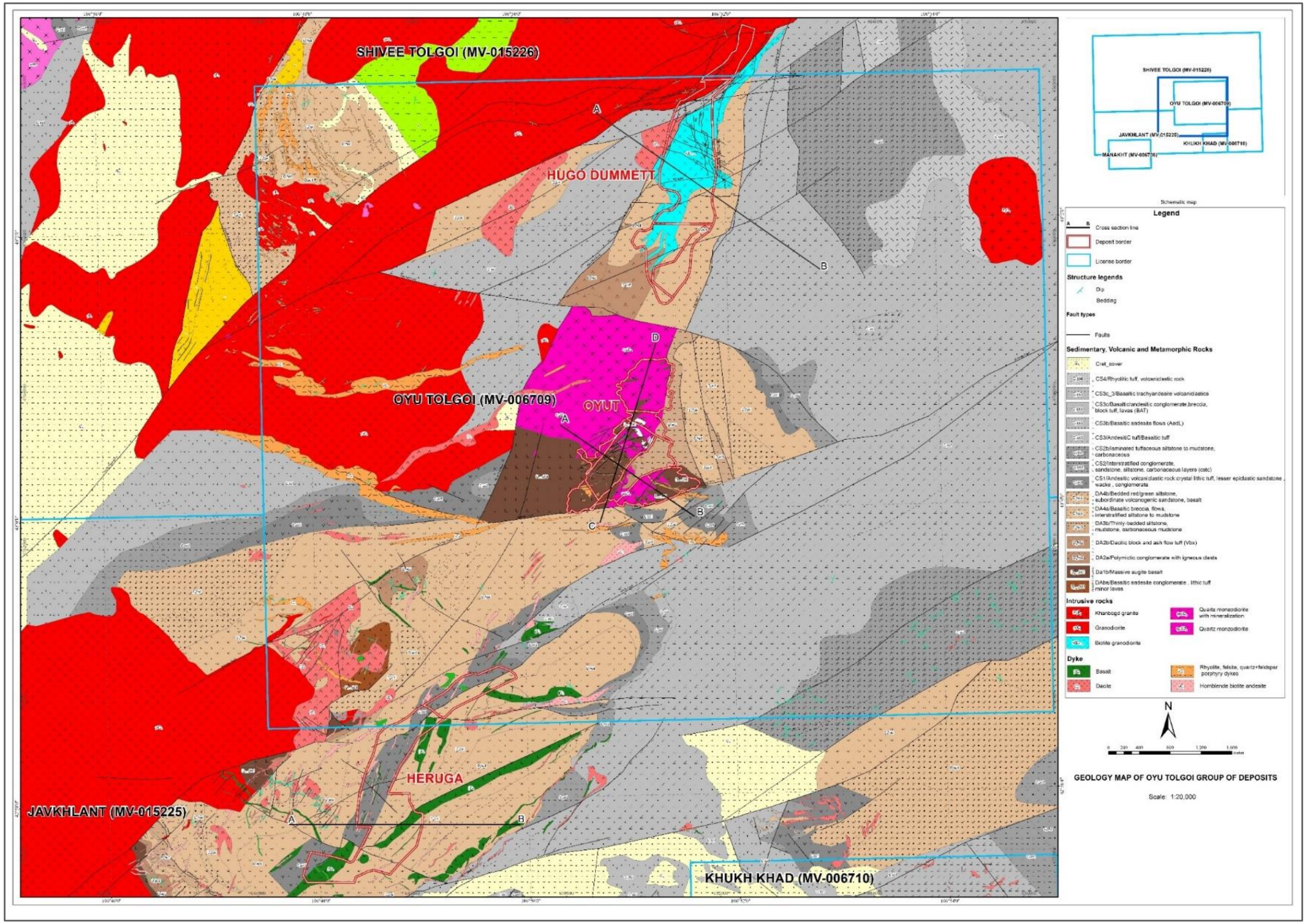

Figure 6-2: Geology map of Oyu Tolgoi licenced area

6.2.2 Sedimentary host sequence

The volcanogenic-sedimentary rocks distributed through the Oyu Tolgoi area referred to as the Upper Devonian Alagbayan group and Lower Carboniferous Gurvankharaat group (Table 6-1 and Table 6-2) because those rocks are similar to the rocks distributed in the South Mongolian volcanic zone.

6.2.2.1 Upper Devonian Alagbayan Group

The Alagbayan suite, which was first outlined by Goldenberg et al. (1978), is classified as a group consisting of the Tsavchir, Bulagbayan and Khalzan-Ovoo Formations (Minjin 2004). Only the Bulagbayan and Khalzan-Ovoo Formations are distributed in the Oyu Tolgoi area. A stratigraphic column that shows the relative thicknesses of the various lithologies in the Project area is presented in Figure 6-3.

- Bulagbuyan Formation:

  Distributed through the Alagbayan district, the formation was cross sectioned near the area of the Bulagbayan well. The lower part of the formation, approximately 750 m thick, consists of green sandstone interlayered with siltstone containing andesite, andesite-basalt, porphyry with sulfide mineralisation. Late Devonian brachiopods and faunal remains are also found. The upper part consists of basalt lapilli tuff, conglomerate containing volcanoclastics conglomerate and conglomerate-breccia.

  The formation typically corresponds to the DA1 member units and is composed of thinly bedded siltstone (DA1a), basalt with augite (DA1b) and basaltic-clastic rock (DA1c).

- Khalzan-Ovoo Formation:

  The Khalzan Ovoo Formation is distributed through the Alagbayan Mountains forming rolling hills such as Khalzan Ovoo, Shavagtai Mountain, Nuden khudag, and near Ger Chuluu well in the southeast of the Tsagaan Suvarga mine. The lower part (DA2) is 200 m thick, composed of polymictic conglomerate and a blocky tuff of dacite composition, the middle part (DA3) is 50 m to 400 m thick, comprising grey and green-grey sandstone interlayered with basalt, andesite and siltstone. The upper part (DA4) is poorly exposed in the mine area and appears to be similar to the basalt tuff unit (DA4a).

  Sediments typically correspond to the DA2-DA4 units and include tuff (DA2b2) with ash flow of dacitic composition and blocky and ashy tuffs, and flow like breccia of basaltic composition and coarse-grained volcanoclastic rocks (DA4) and red, green and variegated sedimentary series.

Table 6-1: Major units of the Alagbayan Formation

Fm	Unit	Lithologies	Description
Bulagbuyan	DA1	Basaltic flows and volcaniclastic rocks; several hundred metres in thickness.	Two subunits: Lower: grey to green, finely laminated, volcanogenic siltstone and interbedded fine sandstone (DA1a). Upper: dark green, massive porphyritic (augite) basalt. Overlies and partially intercalated with basal unit (DA1b). Basalt lapilli tuff (DA1c) overlies DA1b in some locations.

Fm	Unit	Lithologies	Description
Khalzan-Ovoo	DA2	Dacite tuff / volcaniclastic rocks; at least 200 m thick	Three subunits: Lower: monolithic to slightly polylithic basaltic lapilli tuff to volcaniclastic conglomerate/breccia. Underlies and partially intercalated with middle unit (DA2a). Middle: buff to dark green, dacite lapilli tuff. Overprinted by intense sericite and advanced argillic alteration (DA2b_1). Upper: weakly altered to unaltered polymictic block tuff to breccia, with lesser intercalated lapilli tuff (DA2b_2).
	DA3	Clastic sedimentary sequence; approximately 100 m thick	Two subunits: Polylithic conglomerate, sandstone, and siltstone. Abundant in the South zone and parts of the Hugo South deposit (DA3a). Rhythmically interbedded carbonaceous siltstone and fine brown sandstone. Ubiquitous in drill holes in Hugo North and is also discontinuously distributed in the more southerly deposits (DA3b).
	DA4	Basaltic flows / fragmental rocks, siltstone; approximately 600 m thick	Three subunits: Dark green basaltic volcanic breccia with vesicular, fine-grained to coarsely porphyritic basaltic clasts is the dominant lithotype; interlain with volcanogenic sandstones and conglomerates (DA4a). Thinly interbedded red and green siltstone, which contain subordinate basalt layers in their lower levels (DA4b). Massive green to grey sandstone with rare siltstone interbeds (DA4c).

6.2.2.2 Lower Carboniferous Gurvankharaat Group

The Gurvankharaat Group units lie to the east of the Oyu Tolgoi mineralized sequence. They were previously classified as separate units by Suetenko and Durante (1976) near Tsokhiot massive and Gurvan Kharaat Mountain on the border of Khanbogd and Manlai soums of Umnugovi Aimag but were classified as a group by Goldenberg et al. (1978). This group consists of three formations, including Sainshandkhudag, Murgutsug and Tsohiot. Lower Carboniferous rocks distributed through the Oyu Tolgoi area are referred as Sainshand Formation.

- Sainshandkhudag Formation:

  The Sainshandkhudag Formation is divided into three major units (Table 6-2) at Oyu Tolgoi:

  - Ulgii—a lowermost tuffaceous sequence (CS1)
  - Tsagaan Suvarga—an intermediate clastic package (CS2)
  - Aman-us—an uppermost volcanic/volcaniclastic sequence (CS3)

  The unit post-dates porphyry mineralisation and is separated from the underlying Devonian rocks by a regional unconformity.

Table 6-2: Major units of the Sainshandhudag Formation

Fm	Unit	Lithologies	Description
Sainshandkhudag	CS1	Andesitic lapilli tuff and volcaniclastic rocks; approximately 200 m thick	Andesitic lapilli tuff with abundant fiamme, and subordinate block tuff to breccia.
	CS2	Conglomerate, sandstone, tuff, and coal; approximately 200 m thick	Typically shows a progression from a lower conglomerate-sandstone-siltstone dominant unit (CS2a) to an overlying siltstone- waterlain tuff unit (CS2b). Carbonaceous siltstone and coal beds occur in the lower part of the sequence.
	CS3	Basaltic and andesite lava and volcaniclastic rocks; approximately 800 m thick	Four sub-units: Basal: thin volcanic sandstone (CS3a). Lower middle: discontinuous porphyritic basaltic andesitic lava sequence (CS3b). Upper middle: thick basaltic breccia-to-block tuff unit (CS3c_1). Upper: intercalated to overlying porphyritic basalt flow sequence (CS3c_2).

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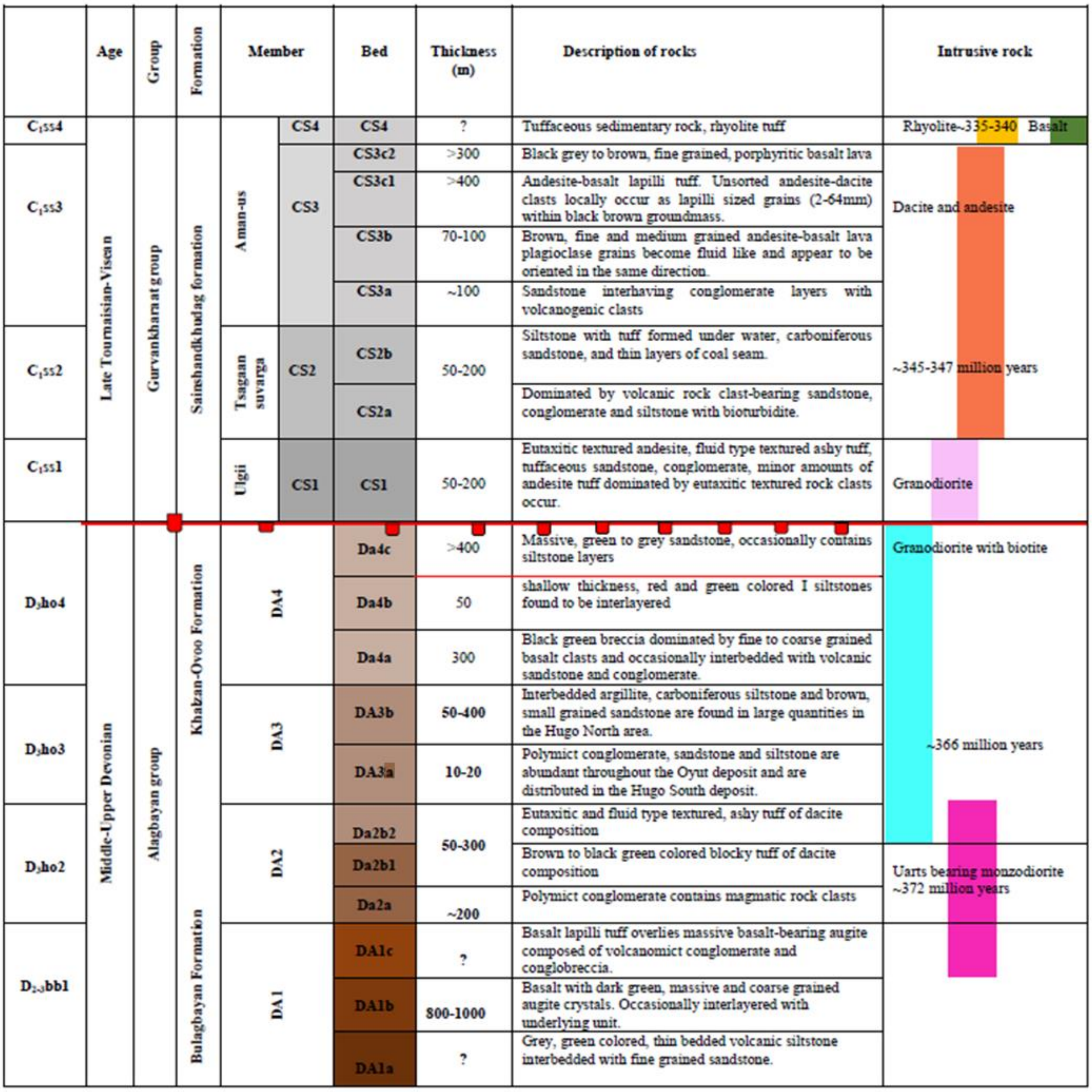

Figure 6-3: Stratigraphy of the Oyu Tolgoi area

Source: Otgonbayar at al. (2014). Note Bayanshiree and Quaternary sediments overlie this stratigraphy.

6.2.2.3 Upper Cretaceous Bayanshiree Formation

Bayanshiree Formation sediments unconformably overlie the mineralized sequence at Oyu Tolgoi and are distributed in the north of the Oyu Tolgoi deposit. They were initially mapped (1:200,000 scale) as individual Bayanshiree Formations by Burenkhuu et al. (1995). The Formation sediment is composed of uncemented or weakly cemented, dark-brown, reddish-yellow clay and clayey gravel and is locally poorly sorted with occasional coarse gravels. These sediments overlay secondary enrichment and weathering zones and are in turn overlain by quaternary sediments.

6.2.3 Intrusive rock

Intrusive rocks are widely distributed through the Project area and range from large batholithic intrusions to narrow discontinuous dykes and sills. At least seven classes of intrusive rocks are recognised based on compositional and textural characteristics. Intrusive composition, structure, texture, distribution and ages are presented in Table 6-3.

Copper-gold porphyry mineralisation is related to the oldest recognized intrusive suite, consisting of large Devonian quartz-monzodiorite intrusions that occur in the deposit areas.

Table 6-3: Major intrusive rock units

Unit	Lithologies	Age	Description
Intrusions	Quartz-monzodiorite to monzodiorite	371 ± 2 Ma	Texturally and compositionally varied. Typically, phenocryst-crowded, with >40% plagioclase phenocrysts up to 5 mm long, and 10–15% biotite and hornblende. Abbreviated to QMD.
Intrusion, dykes and sills	Biotite granodiorite	366 ± 4 Ma	Contain large plagioclase phenocrysts with lesser small biotite phenocrysts, within a fine-grained to aphanitic brown groundmass. Intrusions are compositionally and texturally varied and probably include several intrusive phases. Forms a large stock at Hugo North (BiGd).
Intrusions	Syenite, granite, quartz-monzonite, quartz diorite, and quartz syenite	348 ± 3 Ma	Large, polyphase granitic complex bounding the Project to the northwest.
Dykes	Hornblende-biotite andesite and dacite	343 ± 3 Ma	Typically, strongly porphyritic with feldspar, hornblende, and biotite. Quartz phenocrysts are common.
Dykes and sills	Rhyolite; range from metres to a few tens of metres wide	320 ± 10 Ma	Aphanitic and aphyric. Intrusive breccias are common along dyke contacts, commonly incorporating both rhyolitic and wall rock fragments within a flow banded groundmass.
Dykes	Basalt/dolerite; in deposit area range from metres to a few tens of metres wide; in southwest part of the Project area can occur as large, sill-like intrusive masses	Carboniferous	Intrude all stratified units. Typically, aphanitic to fine-grained, locally vesicular, and contain variable amounts of plagioclase phenocrysts.
Intrusions	Alkaline granite	Permian	Large, circular intrusion exposed just east of the Project that is defined by abundant pegmatite dykes.

6.2.4 Structural setting

Variations in bedding attitude recorded in both oriented drill core and surface outcrops define two orientations of folds at Oyu Tolgoi: a dominant set of northeast trending folds, and a less-developed set of northwest trending folds. These folds are well defined in bedded strata of both the Sainshandhudag Formation and Alagbayan Group. They may be present in stratified rocks throughout the Oyu Tolgoi Property, but outcrop and drill hole data are insufficient to define them in many areas. There is no evidence of a penetrative fabric (e.g., cleavage) associated with folding.

Together, the two orientations of folds form a dome-and-basin interference pattern, but it is not possible to determine their relative ages. Both dominant fold orientations occur in Lower Carboniferous strata, indicating that both folding events post-date mineralisation.

Sedimentary facing direction indicators, including grading, scour and fill structures, load casts, and crossbedding, are sporadically observed in drill core by Oyu Tolgoi geologists along the east flank of the Hugo Dummett deposits. These suggest that parts of the Alagbayan Group are overturned. However, no large isoclinal folds have been mapped from drill core. These folds are cut by dykes of the 366 Ma biotite-granodiorite suite and therefore were formed within the Late Devonian. Such folds and geopetal features are difficult to ascribe to regional tectonic events and may simply be localized features of rapid facies changes in a proximal submarine volcanic environment.

The Project area is underlain by complex networks of faults, folds, and shear zones. Most of these structures are poorly exposed on surface and have been defined through integration of detailed exploration data (primarily drill-hole data), property-scale geological mapping, and geophysical data. There is evidence for several phases of deformation and reactivation of the early faults during later deformational events.

6.3 Local geology

Oyu Tolgoi consists of Oyut, Hugo Dummett (Hugo South and Hugo North) and Heruga deposits. In this section a discussion of the geology and mineralisation at each deposit is discussed. The Oyu Tolgoi copper-gold deposits currently comprise, from north to south:

- Hugo North – The Hugo Dummett Deposit north of approximately 4766300 N (or the 110 Fault).
- Hugo South - The Hugo Dummett Deposit south the 110 Fault.
- Oyut - The Oyut Deposit includes the Southwest Oyu, South Oyu, Wedge, Central Oyu, Bridge, Western, and Far South zones within mining licence MV-006709.
- Heruga – is within the area governed by the arrangements between Oyu Tolgoi LLC and Entrée Resources Ltd. except for a small northern portion that lies within the Oyu Tolgoi mining licence MV-006709.

A long section showing the spatial distribution of the Oyu Tolgoi deposits is shown in Figure 6-4.

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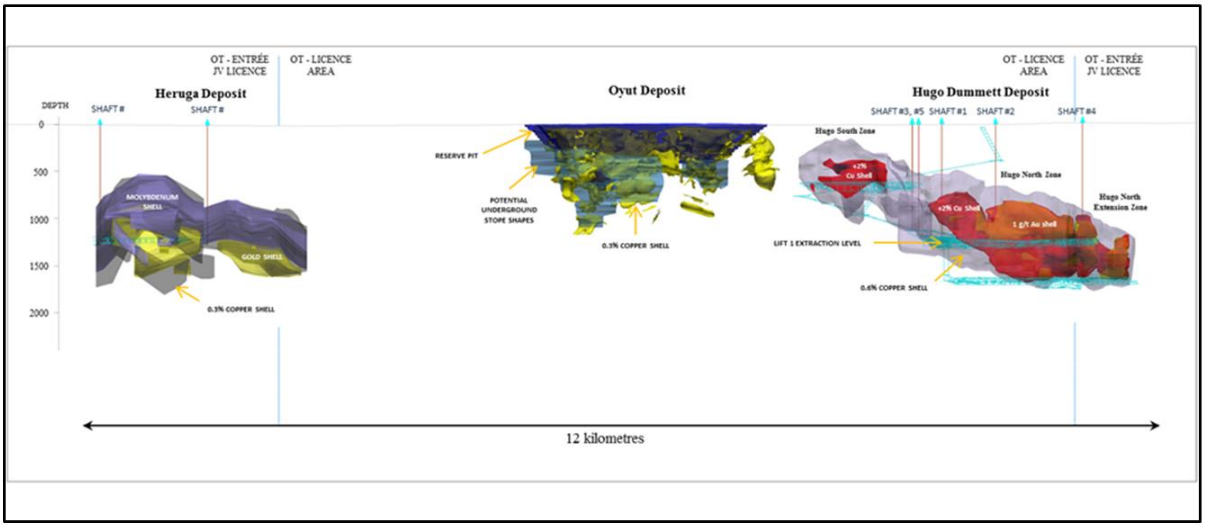

Figure 6-4: Idealized view of the Oyu Tolgoi mineral deposits (long-section looking west)

6.3.1 Hugo Dummett deposits

The Hugo Dummett deposits, Hugo North and Hugo South, contain porphyry-style mineralisation associated with quartz-monzodiorite intrusions, concealed beneath a sequence of Upper Devonian and Lower Carboniferous sedimentary and volcanic rocks. The deposits are highly elongated to the north-northeast and extend over 3 km.

The Hugo North zone is virtually contiguous with the Hugo South zone and lie within a similar geological setting. The two deposits are separated by a 110°-striking, 45° to 55° north-dipping fault that displaces Hugo North vertically down a modest distance from Hugo South. The dividing line between the two deposits is approximately 4766300 N, a location marked by the thinning and locally discontinuous nature of the high grade copper mineralisation (defined by greater than 2% copper). The east-striking 110° Fault (Figure 6-5) for the projections of the major faults in the area of the Hugo Dummett deposits), delineates the gold- and copper-rich zone hosted in augite basalt and quartz–monzodiorite of the Hugo North deposit from the more southerly, gold-poor, ignimbrite- and augite basalt-hosted mineralisation at Hugo South.

The quartz monzodiorite bodies are contemporaneous with alteration and mineralisation. The quartz monzodiorite is considered to be the progenitor porphyry, and two zones are distinguished on the basis of alteration characteristics and position within the deposit.

A late to post-mineralisation biotite-granodiorite intrusion forms a northerly striking dyke complex cutting across the western edge and deeper levels of the deposit. At higher levels, the biotite-granodiorite flares out considerably to form a voluminous body (Figure 7.6). Although this intrusion locally contains elevated copper grades adjacent to intrusive contacts or within xenolith-rich zones, it is essentially barren.

Based on correlations between drill hole intersections and measurements of individual contacts using oriented drill core, the positions and orientations of dyke contacts are reasonably well established in the Hugo North deposit area. Dominant dyke orientation varies with depth. At levels above approximately 250 mRL, where the biotite-granodiorite cuts through the non-mineralized hanging wall strata, it is present as a single intrusive mass with contacts dipping moderately to steeply to the west. The hanging wall sequence model should identify the nature of the contact between the hanging wall strata and the biotite-granodiorite and assist in modelling the subsidence zone. Below this level, the biotite-granodiorite is more complex, found as multiple and sub-parallel to anastomosing dykes that cut through the quartz monzodiorite intrusion and mineralized Alagbayan Group strata.

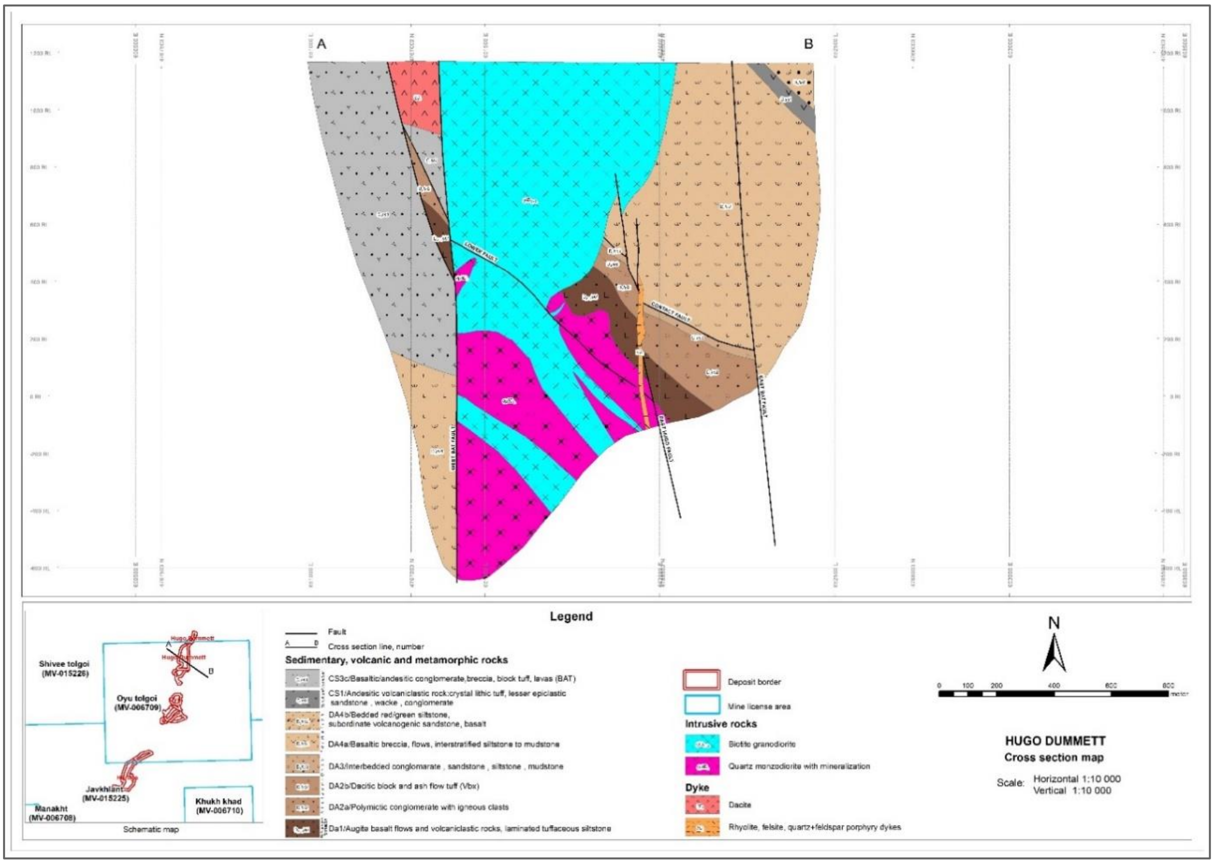

Figure 6-5: Idealized view of the Oyu Tolgoi mineral deposits (long-section looking west)

The highest-grade copper mineralisation in the Hugo North deposit is related to a zone of intensely stockworked to sheeted quartz veins known as the QV90 zone, so named because >90% of the rock has >15% quartz veining. The high grade zone is centred on thin, east dipping quartz monzodiorite intrusions or within the apex of the large quartz monzodiorite body and extends into the adjacent basalt. In addition, moderate-to-high grade copper and gold values occur within quartz monzodiorite below and to the west of the intense vein zone, in the Hugo North gold zone. This zone is distinct and has a high gold (Au parts per million (ppm)) to copper (Cu%) ratio of 0.5 to 1.

6.3.2 Oyut deposit

The Oyut deposit includes the most mineralized domain called Southwest Oyu (Southwest), but also includes South Oyu (South), Wedge, and Central Oyu (Central) domain (Figure 6-6) and several smaller, fault-bounded zones. The open pit incorporates most of these domains. They form contiguous sectors of mineralisation representing multiple mineralizing centres, each with distinct styles of mineralisation, alteration, and host rock lithology. The boundaries between the individual zones coincide with major faults. Faulting has resulted in different erosional histories for the zones, depending on the depth to which a zone has been downfaulted or uplifted relative to neighbouring zones. Geological mapping of the pit walls is compiled in the plan and section views shown in Figure 6-7.

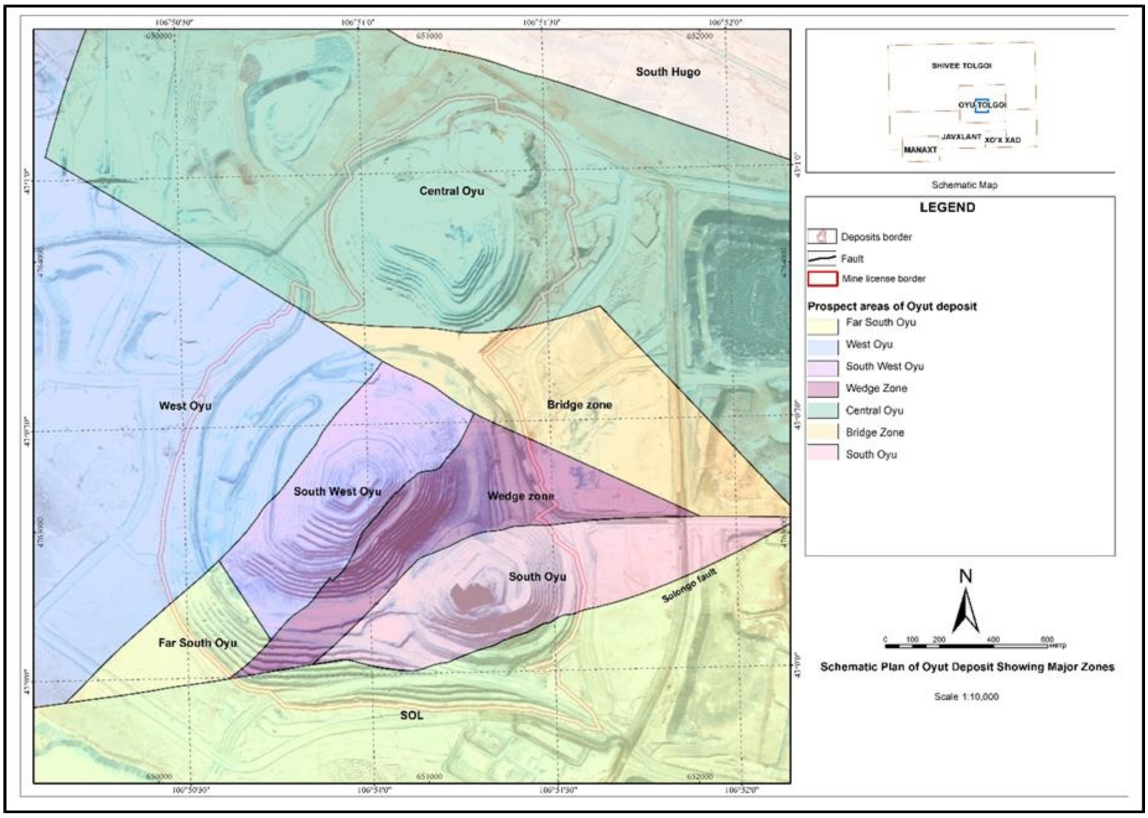

Figure 6-6: Oyut deposit schematic plan showing major zones

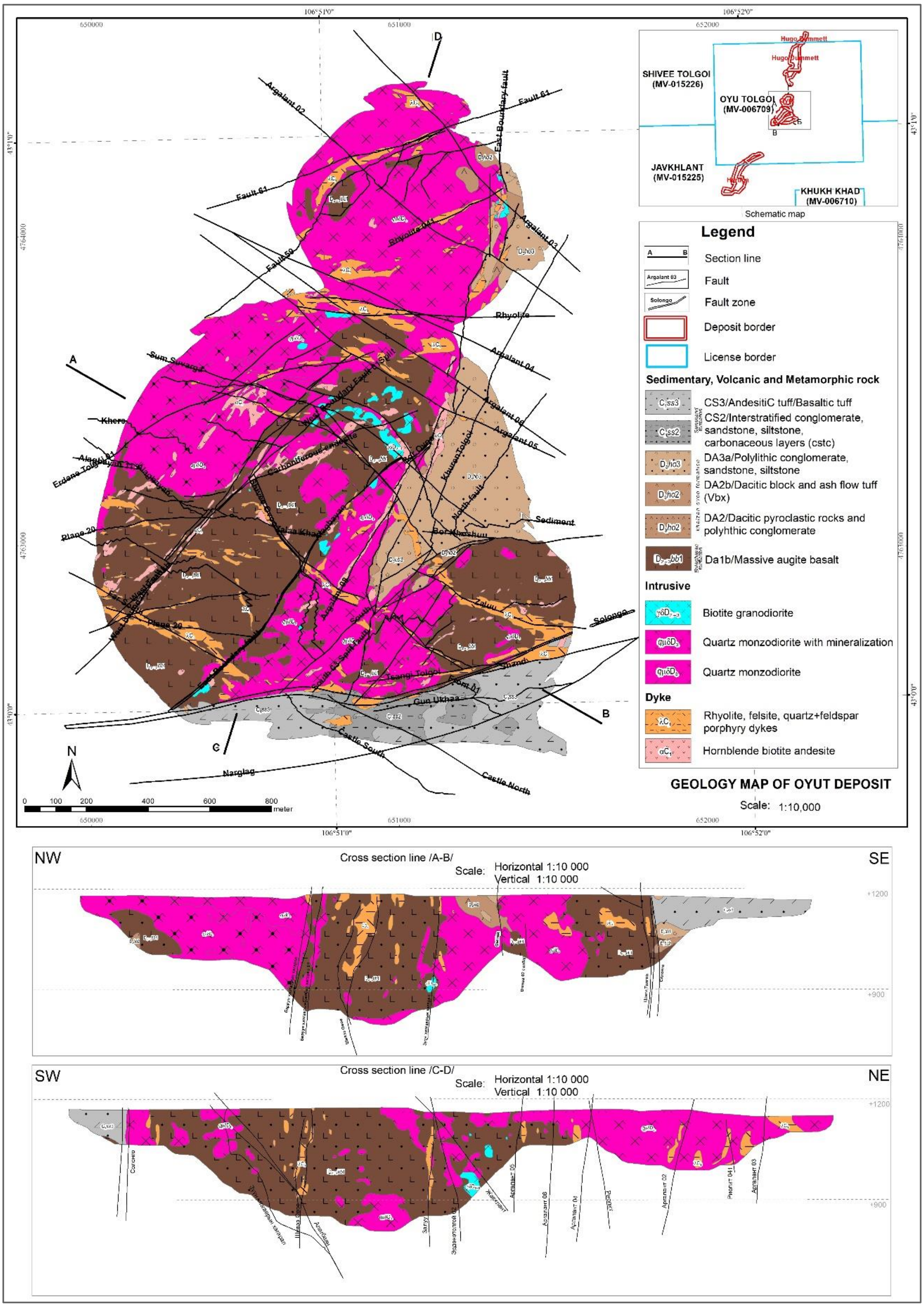

Figure 6-7: Oyut deposit geological map and cross-sections

6.3.2.1 Southwest Oyu zone

The Southwest Oyu zone is a gold-rich porphyry system characterized by a southwest–plunging, pipe-like geometry that has a vertical extent of as much as 700 m. The high grade core of the zone is about 250 m diameter; the low grade shell (0.3% Cu) surrounding the core may extend for distances as much as 600 m by 2 km.

Over 80% of the deposit is hosted by massive to fragmental porphyritic augite basalt of the Upper Devonian Alagbayan Group, with the remainder hosted by intra-mineral, Late Devonian quartz-monzodiorite intrusions. The quartz-monzodiorite intrusions form irregular plugs and dykes related to several distinct phases:

- Early, strongly altered quartz-veined dykes mainly limited to the high grade Central deposit core (informally referred to as OT–QMD).
- Superimposed younger fragmental dykes entraining early quartz vein clasts but lacking strong sulfide mineralisation (informally referred to as xQMD).
- Voluminous massive quartz-monzodiorite (informally referred to as QMD) containing weaker mineralisation, flanking and underlying the high grade deposit core.

Several phases of post-mineral dykes cut the Southwest zone. Most of the dykes belong to the rhyolite, hornblende-biotite andesite, or biotite granodiorite intrusive phases. Dykes commonly have steep dips, and many are localized along faults. The rhyolite dykes tend to strike west to west-northwest in the deposit core and northeast when emplaced along major faults. Hornblende-biotite andesite dykes strike east-northeast except where they intrude along the major northeast trending faults.

Most of the Southwest zone, including the entire high grade, gold-rich core of the zone, lies between two northeast striking faults, termed the West Bounding Fault and the East Bounding Fault. Both faults are clearly defined on ground-magnetic geophysical images, and their positions and orientations are well constrained by numerous drill hole intersections.

The bounding faults consist of foliated cataclasite, gouge/breccia, and mylonitic bands that occur in zones ranging from a few metres to a few tens of metres wide. The cataclasite within the fault zones contains abundant quartz, quartz sulfide, and sulfide (pyrite, chalcopyrite, sphalerite, and galena) clasts in a comminuted matrix that is locally overprinted by fine-grained pyrite and chalcopyrite. These relationships imply that at least some of the fault movement was contemporaneous with mineralisation. Kinematic indicators within the fault zones imply dominantly sub-horizontal, sinistral movement on the bounding faults. Both faults have local subparallel splays. Correlation of drill hole intersections constrains an average fault dip of 80° towards 310° for both faults.

The East Bounding Fault juxtaposes younger rocks to the southeast against the Alagbayan Group rocks (augite basalt) hosting the deposit, while the West Bounding Fault is mainly intra-formational within the augite basalt. The West Bounding Fault is commonly intruded by hornblende-biotite andesite dykes, whereas rhyolite dykes are more common along the East Bounding Fault.

6.3.2.2 Central Oyu zone

The Central zone is about 2,300 m wide and tapers from about 200 m long in the east to more than 600 m to the west (Figure 7.6). Mineralisation extends to depths of over 500 m.

The Central zone is hosted within a swarm of feldspar-phyric quartz-monzodiorite intrusions, emplaced into porphyritic augite basalt and overlying basaltic tuff of the Alagbayan Group. The basaltic tuff is in turn overlain by unmineralized sedimentary and mafic volcanic rocks of the Alagbayan Group unit DA4, which dip moderately to the east (30–60°).

Several phases of intra-mineral and late-mineral quartz-monzodiorite intrusions have been distinguished in the Central zone based on textural variations and intensity of mineralisation and alteration. Most have dyke forms, emanating from a larger intrusive mass to the north and west of the deposit area. The quartz-monzodiorite dykes terminate within the base of the sedimentary units of the upper Alagbayan Group.

6.3.2.3 South Oyu zone

The South Oyu zone is developed mainly in basaltic volcanics and related to small, strongly-sericite altered quartz–monzodiorite dykes. Zone dimensions are about 400 m by 300 m in area, and mineralisation extends to depths of more than 500 m.

6.3.3 Heruga

The Heruga deposit is the most southerly of the currently known deposits at Oyu Tolgoi. The deposit is a copper–gold–molybdenum porphyry deposit and is zoned with a molybdenum-rich carapace at higher elevations overlying gold-rich mineralisation at depth. The top of the mineralisation starts 500–600 m below the present ground surface. The deposit has been drilled over a 2.3 km length, is elongated in a north–northeast direction and terminates to the north on an east–northeast-trending regional fault with 500 m of apparent dextral displacement.

Quartz monzodiorite intrudes the Devonian augite basalts as elsewhere in the district, and again are the progenitors of mineralisation and alteration. The quartz monzodiorite intrusions are small compared to the stocks present in the Hugo Dummett and Oyut areas, perhaps explaining the lower grade of the Heruga deposit. Non-mineralized dykes, comprising about 15% of the volume of the deposit, cut all other rock types.

The deposit is transected by a series of north–northeast trending vertical fault structures that step down 200 m to 300 m at a time to the west and have divided the deposit into at least two structural blocks.

Mineralized veins have a much lower density at Heruga than in the more northerly Oyut and Hugo Dummett deposits. High grade copper and gold intersections show a strong spatial association with contacts of the mineralized quartz monzodiorite porphyry intrusion in the southern part of the deposit, occurring both within the outer portion of the intrusion and in adjacent enclosing basaltic country rock.

At deeper levels, mineralisation consists of chalcopyrite and pyrite in veins and disseminated within biotite–chlorite–albite–actinolite-altered basalt or sericite–albite-altered quartz monzodiorite. The higher levels of the orebody are overprinted by strong quartz–sericite–tourmaline–pyrite alteration where mineralisation consists of disseminated and vein-controlled pyrite, chalcopyrite and molybdenite.

There is no oxide zone at Heruga, nor is there any high sulphidation style mineralisation known to date.

6.4 Deposit types

6.4.1 Geological model of typical porphyry copper systems

The information in Section 6.4 is collated from geological and technical reports completed on the Project during the period 2003 to 2019, the PhD thesis completed by Alan Wainwright in 2008, and other sources as noted.

The discussion of the typical nature of porphyry copper deposits is sourced from Sillitoe (2010), Singer et al. (2008), and Sinclair (2007).

The Oyu Tolgoi deposits are characterised as copper-gold porphyry and related high sulfidation copper-gold deposit styles.

Porphyry copper systems commonly define linear belts, some many hundreds of kilometres long, and some occurring less commonly in apparent isolation. The systems are closely related to underlying composite plutons, at paleo-depths of 5 to 15 km, which represent the supply chambers for the magmas and fluids that formed the vertically elongate (>3 km) stocks or dyke swarms and associated mineralisation.

Commonly, several discrete stocks are emplaced in and above the pluton roof zones, resulting in either clusters or structurally controlled alignments of porphyry copper systems. The rheology and composition of the host rocks influence the size, grade, and type of mineralisation generated in porphyry copper systems. Individual systems have life spans of circa 100,000 years to several million years, whereas deposit clusters or alignments, as well as entire belts, may remain active for 10 Ma or longer.

Deposits are typically semi-circular to elliptical in plan-view. In cross-section, ore-grade material in a deposit typically has the shape of an inverted cone with the altered, but low grade, interior of the cone referred to as the “barren” core. In some systems, the barren core may be a late-stage intrusion.

The alteration and mineralisation in porphyry copper systems are zoned outward from the stocks or dyke swarms, which typically comprise several generations of intermediate to felsic porphyry intrusions. Porphyry copper-gold-molybdenum deposits are centred on the intrusions, whereas carbonate wall rocks commonly host proximal copper-gold skarns and less commonly, distal base metal and gold skarn deposits. Beyond the skarn front, carbonate-replacement copper or base metal–gold deposits, and sediment-hosted (distal-disseminated) gold deposits can form. Peripheral mineralisation is less conspicuous in non-carbonate wall rocks but may include base metal or gold-bearing veins and mantos. Data compiled by Singer et al. (2008) indicate that the median size of the longest axis of alteration surrounding a porphyry copper deposit is 4 to 5 km, while the median area of alteration is 7 to 8 km^2.

High sulfidation epithermal deposits may occur in lithocaps above porphyry copper deposits, where massive sulfide lodes tend to develop in their deeper feeder structures, and precious metal-rich, disseminated deposits form within the uppermost 500 m.

Figure 6-8 shows a schematic section of a porphyry copper deposit, illustrating the relationships of the lithocap to the porphyry body and associated mineralisation styles.

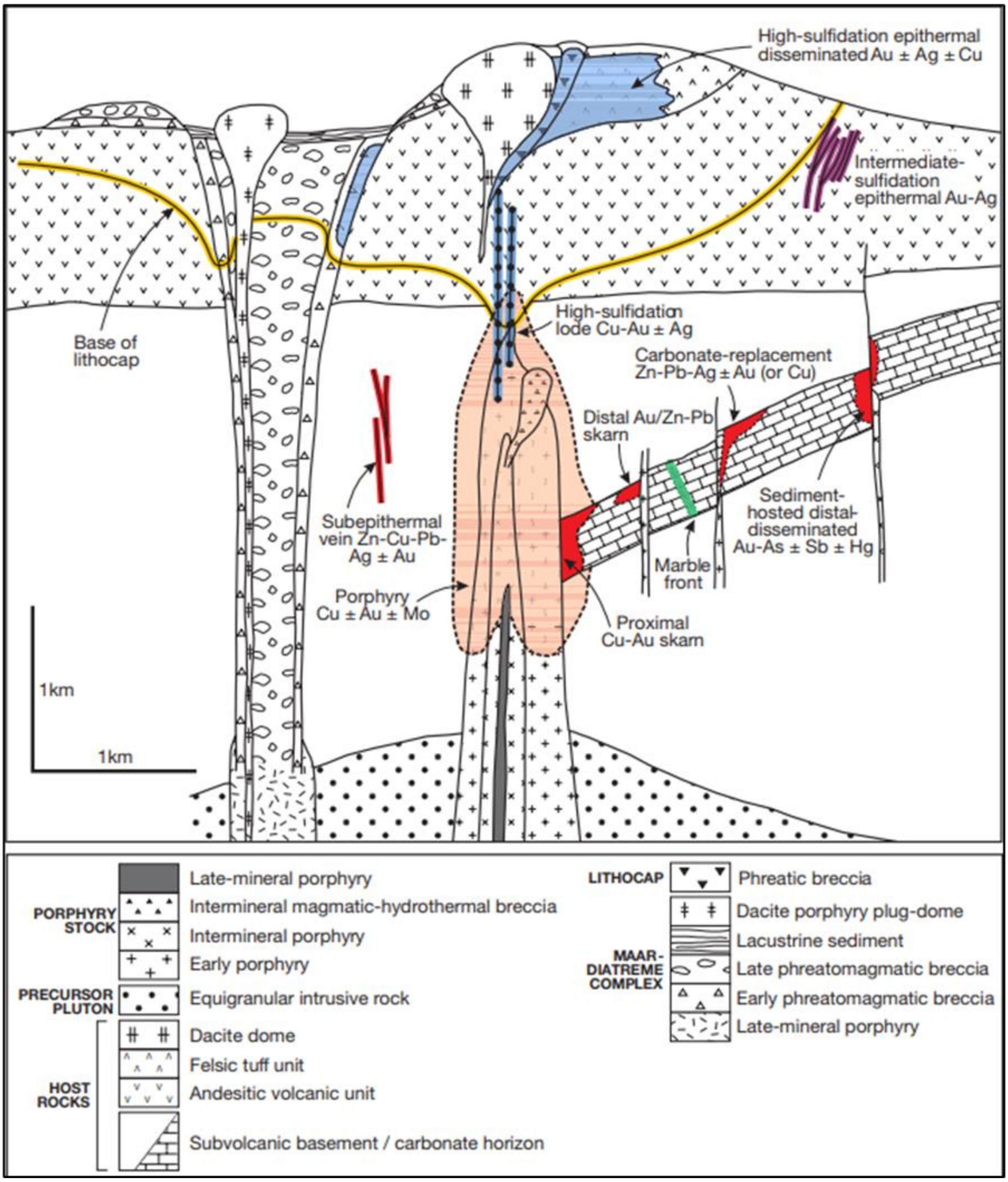

Figure 6-8: Schematic section of porphyry copper deposit (source: Sillitoe, 2010)

6.4.2 Porphyry copper mineralisation

Porphyry copper mineralisation occurs in a distinctive sequence of quartz-bearing veinlets as well as in disseminated forms in the altered rock between them. Magmatic-hydrothermal breccias may form during porphyry intrusion, with some breccias containing high grade mineralisation because of their intrinsic permeability. In contrast, most phreatomagmatic breccias, constituting maar-diatreme systems, are poorly mineralized at both the porphyry copper and lithocap levels, mainly because many such phreatomagmatic breccias formed late in the evolution of systems, and the explosive nature of their emplacement fails to trap mineralizing solutions.

Copper mineral assemblages are a function of the chemical composition of the fluid phase and the pressure and temperature conditions affecting the fluid. In primary, unoxidized or non-supergene-enriched ores, the most common sulfide assemblage is chalcopyrite ± bornite, with pyrite and minor amounts of molybdenite. In supergene-enriched ores, a typical assemblage can comprise chalcocite + covellite ± bornite, whereas in oxide ores a typical assemblage could include malachite + azurite + cuprite + chrysocolla, with minor amounts of minerals such as carbonates, sulfates, phosphates, and silicates. Typically, the principal copper sulfides consist of millimetre scale grains but may be as large as 1 to 2 cm in diameter and, rarely, pegmatitic (larger than 2 cm).

6.4.3 Alteration zones

Alteration zones in porphyry copper deposits are typically classified based on mineral assemblages. In silicate-rich rocks, the most common alteration minerals are potassium (K) - feldspar, biotite, muscovite (sericite), albite, anhydrite, chlorite, calcite, epidote, and kaolinite. In silicate-rich rocks that have been altered to advanced argillic assemblages, the most common minerals are quartz, alunite, pyrophyllite, dickite, diaspore, and zunyite. In carbonate rocks, the most common minerals are garnet, pyroxene, epidote, quartz, actinolite, chlorite, biotite, calcite, dolomite, K-feldspar, and wollastonite. Other alteration minerals commonly found in porphyry copper deposits are tourmaline, andalusite, and actinolite. Figure 6-9 shows the typical alteration assemblage of a porphyry copper system.

Porphyry copper systems are initiated by injection of oxidized magma saturated with sulphur-rich and metal-rich, aqueous fluids from cupolas on the tops of the subjacent parental plutons. The sequence of alteration and mineralisation events is principally a consequence of progressive rock and fluid cooling, from >700 °C to <250 °C, caused by solidification of the underlying parental plutons and downward propagation of the lithostatic-hydrostatic transition. Once the plutonic magmas stagnate, the high temperature, generally two phase hyper-saline liquid and vapour responsible for the potassic alteration and contained mineralisation at depth and early overlying advanced argillic alteration, respectively, gives way, at <350 °C, to a single-phase, low to moderate salinity liquid that causes the sericite-chlorite and sericitic alteration and associated mineralisation. This same liquid also is a source for mineralisation of the peripheral parts of systems, including the overlying lithocaps.

The progressive thermal decline of the systems combined with syn-mineralisation paleo-surface degradation results in the characteristic overprinting (telescoping) and partial to total reconstitution of older by younger alteration and mineralisation types. Meteoric water is not required for formation of this alteration and mineralisation sequence, although its late ingress is commonplace.

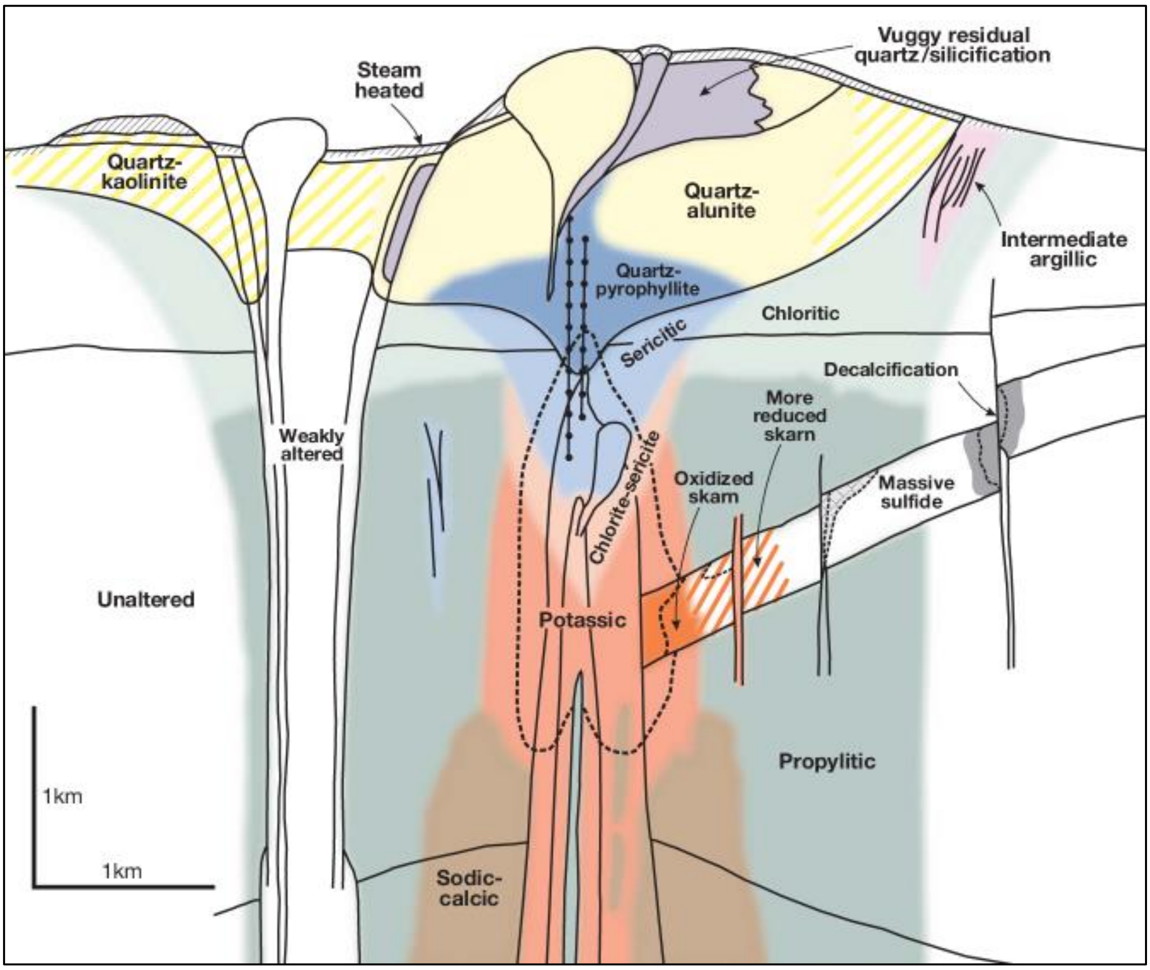

Figure 6-9: Generalized alteration-mineralisation zoning pattern for telescoped porphyry copper deposits (Sillitoe, 2010)

6.5 Applicability of porphyry copper model to Oyu Tolgoi

Features that classify the Oyu Tolgoi deposits as porphyry copper-type deposits include:

- Mineralisation is in or adjoining porphyritic intrusions of quartz monzodiorite composition.
- Multiple emplacements of successive intrusive phases and a variety of breccias are present.
- Mineralisation is spatially, temporally, and genetically associated with hydrothermal alteration of the intrusive bodies and host rocks.
- Large zones of veining and stockwork mineralisation, together with minor disseminated and replacement mineralisation, occur throughout large areas of hydrothermally altered rock, commonly coincident wholly or in part with hydrothermal or intrusion breccias.
- Hydrothermal alteration is extensive and zoned, which is common to porphyry copper deposits. Major alteration minerals in the biotite-chlorite, intermediate argillic, sericite, and K-feldspar alteration zones include quartz, chlorite, sericite, epidote, albite, biotite, hematite-magnetite, pyrophyllite, illite, and carbonate. Advanced argillic alteration zones can contain minerals such as kaolinite, zunyite, pyrophyllite, muscovite, illite, topaz, diaspore, andalusite, alunite, montmorillonite, dickite, tourmaline, and fluorite. In the leached cap, smectite and kao-smectite can also occur. The alteration assemblages are consistent with the physio-chemical conditions of a porphyry environment.

- Pyrite is the dominant sulfide, reflecting the typical high sulphur content of porphyry copper deposits. The major ore minerals include chalcopyrite, bornite, chalcocite, covellite, and enargite. In some zones, minerals such as tennantite, tenorite, cubanite, and molybdenite have been identified. Gold typically occurs as inclusions in the sulfide minerals.
- Copper grades are typical of the range of porphyry copper grades (0.2% Cu to >1% Cu).

The Oyu Tolgoi porphyry copper deposits display a range of mineralisation styles, alteration characteristics, and deposit morphologies that are likely to reflect differences in structural controls, host rock lithology, and depth of formation. For the most part, structural influences account for the differences in shape and distribution of mineralisation within the deposits. The more typical copper-gold porphyry style alteration and mineralisation tend to occur at deeper levels, predominantly within quartz monzodiorite extending into the host basaltic rocks.

High sulfidation mineralisation and associated advanced argillic alteration are most common within the wall rocks (basaltic tuffs and fragmental rocks) to the quartz monzodiorite, where it intrudes to levels high in the stratigraphic succession and in narrow structurally controlled zones. High sulfidation mineralisation often forms in steam condensate zones and then collapses back into the hypogene zone, causing overprinting and textural destruction.

The Hugo Dummett deposits have several features that are unusual when compared with typical porphyry copper systems, including:

- Anomalously high copper and gold grades, particularly in the northern part.
- An unusually weakly altered pre-mineralisation volcano-sedimentary cover sequence that lies just above the porphyry system.
- Quartz + sulfide vein contents commonly exceeding 15%, and locally in excess of 90%, in the high grade part of the deposit.
- A highly elongate, gently plunging tabular shape to the high grade stockwork system.

The formation of the known, 800 m extent, high grade portion of the Hugo Dummett deposits as a tabular, intensely veined, sub-vertical body contrasts markedly with most porphyry copper deposits, which tend to have steep, roughly cylindrical, or elongate forms. The unusual form of the Hugo Dummett deposits could be the result of emplacement within a structurally restricted zone. The lack of alteration in the overlying sequence is likely a reflection of the chemical inertness of the siltstone sequences.

The Heruga deposit is also slightly unusual in that, unlike the other Oyu Tolgoi deposits, it has distinctly higher grades of molybdenum, which form a molybdenum-rich carapace at higher elevations overlying gold-copper–rich mineralisation at depth.

7. Exploration

Exploration activities have been undertaken by Rio Tinto subsidiary companies, its precursor companies, consultants, and contractors (e.g., geophysical surveys).

Currently, exploration within the Project area is focused on the identification of new target areas and extensions to known deposits.

7.1 Fundamental data

7.1.1 Grids and surveys

The boundary coordinates of the mining and exploration licences are defined by latitude and longitude coordinates. The official Mongolian survey datum was MSK42 using the Baltic mean sea level as the elevation datum and used until 2011. The coordinates used by Oyu Tolgoi LLC and its predecessors, for exploration are mostly UTM coordinates with the datum set to WGS 84 / UTM zone 48N.

In 2014, 8,760 hectares of land was mapped using an unmanned drone (Gatewing H100) to generate topography to 0.5 m accuracy. Flight height was 250 m high and with a 70% coverage overlap. The survey was conducted in Universal Trans-Mercator (UTM) (WGS 84 / zone 48N) with altitude for Baltic Sea Height datum.

In 2017, a further topographical mapping exercise was carried out, this time using the Trimble UX5 unmanned aircraft system. Flight altitude was 350 m, with a horizontal and vertical overlap of 75%.

7.2 Imaging

Satellite imaging has been used throughout the history of the Project to provide regional and detailed geological information.

Since 2017, Interferometric Synthetic Aperture Radar (InSAR) data is obtained on an 11-day cycle to detect and monitor surface movement (land subsidence). This is used at Oyu Tolgoi to monitor the tailings storage facility. InSAR is obtained from the TerraSAR-X satellite with a phased array synthetic aperture radar (SAR) antenna (X-band wavelength 31 mm, frequency 9.6 GHz); TerraSAR-X acquires new high quality radar images of the entire planet whilst circling Earth in a polar orbit at 514 km altitude.

7.3 Geological mapping

7.3.1 Surface mapping

Outcropping mineralized zones (Southwest, South, and Central) were mapped at 1:1,000 scale and the central part of the Oyu Tolgoi licence at 1:5,000 scale in 2001. The entire Oyu Tolgoi Property was mapped at 1:10,000 scale in 2002. Additional geological and structural mapping was completed by Alan Wainwright during 2005–2008 as part of his PhD thesis research (Wainwright, 2008).

Mapping on the Shivee Tolgoi licence area consists of 1:20,000 and 1:10,000 scale regional mapping, with detailed prospect-scale mapping at 1:2,000 scale, undertaken between 2004 and 2008.

In 2011, a detailed 1:2,500 surface geological mapping program was initiated across part of the Javkhlant area west and south-west of Heruga. This program focused on determining stratigraphic relations that may indicate vectors to prospective stratigraphy.

Open-pit face mapping has been conducted since 2011 to improve open pit fault modelling, and to predict and mitigate further pit failures. Open pit face mapping has been conducted since 2011 to improve open pit fault modelling, and to predict and mitigate further pit failures. Due to accelerated rate of mining development, increased number of active mining areas and dangerous geotechnical areas, comprehensive face mapping is not achievable throughout the mine.

Photogrammetric mapping is used in the pit for geological and geotechnical interpretation (Figure 7-1).

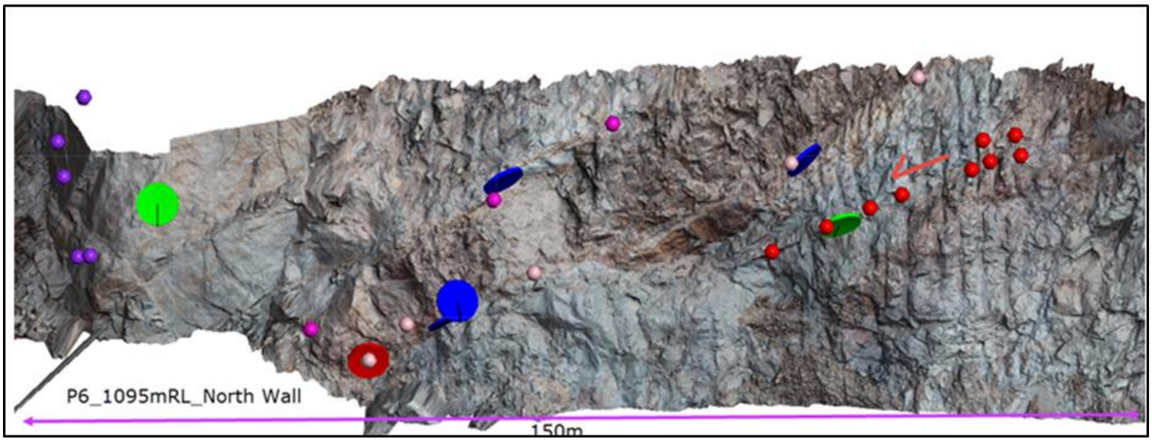

Figure 7-1: Oyut photogrammetric image of pit wall with annotations

Drone imagery survey has been used in the Oyut open pit since 2018 for geological and geotechnical modelling (Figure 7-2).

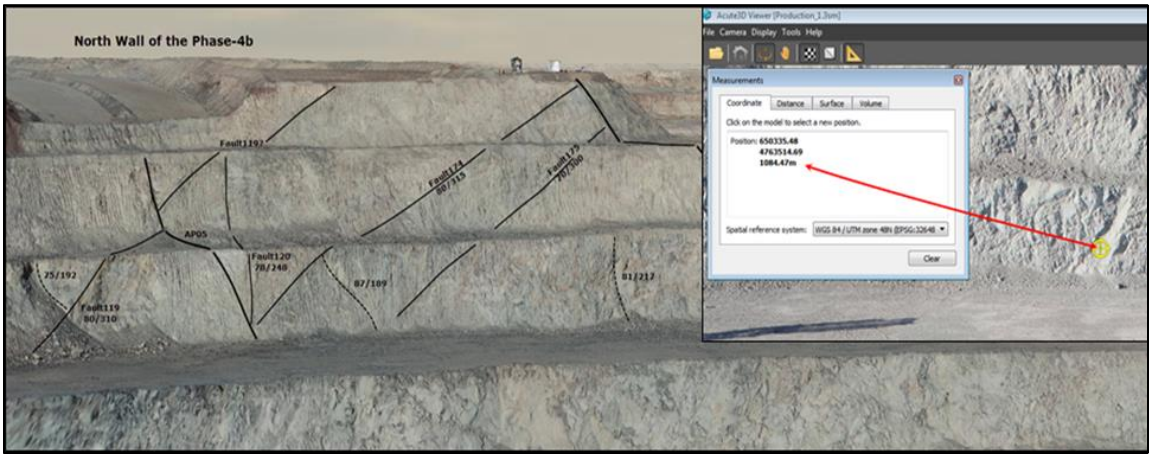

Figure 7-2: Oyut drone imagery of open pit wall

7.3.2 Underground mapping

Detailed geological mapping is undertaken during the development of Hugo North to systematically update geological interpretation and modelling.

The mapping of underground areas continues to define relationships between mineralisation, lithology and fault structures. A total of 24,500 m of development has been mapped since 2016.

In 2018, an in-house underground mapping tablet-based application was deployed, called Facemapper. The application allows both geotechnical and geological data to be collected simultaneously at the face, as well as drawing a digital map, which is easily uploaded into a central data base. The data collected from the mapping is used to help predict ground conditions in front of planned development. The mapping is used to validate and update the geology model which was initially generated from diamond drill holes.

Prior to 2018, geological maps were scanned and converted to digital format, and imported to Vulcan software and geo-referenced for structural interpretation.

The geology model updates continuously incorporate information from the underground mapping, such as the location and nature of contacts between the biotite granodiorite and quartz monzodiorite units, the location and orientation of the major structures, exposure of minor structures, and cross-cutting relationships.

In addition to the underground mapping data, historical diamond drilling was scrutinised to validate and update the structural model for Panel 0.

The hangingwall sequence east of the Hugo North deposit and west of the West Bat Fault continues to be studied. This work will lead to a better understanding of the continuity of structures across the West Bat Fault and the relationship with the overlying carboniferous sediments.

7.4 Structural studies

7.4.1 Oyut

The structural understanding of the overall Project area and within Oyut open pit has increased through time and access. Currently, a total of 81 first- and second-rank faults (identified in drilling and pit walls), 295 third-rank faults (identified in pit wall, but relationship to first- and second-rank faults is unclear) and 11 fourth-rank faults (identified by magnetic surveys) are recognized.

The time sequence of faulting within the licence area has been defined in the following stages (in a sequence of young to old):

1. Late stage: East-northeast trending faults (Solongo fault system and splays, Central fault).
2. Northwest trending faults: These faults cut and displaced Devonian and carboniferous rocks and dykes.
3. Northeast trending faults filled with carboniferous rhyolite dykes.
4. West and northwest trending faults filled with rhyolite dykes forming right-lateral displacements.
5. Northeast trending faults filled with andesite dykes.
6. Pre-Devonian: These faults are defined in the pit wall as cut and displaced by other faults.

Geotectonically, the deposit has complex structure and some major faults were activated two to three times. A summary of the characteristics of the faults in the Oyut area is shown in Table 7-1.

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Table 7-1: Stages and evolution characteristics of faults in Oyut area

No	Stage	Major faults	Dip angle	Cut by	Filled dykes	Fault characteristics
11	Late fault	SOL, SND, NAR	NW/80-90	All rocks	Rhyolite	Non-foliated breccia
		CENT	N/50		–	Non-foliated breccia
12	Northwest trending	JK, SZ, AB, Plan 20, Fault 100, F01, AP01	NE/45-60	Devonian & Carboniferous sediment, rhyolite, andesite, granodiorite	–	Foliated gouge
		AP02, AP03, AP04, AP05, AP06, ET02	NE/80-90			
33	Northeast trending	Fault61, Fault59, ER01, STH, STH025	NE/70-85	Devonian sediment, granodiorite, andesite rhyolite	Rhyolite/ Dacite	Foliated gouge
		BO, HUT, HUT01S	NE/45-50		–	Non-foliated breccia
		EB, WB (next action)	NW/80-85		Rhyolite	
44	Northeast trending	RHY, RHY03S, AP11, FRS, SHO, CST, ZALUU, ABU	NNE/80-90	Devonian sediment, granodiorite, andesite	Rhyolite	Foliated gouge
55	Northeast trending	AND, CAD, EB, WB, STH01S, STH03S, AND154	NW80-90	Devonian sediment, granodiorite	Andesite/ Rhyolite	Non-foliated breccia
		AP08, BO	SE/45-50			
56	Early faults	EB, ZL, ZL01S, BOZ, SED, NF, Plan 18, 3rd rank fault	various	Devonian sediment	Granodiorite	Foliated gouge

7.4.2 Hugo Dummett

The interpretation of the structural framework of Hugo North has evolved over time. Rio Tinto staff, on behalf of Oyu Tolgoi LLC, performed an initial structural review of the faulting and fault models during 2009-2010 for the Hugo Dummett deposit area in support of the planned caving operation.

In 2018, a mine design scale structural model for the Panel 0 mining volume at Hugo North was completed. The regional structural geology model was used as a guide. All diamond drill hole core photographs were scrutinized in conjunction with available mapping for structural modelling purposes. The regional structural model was generated as planes, but the local structural model update generated three dimensional shapes, snapping to drill holes logged as fault zones, which were verified by core photographs. Fault planes were also mapped from development, with dip and dip direction measurements used for fault orientations and projections.

The 2018 structural model updated in 2019 for the Panel 0 design studies includes the following changes:

- Lower fault. Eight splays were recently interpreted, compared to the two main limbs from 2016 regional model update.
- West Bat fault. The 2018 WBAT fault is modelled to be offset by both the Bumbat fault and the Dugant fault. Recent drilling has also indicated the high probability of the WBAT being offset by the Dugant fault farther north of the Bumbat fault.
- Bumbat fault. The 2018 Bumbat fault has been modelled farther north compared to the 2016 Bumbat fault. The Bumbat fault offsets the WBAT fault and is associated with the movement of the North Boundary fault to the west.
- Dugant fault. The 2018 Dugant fault has been modelled slightly north compared to the 2016 Dugant fault. The 2018 Dugant fault has also been modelled to offset the WBAT fault.
- Intermediate fault. The Intermediate fault has been removed. This was based on the review of core intercepts along the 2014 Intermediate fault model, which lacked fault intercepts and continuity.
- Intermediate splay faults. The 2018 model update has identified two small, highly damaging structures with orientations subparallel to the Lower fault. It is possible these two structures are part of the Lower fault system.
- Gobi fault. The 2018 model update removed the Gobi fault. This was based on the review of core intercepts and development and mapping along the 2014 Gobi fault model, which lacked fault intercepts and continuity.

7.4.3 Heruga

In 2013, the geological and structural model of the Heruga deposit was updated. Mapping shows a northeast trending carboniferous syncline axial trace directly above the Heruga deposit footprint. At 1 km depth the mineralized zone shows the existence of the Devonian sequence at the core and Carboniferous sediments at the flanks, indicating the potential of an anticline fold. The corresponding anticline axial trace at surface lies ~500 m to the east, suggesting that the axial surface dips in the order of approximately 60° to 70° to the west-northwest. Faults are modelled as vertical.

The current interpretation of Heruga is valid based on widely spaced drilling, which is taken into consideration with the classification of the resource. Further work is required to increase confidence of structural and mineralisation interpretations. No recent work has been conducted at Heruga.

7.5 Geochemical surveys

In 2011, a summary of all geochemical studies carried out on the Oyu Tolgoi Property was consolidated by Sketchley (2011). On that basis, an independent database was created with the categories of geochemical anomaly and type (Bell et al. 2011).

The soil sampling programs between 1997 and 2018 are summarized in Table 7-2. Trenching, soil sampling (mobile metal ion—MMI), grab sampling, stream sampling and heavy concentrate sampling were conducted over the areas covered by the joint venture arrangements. The numbers of geochemical samples taken are shown in the Table 7-3.

The locations of soil geochemical copper, lead, molybdenum and tungsten anomalies are shown in Figure 7-3. Soil sampling is not a material factor in current or planned mining.

Table 7-2: Soil sample surveys by area and year

Area/Prospect	Year	Company
Southwest	1997–1999	BHP
Copper Flats	2002–2003	Entrée LLC
Eastern Entrée	2003–2004	Entrée LLC
Oortsog	2003–2004	Entrée LLC
Southwest	2004	EntréeLLC
West RAB	2004	TRQ
Western Entrée	2004–2005	Entrée LLC
Exotic Cu	2005	TRQ
OT South	2005	TRQ
Hugo South	2005–2006	TRQ
West	2006	TRQ
Gandulga	2006	TRQ
Ulaan Khuud	2006	TRQ
BHP3	2006	TRQ
Heruga	2008	Entrée Resources Ltd
SEIP	2016-17	Entrée Resources Ltd.
Western Mag	2016	Entrée Resources Ltd.
Castle rock	2016	Entrée Resources Ltd.
Bumbat Ulaan	2018	Entrée Resources Ltd.
West Corridor	2018	Entrée Resources Ltd.
Central Javkhlant	2018	Entrée Resources Ltd.
Heruga corridor	2018	Entrée Resources Ltd.
Khukh Khad (re-sampling, 184)	2019	Oyu Tolgoi
Manakht South (226)	2019	Oyu Tolgoi
Khukh Khad (204)	2022	Oyu Tolgoi

Table 7-3: Geochemical sampling of areas covered by the joint venture arrangements

Licence	Year	Rock grab sample	Soil sample	Stream sediment sample	Channel sample
Shivee Tolgoi	2003–2003	75	2140	–	450
	2004	–	–	–	1363

Licence	Year	Rock grab sample	Soil sample	Stream sediment sample	Channel sample
Javkhlant	2002–2003	45	–	25	–
	2006–2007	43	314	–	–
	2016-2018	11	2583	–	–
	2019	56	-	-	-

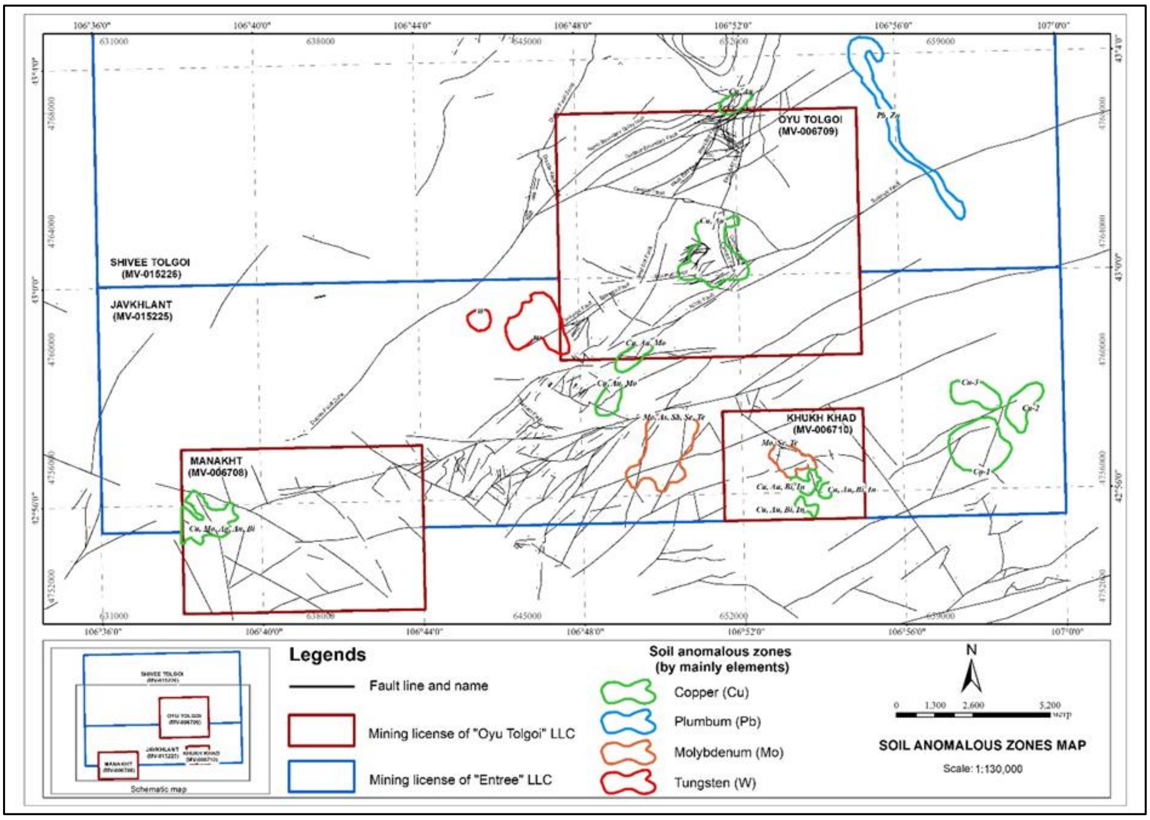

Figure 7-3: Regional soil geochemistry – anomaly map (Projection WGS84 Lat/Long)

The analysis of the results from these programs show that:

- The anomalies detected in the areas are caused by either identified ore mineralisation or lithological types.
- The areas that had not been covered by soil geochemistry are underlain by large intrusions, non-prospective rock outcrops or thick alluvial blankets.
- Highly prospective areas have been explored by several drilling programs.
- Thick cover sequences render buried mineralisation undetectable by surface geochemical methods.

7.6 Geophysics

Geophysical surveys have been conducted regularly and consistently updated throughout the exploration timeline for Oyu Tolgoi. A summary of geophysical surveys completed in the Oyu Tolgoi Property are shown in Table 7-4.

Table 7-4: Geophysical survey completed in Oyu Tolgoi Property

Company	Timeline	Type of survey	Survey information	Area
BHP LLC	1997-1998	Gradient array induced polarization (IP)	250 m line spacing	Central, South, Southwest Oyu
		Airborne magnetics	300 m line spacing	Oyu Tolgoi
		Ground magnetics	250 m line spacing	Central, South, Southwest Oyu
TRQ	2001	Gradient array IP	100 m north-south	Oyu Tolgoi
		Gradient array IP	100 m east-west	Hugo Dummett
		Ground magnetic	25 m by 5 m and 50 m by 10 m	Oyu Tolgoi
TRQ	2002	Gravity	100 m by 50 m	Oyu Tolgoi
	2005	Transient electromagnetic		Eastern half of concession for water
	2009	Zeus IP	East – west	Oyu Tolgoi
	2011	Magnetotelluric	1,006 stations	Regional

A district-wide magnetotelluric survey provided a method that can potentially detect and delineate isolated conductors at substantial depths and reliable 3D models of conductivity can be derived that are readily integrated with geology (Figure 7-4). Approximately 30 planned stations around the South Oyu and to the west of the Hugo Dummett areas were omitted because of mine construction activities.

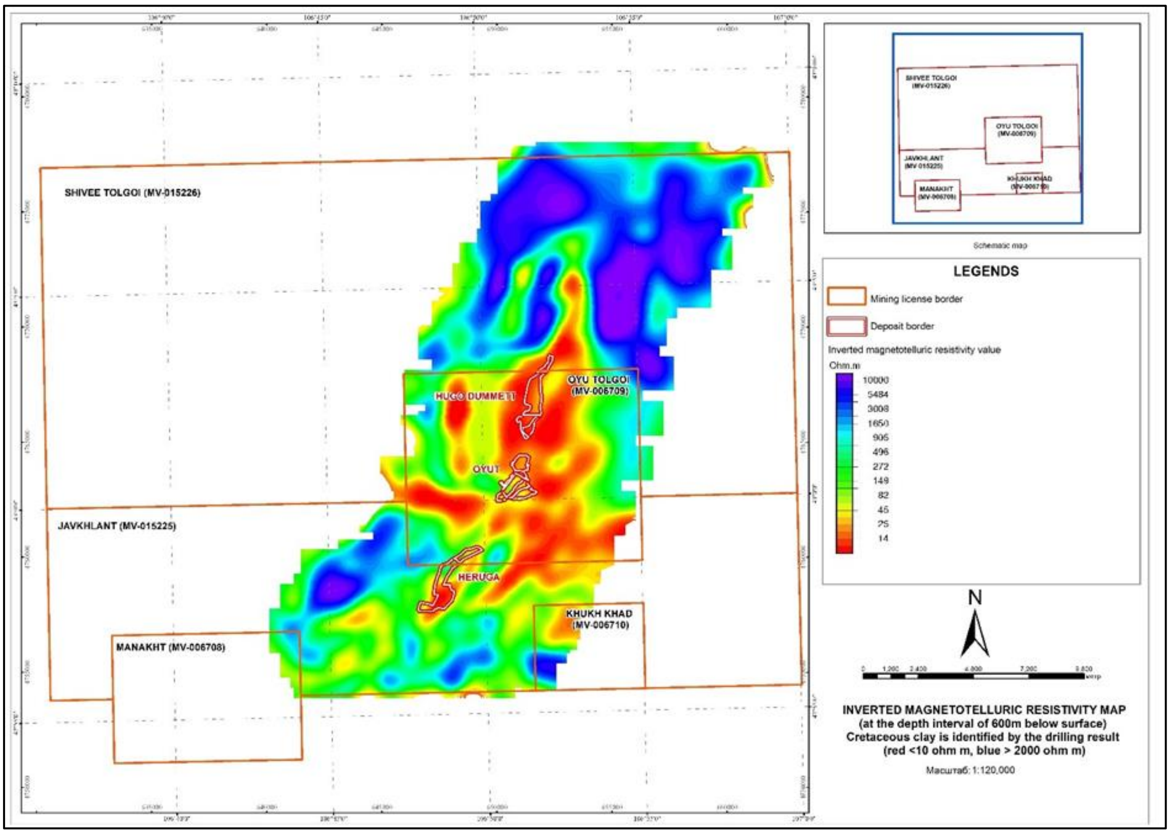

Figure 7-4: Regional inverted magnetotelluric sections at the depth interval of 600 m below surface (Projection WGS84 Lat/Long)

7.6.1 Entrée Resources Ltd.-Oyu Tolgoi LLC joint venture arrangements area

A summary of geophysical surveys completed in the Entrée Resources Ltd. joint venture arrangements area are shown in Table 7-5.

Table 7-5: Geophysical survey completed Entrée Resources Ltd. joint venture arrangements areas

Company	Timeline	Type of survey	Survey information	Area
Oyu Tolgoi LLC	2005	Gradient array induced polarization (IP)		Shivee Tolgoi, Javkhlant
	2008	Ground magnetic	26.6 km^2, east-west 25 m line spacing	Heruga
	2008	Magnetic	26.6 km^2, east-west 25 m line spacing	Hugo North Extension
	2011	Magnetic	Manakht licence: 1,138 line-km over 161 lines with east-west 25 m line spacing	
	2016	Gravity (surface)	100 m by 200 m out to 200 m by 200 m	
		IP dipole-dipole	8-11 channel, 200 m dipole spacing, electrode 200 m spacing	
	2016	IP dipole-dipole	Two east-west lines (total 14.4 line km)	Castle Rock

Company	Timeline	Type of survey	Survey information	Area
	2017	Ground magnetic	25 m line spacing	Northern part of SE anomaly (Javkhlant)
	2018	Ground gravity	200 m by 200 m (3245 stations)	West and east of Javklant
		Seismic	Nine lines at 300 m to 400 m spacing for 294 stations	Airstrip (Shivee Tolgoi)
		IP dipole-dipole	Three east-west lines (14 km)	Airstrip (Shivee Tolgoi)
OT-Entrée	2022	Dipole-dipole IP	A total of 36.1 line.km, 8-12 channel, dipole spacing of 100 & 200m	Ductile Shear & East Au (Shivee Tolgoi)
OT-Entrée	2022	Dipole-dipole IP	A total of 46.5 line.km: 8-channel, dipole spacing of 200m	East Bumbat Ulaan & SEIP (Javkhlant)

7.7 Petrology, mineralogy and other research studies

Several petrological, mineralogical and other research studies have been undertaken. These include age dating of key lithological units, detailed stratigraphic reviews, petrographic and spectral analysis of alteration products and minerals, and detailed structural reviews, particularly in the areas proposed for the block caving operation at Hugo Dummett.

TRQ established and Oyu Tolgoi LLC maintains an in-house petrology laboratory in the Oyu Tolgoi Geosciences Department. Equipment for making polished mineral specimen blanks and polished thin sections is currently housed there.

Alteration minerals are determined by short-wave infrared spectrometry (short-wave infrared (SWIR) or portable infrared mineral analyzer (PIMA) analysis) on typical specimens from several alteration zones in each drill hole.

A program of preparing mineralisation samples and making metallurgical index estimates from all the Oyu Tolgoi deposits was undertaken between 2002 and 2006.

7.7.1 Research studies

Several research theses have been completed on the Project area and are listed below in alphabetical order by author surname:

- Ayush, O 2006, “Stratigraphy, geochemical characteristics and tectonic interpretation of Middle to Late Paleozoic arc sequences from the Oyu Tolgoi porphyry Cu-Au deposit”, MSc thesis (in Mongolian), Mongolian Univ. Science and Technology, Ulan Bator, Mongolia, 80 p.
- Jargaljav, G 2009, “Mineralisation and metasomatic alteration of Central Oyu copper-gold deposit”, PhD thesis (in Russian), Irkutsk Technical University, Irkutsk, 129 p.
- Khashgerel, B 2010, “Geology, whole-rock geochemistry, mineralogy and stable isotopes (O, H and S) of sericitic and AA alteration zones, Oyu Tolgoi porphyry Cu-Au deposits, Mongolia”, PhD thesis, Univ. of Tsukuba, Japan, 114 p.
- Myagmarsuren, S 2007. “Sulphide mineral paragenesis at the Hugo Dummett porphyry Cu-Au deposit, Oyu Tolgoi, Mongolia”, MSc thesis, Tohoku University, Japan, 93 p.

- Oyunchimeg, R 2008, “Sulphide mineralogy and gold mineralisation at Hugo Dummett porphyry Cu-Au deposit, Oyu Tolgoi mineral district, Mongolia”, PhD thesis (in Mongolian), Mongolian Univ. Science and Technology, Ulan Bator, Mongolia, 116 p.
- Savage, N 2010, “Origin of clasts, mineralisation and alteration within the DA2a conglomerate, Heruga porphyry Cu-Au-Mo deposit, Oyu Tolgoi, Mongolia: evidence for an older porphyry system or part of the early Oyu Tolgoi paragenesis?”, MSc mining geology dissertation, Cambourne School of Mines, UK, 119 p.
- Wainwright, AJ 2008, “Volcanostratigraphic framework and magmatic evolution of the Oyu Tolgoi porphyry Cu-Au district, South Mongolia”, PhD, Univ. British Columbia, Vancouver, 263 p.

7.8 Drilling

7.8.1 Drill programs

Diamond core drill holes (DDH) are the principal source of geological and grade data for Oyu Tolgoi. A small percentage of the total drilling comes from reverse circulation (RC) or combined RC/DDH (RCD) (RC at the collar and diamond at depth). Most of the RC holes were drilled in the early days of exploration at the Oyut deposit. RCD holes make up a small percentage (<2%) of the total number of holes on the Project. Fifty-two polycrystalline (PCD) holes were also drilled, but these are peripheral to the mine area.

The first drilling was completed by BHP between 1997 and 1998, when 23 diamond core holes (3,902 m) were drilled at the deposit now known as Oyut. TRQ completed approximately 109 holes (8,828 m) of RC drilling in 2000, mainly at Central zone, to explore the chalcocite blanket discovered earlier by BHP.

In 2001, TRQ continued RC drilling (16 holes totalling approximately 2,091 m), mostly in the South zone area; however, an RCD method was tested for hole number OTRCD149. TRQ drilled two additional holes using RCD method (OTRCD50 and OTRCD52), along with seven additional RC holes totalling 801.5 m (up to drill hole OTRC158), before switching to diamond core drilling methods for all exploration.

As at 31 December 2022, a total of approximately 1,478,907 m of drilling in 3,977 holes has been completed on the Project. Of this, 1,356,477 m was diamond core drilling in 2,928 holes and 122,430 m was completed in 1,049 RC holes. The drilling has been spread mostly over the Hugo Dummett, Oyut, and Heruga deposits. These totals include approximately 525 holes (75,427 m) drilled as part of a condemnation program to assist in the determination of suitable sites for the proposed plant, infrastructure, and dumps, and for water and geotechnical purposes.

Table 7-6 provides a summary of all drilling to 31 December 2022. The near-mine drill hole collar locations and types are shown in Figure 7-5. Some of the more recent drilling has not yet been incorporated into resource models of the deposits but an assessment shows that inclusion is not likely to be material to the estimates.

In the opinion of the QP, the processes outlined below are adequate for collecting quality samples and information for use in the interpretation and estimation of Mineral Resources.

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Table 7-6: Summary of exploration drilling across the Property as at 31 December 2022

Location	Surface DDH Count	Length of Surface DDH (m)	RC Holes Count	Length of RC (m)	RCD Holes Count	Length of RCD (m)	UG DDH Count	Length of UG DDH (m)	PCD Holes Count	Length of PCD Holes	All Holes Count	Total Length (m)
Hugo South	127	87,248.06	45	3,263.00	12	7,988.95	1	644.70			185	99,144.71
Hugo North	458	419,159.45	4	319.00	4	2,417.50	707	123,097.52			1173	544,993.47
Total Hugo Dummett	**585**	**506,407.51**	**49**	**3,582.00**	**16**	**10,406.45**	**708**	**123,742.22**			**1358**	**644,138.18**
Southwest	355	157,424.13	210	33,675.20	3	2,092.00					568	193,191.33
Southeast	2	800.00	5	1,248.00							7	2,048.00
Far South	81	72,964.40	12	2,928.00							93	75,892.40
Central	310	107,178.13	81	8,010.30							391	115,188.43
South	120	42,215.89	52	4,847.00	2	890.90					174	47,953.79
Wedge	49	27,565.85	12	1,337.50							61	28,903.35
West	63	23,158.75	119	5,880.70							182	29,039.45
Shallow Hugo West	46	16,973.40	55	13,968.50							101	30,941.90
Total Oyut	**1026**	**448,280.55**	**546**	**71,895.20**	**5**	**2,982.90**					**1577**	**523,158.65**
Shaft exploration geotechnical	87	37,103.40	37	1,184.40	8	2,400.00	42	3,018.90			166	41,306.70
X Grid	6	571.00									6	571.00
East Side Licence	38	7,092.05	159	19,557.00							205	29,049.05
Other	224	39,503.81	127	17,589.50	2	338.80	3	1,737.40			356	59,169.51
Total "Other "Drilling	**355**	**84,270.26**	**323**	**38,330.90**	**10**	**2,738.80**	**45**	**4,756.30**			**733**	**130,096.26**
Hugo North Extension	122	99,838.90	73	4,868.00	2	736.00			58	3,754.40	255	109,197.30
Heruga	54	72,317.40									54	72,317.40
Total Entrée Drilling	**176**	**172,156.30**	**73**	**4,868.00**	**2**	**736.00**			**58**	**3,754.40**	**309**	**181,514.70**
Grand Total (All Drilling)	**2142**	**1,211,114.62**	**991**	**118,676.10**	**33**	**16,864.15**	**753**	**128,498.52**	**58**	**3,754.40**	**3977**	**1,478,907.79**

7.8.2 Drill orientations

Drill holes have been drilled at a wide range of azimuths and dips depending on the orientation of the mineralisation, but an east-to-west orientation is dominant throughout the Project area. Drilling is normally oriented perpendicular to the strike of the mineralisation. Depending on the dip of the drill hole and the dip of the mineralisation, drill intercept widths are typically greater than true widths. Average drill hole lengths at the Hugo Dummett and Oyut deposits range from 316 m (South zone) to 894 m (Hugo North) and the average overall is approximately 525 m. The drill spacing is a nominal 70 m on and between drill sections in the Oyut zones. Drill spacing at Hugo North is on approximate 125 m by 75 m centres. Drill spacing typically widens toward the margins of the deposits.

7.8.3 Diamond-core diameters

The vast majority of the core holes have been drilled with PQ (85 mm), HQ (63.5 mm), NQ (47.6 mm) or BQ (36.4 mm) diameters. Core diameter is reduced at depth depending on drilling condition, and it is also reduced to HQ when daughter holes split off the main drill hole. As at 31 December 2022, 91% of total drilling was diamond and the remaining 9% was RC drilling.

Many of the deeper holes were drilled with multiple drilling methods and hole deviation equipment. The Navi-Drill® hole deviation equipment can create daughter holes from parent holes by using a motorized bit to achieve 1° gradient deviation every 3 m.

7.8.4 Diamond core transport

At the drill rig, the drillers remove the diamond core from the core barrel and place it directly in wooden or plastic core boxes. Individual drill runs are identified with small wooden or plastic blocks, where the depth (m) and drill hole number are recorded. Unsampled core is never left unattended at the rig; boxes are transported to the Oyu Tolgoi LLC core logging facility at the main camp twice a day under a geologist’s or technician’s supervision. Core is transported in open boxes in the back of a truck. Those holes drilled specifically for geotechnical purposes typically use triple tube methods and are pumped out at the rig, transferred to a steel V-rail, and logged on-site before transport back to the core shed.

7.8.5 Geological logging

Diamond core logging facilities are indoors. Core logging takes place on sturdy steel racks, each of which can hold upwards of 25 or more core boxes. Upon arrival at the core shed, the core is subject to the following procedures shown in Table 7-7.

Table 7-7: Diamond drill core logging procedure

Step	Description
1. Quick review	Review core.
2. Box labelling check	The core boxes are checked to ensure they are appropriately identified with the drill hole number, meters from and to, and box number written with an indelible marker on the front.
3. Core rebuilding	Core is rotated to fit the ends of the adjoining broken pieces.
4. Core photography	Take photographs.

Step	Description
5. Geotechnical logging	Using pre-established codes and logging forms, includes length of core run, recovered, drilled ratio, rock quality designation (RQD), maximum length, structural data, and oriented core data. Orientated core measurements were logged as interval data using standardised codes for structural and vein data only; the orientated core measurement did not usually begin until the hole was within the mineralized zone.
6. Geological logging	Until August 2010 this was completed on paper logging forms. Subsequently, Oyu Tolgoi LLC implemented a digital logging data capture system, using commercially available acQuire™ software, which uses standardised templates and validated logging codes that must be filled out prior to log completion. The logging is entered directly into laptops at the core shed and is wirelessly synchronized with the geological database. The template includes header information, lithology description and lithology code, graphic log, coded mineralisation, and alteration.
7. Mark cutting line	The geologist marks a single, unbiased cutting line along the entire length of the core for further processing.

The RC logging involves capture of geological, alteration, and mineralisation data on a digital logging data capture system.

7.8.6 Recoveries and rock quality designation

Oyu Tolgoi LLC's geological staff measure the following core recovery and RQD parameters at the core logging area:

- Block interval
- Drill run (m)
- Measured length (m)
- Calculated recovery (%)
- RQD measured length (m)
- Calculated RQD (%)

The RQD method used for measuring recovery is standard industry practice.

In general, core recoveries obtained by the various drilling contractors have been very good, averaging between 97% and 99% for all deposits. In localised areas of faulting or fracturing, the recoveries decrease; however, this occurs in a very small percentage of the overall mineralized zones. In addition, there is decreased recoveries near surface in overlying non-mineralized Cretaceous clays and to a lesser extent in some of the oxidized rocks (generally above 100 m depth below surface), owing to the lower competencies of these units.

Most core has been drilled using Ball Mark™ or Ace™ oriented core marking systems to assist with geological and structural interpretations and for geotechnical purposes.

7.8.7 Collar surveys

Collar survey methods are similar for diamond core and RC drill holes.

Upon completion of a drill hole, collar and anchor rods are removed, and a PVC pipe is inserted into the hole. The drill hole collar is marked by a cement block inscribed with the drill hole number (e.g. OTD663). Proposed drill hole collars are surveyed by a hand-held global positioning system (GPS) unit for preliminary interpretations. After the hole is completed, a Nikon theodolite or Differential GPS (DGPS) instrument is used for final survey pickup. The two collar readings are compared, and if any significant differences are noted the collar is resurveyed; otherwise, the final survey is adopted as the final collar reading in acQuire™.

7.8.8 Downhole surveys

RC drill holes have been drilled mostly in the vertical position and typically not downhole surveyed. In general, most RC holes are less than 100 m in depth and are therefore unlikely to experience excessive deviations in the drill trace. These holes are assumed to have minimal deviation from the collar survey. Most core drilling programs use downhole survey instruments like Eastman Kodak, Flexit, Ranger, and Gyro to collect azimuth and deviation with specific intervals for most of the diamond drilling programs.

Downhole survey data was not conducted on the first 149 holes, including the initial core drilling program by BHP in 1998 and RC holes completed by TRQ in 2001 and 2002.

The first surveys, initiated by TRQ, for holes OTRCD149, 150, and 152 were surveyed by the Eastman Kodak method. This method was used interchangeably with Gyro and Ranger as the principal means of measuring deviations until hole OTD397, after which Gyro, North-Seeking Gyro, Flexit, and Ranger methods were used. It should be noted that the Eastman Kodak, Pontil, Flexit, and Ranger methods derive azimuth measurements using a magnet and therefore could be problematic for some deposits due to their content of magnetic minerals.

Since January 2006, procedures are to measure deviations using a Flexit instrument at 60 m intervals to monitor the drill hole progress. At completion, all holes are re-surveyed with a north-seeking gyro or SRG-gyro instrument at approximately 5 to 20 m intervals. The gyro instruments are not dependent on magnetic readings and are therefore considered to be more appropriate methods for this type of deposit. The hole deviations are checked for irregularities such as kinks or significant deviations in the downhole data. All data are checked and adjusted, if required, before finalizing the database.

7.8.9 Acoustic televiewer data

Acoustic borehole imaging devices, also known as acoustic televiewers, generate an image of the drill hole wall by transmitting ultrasound pulses and recording the amplitude and the travel time of the reflected signal. The system assists in identifying faults, fractures, layers, and geological boundaries in the drill hole wall. The nature, azimuth and inclination of these features can be determined with high resolution from the data obtained.

This methodology has been used on drill holes at Oyu Tolgoi since 2010. A total of 270 drill holes have been completed with a total of 136,604 m logged by the acoustic televiewer system. Interpretation of these logs has defined the number and orientation of fractures and discontinuities in the drill holes.

7.8.10 Core storage

All core is stored in a secure location at the main camp. Core is stacked on pallets in a stable, 3 by 3 box configuration to a height of approximately 1 m (15 boxes per pallet). Each pallet is covered with a canvas tarpaulin, which is labelled with drill hole identification and the interval stacked in the pallet.

In the opinion of the QP, the processes outlined above are adequate for collecting quality samples and information for use in the interpretation and estimation of Mineral Resources.

7.9 Hydrogeology data

Groundwater modelling is undertaken in accordance with the Rio Tinto groundwater modelling framework which provides guidance for modellers, reviewers and managers on groundwater modelling in the context of pit dewatering, geotechnical input parameters and processing water requirements.

7.9.1 Geological setting

The Oyu Tolgoi area geology is dominated by a Silurian-Devonian sequence of stratified and porphyritic andesitic and basaltic flows. Interbedded within these flows are fine to coarse-grained volcanoclastic sediments. A clastic sedimentary sequence unconformably overlies these rocks. The area has been intruded by a complex variety of felsic to intermediate porphyries emplaced in parallel with mineralisation and post-mineralisation has been intruded by syenitic granitoids and rhyolite and andesite dykes.

A thin covering of gently dipping to horizontal Cretaceous stratified clays and sand/gravels overlie the above formations, in-filling palaeochannels and small fault-controlled basins. The majority of the Oyu Tolgoi area is covered by a thin veneer of Quaternary Aeolian sediments (windblown).

Quaternary river alluvium is associated with the ephemeral rivers which occur in topographical low areas.

7.9.2 Structural setting

The area is underlain by complex networks of faults, folds, and shear zones. Most of these structures are poorly exposed on the surface and have been defined through integration of detailed exploration data (primarily drill hole data), property-scale geological mapping, and geophysical data.

The Central Fault lies between the Hugo South and Central Oyu deposits and shows significant stratigraphic off-set. The boundaries between the individual Oyut deposits coincide with major fault zones.

The Central Oyu deposit occupies a structurally intact block within which no significant internal fault disruption has been identified. The Central deposit is juxtaposed against the Southwest deposit area by an east–west-striking fault that is now occupied by a Rhyolite dyke (the Rhyolite Fault).

The Southwest Oyu deposit, lies between two northeast-striking faults, the West Bounding Fault and the East Bounding Fault. The bounding faults consist of foliated cataclasite, gouge/breccia, and mylonitic bands in zones ranging from a few meters to a few tens of meters wide.

The South Oyu deposit lies within a faulted block bound on the northwest by the northeast striking South Fault, and on the south by the east-northeast–striking Solongo Fault. The Solongo Fault forms a major structural break and truncates the southern extent of the Southern deposits.

7.9.3 Hydrology

The Oyu Tolgoi area is located in a shallow alluvial valley surrounded by low bedrock hills. Stream flow is ephemeral, with localised flash flooding following short duration, but intense rainfall events usually during the summer months. There are three main drainage courses within the Project area, all tributaries of the Undai River. The confluence of these channels is to the south of Oyu Tolgoi, with drainage generally towards the southeast. The open pit and the footprint of the waste dump will encroach into the original Undai River position; a surface water diversion and groundwater cut-off was completed in early 2013 and is functioning effectively.

The main rivers in each catchment are listed below:

- Western (KhurenTolgoi and Ulziit Rivers) catchment.
- Undai River catchment.
- Dugt River catchment.
- Small Valley catchment.
- Ust Bag Mod catchment.
- Budaa river catchment.

7.9.4 Hydrogeology

Generally, four hydrogeological units have been identified for the area:

- Alluvial sediments associated with streambeds.
- Cretaceous sediments.
- Weathered bedrock.
- Deeper, fresh bedrock.

The water quality ranges from 100 mg/L (fresh) within the river alluvium to as high as 9,000 mg/L (saline) in the fresh bedrock unit. The general groundwater flow direction identified is from the northwest to the southeast. Test pit excavation along the Undai River near the vicinity of the diversion dam showed that the river alluvium thickness varied from 1.2 to 5 m. Weathered bedrock has an average thickness of 30 m underlain by fresh bedrock.

When all the rock types are grouped together a strong depth-related trend in hydraulic conductivity has been observed. The shallow system (<100 m) can be described as having low hydraulic conductivity while the deep system (>100 m) has a very low hydraulic conductivity.

Recharge into the alluvial sediments occurs primarily through infiltration of stream flow following high rainfall events that occur in summer most years. The weathered bedrock aquifer is recharged where the unit outcrops or sub crops or where the unit is in direct contact with the overlying alluvium. It has been suggested that due to the highly faulted and structurally complex nature of the geology in the Project area that fractured rock zones have potential to transmit water in the bedrock from overlying strata. The nature of the faults and fractures is variable with some open and able to transmit water, whilst others are clay filled and likely to act as barriers to groundwater flow. Some faults may additionally act as both conduits and barriers to groundwater flow. There is strong evidence that the occurrence of fractures capable of transmitting groundwater decreases with depth.

Groundwater discharge from the alluvial system occurs as natural groundwater through flow and leakage into adjacent and underlying strata. On a local scale groundwater flow is likely to be driven by leakage from the saturated alluvial streambed sediments with groundwater levels varying as a function of distance from the streambeds.

7.9.5 Rainfall

There is one weather station in the Oyu Tolgoi minesite and six additional rain-gauges present within the Khanbogd soum territory. Daily rainfall records, measured in the soum of Khanbogd, exist from 1976 to end-2020. According to the 45-year observation dataset (1976-2020), the annual precipitation at the Khanbogd weather stations has ranged between 38 mm and 225 mm; the mean annual rainfall for this period is 103.6 mm. Annual totals based on the daily rainfall dataset between 2002 and 2021 at the Oyu Tolgoi minesite ranged between 45 mm and 217 mm; the mean annual for the measured 20-year period is 103.7 mm.

7.9.6 Gunii Hooloi aquifer

A major groundwater resource was discovered by hydrogeologists, geophysicists, and drilling engineers at Gunii Hooloi, which provides the raw water supply for the exploitation of the Project.

On discovery in 2004, it was described as being a leaky aquifer, 45 km in length, 15 km in width and 175 m thick. Table 7-8 documents the Gunii Hooloi groundwater reserve reported in the different reports.

Table 7-8: Summary of Gunii Hooloi groundwater availability and exploitable reserve estimations

Estimation undertaken (authors name)	Groundwater availability (million m^3)	Groundwater exploitable reserve (m^3/day)				
		A	B	C1	C	Total
Aquaterra (2004b)	600					
Aquaterra (2007)	6,800					
Munkhbaatar.N, Sanjdorj.S, Ulziibayar.G, Chuluunbaatar.Sh (2005)		-	-	69,984	-	69,984
Tuvdendojr.A, Sanjdorj.S, Ulziibayar.G (2008)		-	53,568	43,373	7,670	104,611
Tuvdendorj and Sosorbaram (2015)		29,635	52,099		14,429	96,163
Water Resource Council (2015)		185 L/s	613 L/s		117 L/s	79,315

Notes: **"Groundwater reserve classification and category"—and methodology instruction of minister order number 173, dated April 20, 2015, Ministry of Environment and Tourism, Green development, appendix#1. A is proven—based on detailed hydrogeological studies B is probable – based on preliminary hydrogeological exploration studies C is possible – estimates based on reconnaissance studies**

The Gunii Hooloi aquifer has a demonstrated 870.0 L/s or 75,168 m^3/day exploitable reserve as approved by ministerial order number 22, dated January 2009, by the Ministry of Environment and Tourism, which was valid until the date of update and approved by the Water Resource Council meeting in Ministry of Environment and Green Development, 6 July 2015 and the groundwater reserve is 918 L/sec or 79,315 m^3/day.

A groundwater reserve estimation update was undertaken by Tuvdendorj and Sosorbaram (2015) that revised Gunii Hooloi's potential available groundwater reserve to 29,635 m^3/day or 343 L/sec ("A" category), 52,099 m^3/day or 603 L/sec ("B" category), 14,429 m^3/day or 167 L/sec ("C" category) , with a total reserve (A+B+C) of 96,163 m^3/day or 1,113 L/sec.

This report was discussed with the Water Resource Council of the Ministry of Environment and Tourism but the author's estimation of 1,113 L/sec was not approved by the council. At a meeting of the Water Resource Council (6 July 2015) it was resolved that the Gunii Hooloi Groundwater potential available water reserve is 185 L/s ("A" category), 613 L/s ("B" category), 117 L/s ("C" category) and with a total of 918 L/sec or 79,315 m^3/day. This was approved by order number 2015/03 dated 2 November 2015.

The QP is satisfied that the hydrogeological information collected is sufficient and meets requirements for the intended use.

7.10 Geotechnical data

Geotechnical diamond drilling is carried out to provide structural, geological and geotechnical data. This enables the effective evaluation of material and rock mass properties for the economic and safe design of pit walls and underground excavations. Three types of data are collected using geotechnical core logging techniques. These include:

- Interval data – Properties that describe the type and quality of the rock mass.
- Structural data – Characteristics of specific discontinuities that intersect the core.
- Sample data – Information on specific samples is gained through physical tests on the specimens under laboratory conditions to determine properties such as strength, mineralogy, slaking susceptibility etc.

This data is then used to define the geomechanical characteristics of the materials.

Geotechnical diamond drilling preferably uses triple tube drilling techniques to maintain the integrity of the core. Typical geotechnical drilling core sizes include NQ-3 (45 mm diameter), HQ-3 (61 mm) and PQ-3 (83 mm). PQ-3 is the preferred core size for holes that are planned to intersect weak material types such as clays and weak detritals.

Geotechnical samples are collected at the rig for a variety of destructive and non-destructive laboratory tests. This is essential when sampling weak rock types such as clays that degrade quickly on exposure to the atmosphere. The logger is present when critical zones for sampling are intersected. Additional samples may also need to be collected for environmental (e.g. acid rock drainage), metallurgical, petrological, and assay testing. The following aspects are considered when selecting geotechnical samples:

- Samples are selected from the split as soon as the core is marked up and initial interval logging (e.g., recovery, RQD length), is completed.
- The following basic parameters are recorded; lithology, stratigraphy (if possible), weathering, discontinuity characteristics (if applicable) and field strength.
- Photos of the samples are taken prior to wrapping, including both end-on and side-on views.
- At least one sample per tray is wrapped as a matter of routine to provide a good selection of geotechnical samples to choose from. The sampling frequency increases when a specific zone of interest is intersected (e.g., a fault zone).

- A core block is placed in the gap where the sample is taken, marked with the sample ID and start and end depths, test type, lithology, and estimated field strength.

Commonly performed laboratory tests include unconfined compressive strength (UCS), triaxial strength, direct shear and Brazilian tests. Direct shear tests are conducted either on remoulded soil samples, existing defects, or intact rock where a surface is formed by making a saw cut in the core.

The QP is satisfied that the geotechnical information collected is sufficient and meets requirements for the intended use.

7.11 Drill hole location plan

Figure 7-5 presents the locations of all drill holes from the various exploration programs across the Property.

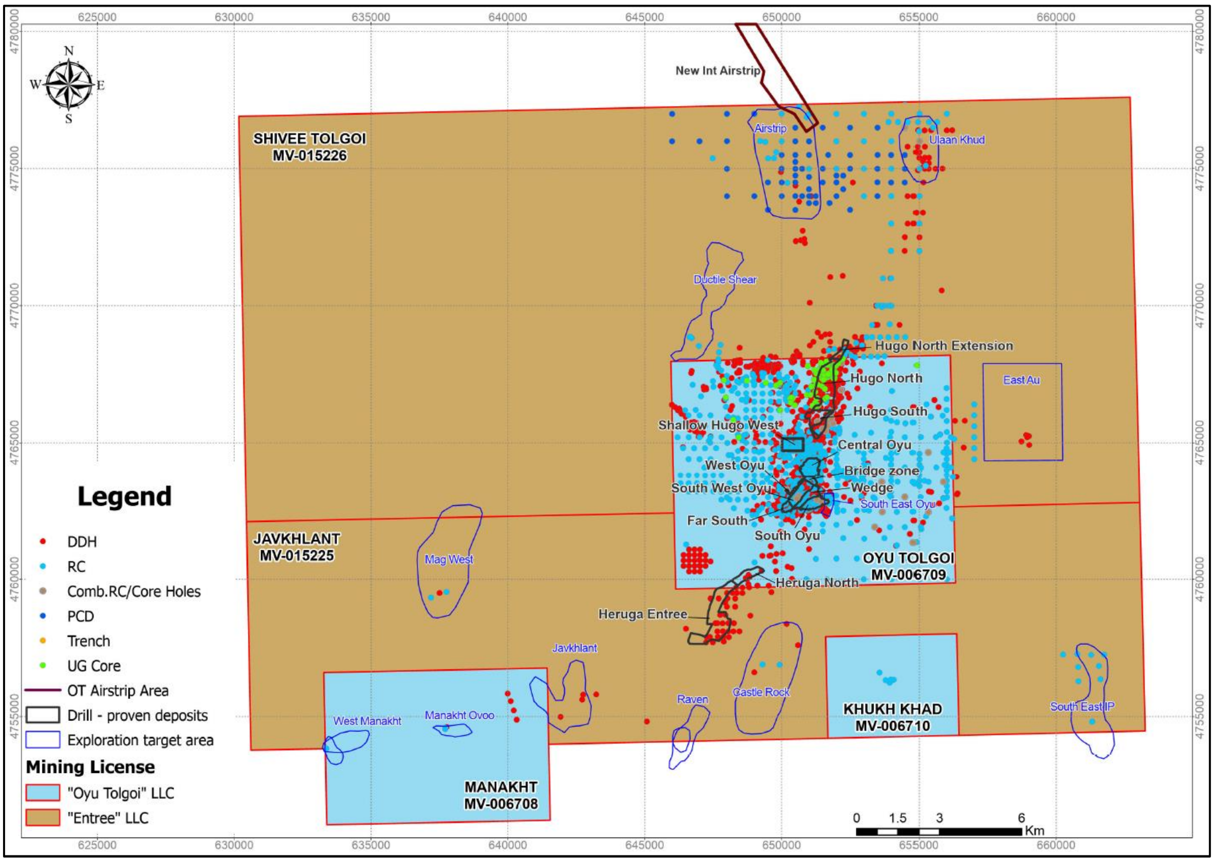

Figure 7-5: Near-mine drill hole collar locations

8. Sample preparation, analyses, and security

8.1 Sample preparation methods

8.1.1 Geochemical sampling

Sampling programs at Oyu Tolgoi included stream sediment, soil, trench, and rock chip samples. All the sampling was carried out by Oyu Tolgoi's or prior owners' personnel or contractors.

Sampling performed by Entrée Resources Ltd. and Oyu Tolgoi personnel on the Entrée Shivee Tolgoi licence also included stream sediment, soil, trench, and rock chip samples.

Because all these early–stage sampling methods have been superseded by drill data, which form the basis of the Mineral Resources estimates, the early–stage sampling methods are not discussed further.

8.1.2 Core sampling

The core cutting protocols at the now decommissioned Oyu Tolgoi Camp core shed for core drilling in both the Oyu Tolgoi LLC and Entrée Resources Ltd. proposed joint venture arrangement areas were as follows:

- Core is photographed.
- The uncovered core boxes are transferred from the logging area to the cutting shed (approximately 50 m) by forklift on wooden pallets.
- Long pieces of core are broken into smaller segments with a hammer.
- Core is cut with a diamond saw, following the line marked by the geologist. The rock saw is regularly flushed with fresh water.
- Both halves of the core are returned to the box in their original orientation.
- The uncovered core boxes are transferred from the cutting shed to the sampling area (approximately 50 m) by a forklift carrying several boxes on a wooden pallet:
    - Constant 2 m sample intervals are measured and marked on both the core and the core box with a permanent marker.
    - A sample tag is stapled to the box at the end of each 2 m sample interval.
    - Sample numbers are pre–determined and account for the insertion of quality assurance and quality control (QA/QC) samples (core twins, standards, blanks).
- Samples are bagged. These are always half–core samples collected from the same side of the core. Each sample is properly identified with inner tags and marked numbers on the outside. Samples are regularly transferred to a sample preparation facility operated by SGS Mongolia LLC (SGS Mongolia) approximately 50 m from the sample bagging area.

The core cutting and sampling procedures in the new Crane–Kavalieris core shed have been modified slightly to the following:

- After being photographed, a pallet jack transfers the core boxes on pallets to the core cutting room.
- Long pieces of core are broken into smaller segments with a hammer.
- The core is placed in a core cradle and cut in half using automated feed Almonte core saws.
- Half the core is placed directly into a pre–numbered sample bag and half the core is returned to the core tray. Samples are collected nominally on 2 m intervals.

The unsampled half of the core remains in the box, in its original orientation, as a permanent record. Where additional sampling is required (e.g., for metallurgical testwork), a skeleton core is left. In some cases, however, the additional testwork has consumed the entire core, and only photographic records remain. Core boxes are subsequently transferred to the on–site core storage area.

Non–mineralized dykes that extend more than 10 m along the core length are generally not sampled.

8.1.3 Assay sample preparation

An on-site preparation laboratory was installed in 2002 as a dedicated facility for Oyu Tolgoi during exploration and resource definition stages. The laboratory was operated by Analabs Co. Ltd and later by SGS Mongolia continuously up to the end of 2008, when it was put on care and maintenance during a slowdown in drilling operations. It re–opened sporadically during 2009, and resumed continuous operations in mid–2010, when drilling operations increased. Although the facility has mostly dealt with samples from the Project, it also has, on occasion, prepared some samples from other projects in Mongolia. In March 2014, the facility was again put under care and maintenance as drilling operations ceased.

Split–core samples were prepared for analysis at the on–site sample preparation facility operated by SGS Mongolia. The prepared pulps were then shipped by air to Ulaanbaatar under the custody of either Oyu Tolgoi LLC personnel, where they were assayed at the laboratory facility operated by SGS Mongolia.

All sample preparation procedures and QA/QC protocols were established by Oyu Tolgoi in consultation with SGS Mongolia (Figure 8-1). The maximum sample preparation capacity has been demonstrated to be around 600 samples per day when the sample preparation facility is fully staffed.

The sample preparation facility has one large drying oven, two Terminator jaw crushers, and three LM2 pulverizers. The crushers and pulverizers have forced air extraction and compressed air for cleaning.

The sample preparation protocol for Oyu Tolgoi samples is as follows:

- Coding – An internal laboratory code is assigned to each sample at reception.
- Drying – The samples are dried at 75°C for up to 24 hours.
- Crushing – The entire sample is crushed to obtain nominal 90% at 3.35 mm.
- Splitting – The sample passes twice through a nominal one-inch (approximately 2.5 cm) Jones splitter, reducing the sample to approximately 1 kg. The coarse reject is stored.
- Pulverization – The sample is pulverized for approximately five minutes to achieve nominal 90% at 75 µm (200–mesh). A 150 g sample is collected from the pulverizer and sealed in a Kraft envelope. The pulp rejects are stored on–site.
- The pulps are put back into the custody of Oyu Tolgoi LLC personnel, and standard reference materials (SRM) control samples are inserted as required.
- Shipping – The pulps are stored in a core box and locked and sealed with tamper–proof tags. Sample shipment details are provided to the assaying facility both electronically and as paper hard copy accompanying each shipment. The box is shipped by air to Ulaanbaatar where it is picked up by SGS Mongolia personnel and taken to the analytical laboratory. SGS Mongolia staff confirm by electronic transmission that the seal on the box is original and has not been tampered with.
- Storing and submitting – The pulp rejects are stored on–site at the laboratory for several months and then returned to the Project office in Ulaanbaatar for storage.

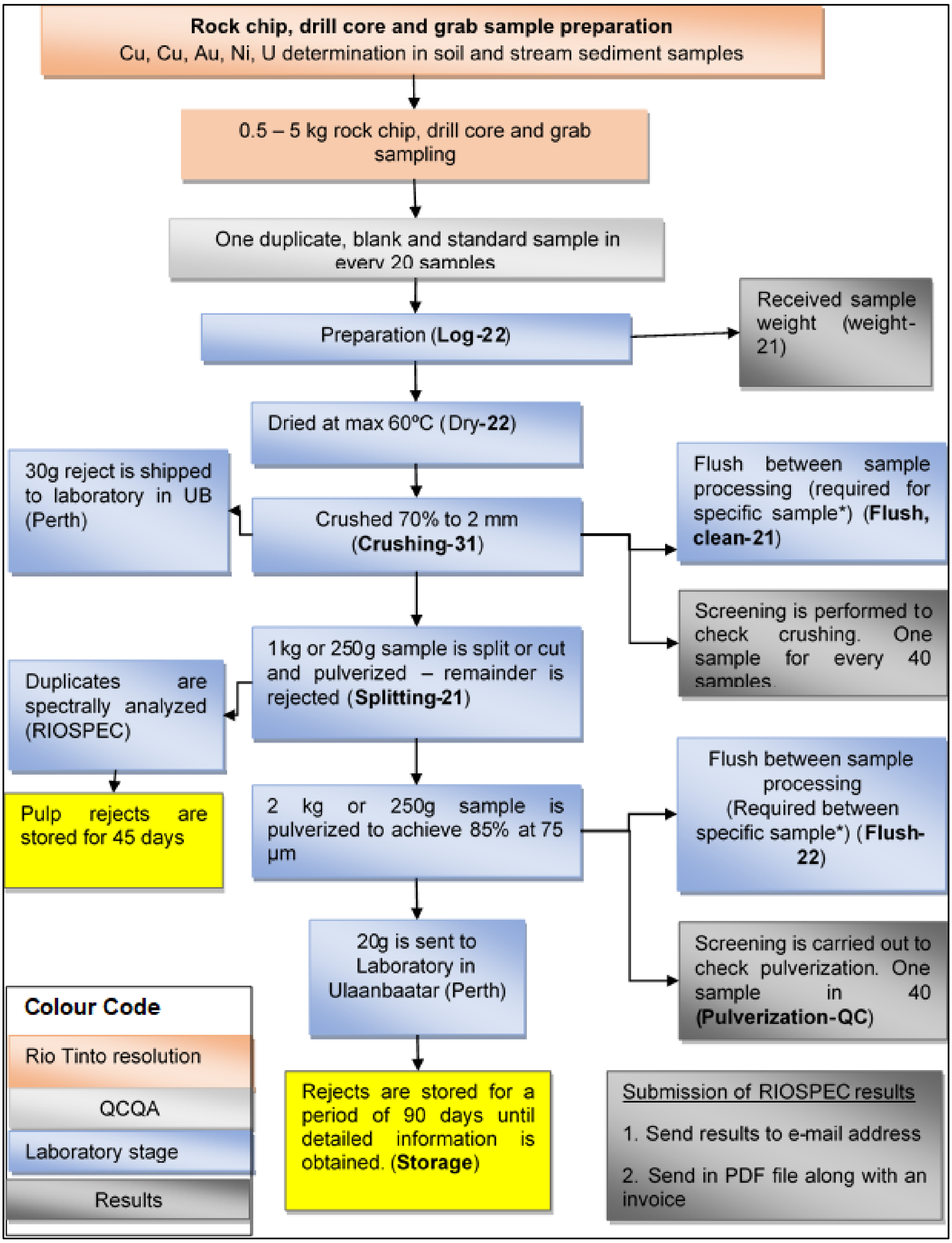

Figure 8-1: Rock chip, drill core and grab sample preparation

Between sample processing, all equipment is flushed with barren material and blasted with compressed air. Screen tests are done on crushed and pulverized material from one sample taken from the processed samples that make up part of each final batch of 20 samples to ensure that sample preparation specifications are being met.

Reject samples are stored in plastic bags inside the original cloth sample bags and are placed in bins on pallets and stored at site. Duplicate pulp samples are stored at site in the same manner as reject samples.

8.1.4 Analytical methods

SGS Mongolia routinely assayed all samples submitted for gold (Au), copper (Cu), iron (Fe), molybdenum (Mo), arsenic (As), and silver (Ag) on 2 m composite intervals.

Up to September 2011, copper and molybdenum were determined by acid digestion of a subsample, followed by an AAS finish. Samples were digested with nitric, hydrochloric, hydrofluoric, and perchloric acids to dryness before being leached with hydrochloric acid to dissolve soluble salts and made to volume with distilled water. Routine assays up to 2% Cu used a sub–sample size of 0.5 g, whereas a sub–sample size of 0.25 g was used for samples expected to be over–range, or >2% Cu. The detection limits of the Cu and Mo methods were 0.001% and 10 ppm, respectively.

Au was determined using a 30 g fire assay fusion cupelled to obtain a bead and digested with aqua regia, followed by an AAS finish, with a detection limit of 0.01 g/t Au. The same acid digestion process used for Cu and Mo was also used for analyses of Ag and As with detection limits of 1 ppm Ag and 100 ppm As, respectively.

A trace element composites (TEC) program was undertaken in addition to routine analyses. Ten metre composites of equal weight were made up from routine 1 m sample pulp reject material. The composites were subject to multi–element analyses comprising a suite of 47 elements determined by inductively coupled plasma atomic emission spectroscopy/mass spectrometry (ICP–AES/MS) after four–acid digestion. Additional element analyses included mercury by cold vapour AAS, fluorine (F) by potassium hydroxide (KOH) fusion / specific ion electrode, and carbon (C)/sulphur (S) by LECO furnace. Results from the TEC program were used for deleterious element modelling.

During 2011, an audit of assay techniques was instigated on the restricted suite of copper, gold, iron, molybdenum, silver and arsenic. It was determined that the higher than optimum detection limits were resulting in limited capability to interpret low grades mineralisation, including interpretation of arsenic zones. Also, gold detection limits were lowered by a factor of 10 when detection by AAS was changed to ICP-AES. Consequently, a shift to high–resolution ICP–MS for routine samples was implemented in September 2011. Given the relative complexity of ICP–MS equipment and the tendency for laboratories to centralize them globally to assist with operation and maintenance, this has necessitated a shift to an off–shore laboratory for analysis of all resource and exploration samples.

As a result, the following actions were taken:

- SGS continued to manage the on–site sample preparation facility.
- SGS in Ulaanbaatar was appointed the primary laboratory for gold and fluorine to ensure rapid turnaround of gold values.
- ALS (Vancouver) was appointed the primary laboratory for the high resolution multi–element ICP–MS based suite (42 elements) and LECO sulphur and carbon analyses.
- ALS and SGS were to act as the secondary laboratories for each other, reinstating the secondary laboratory checks systematically in resource and exploration drilling. The check sample rate was at a nominal check rate ratio of one sample in 20.

The intended outcome for this was to:

- Identify grade and mineralisation type (Cu, Au).
- Identify new mineralisation from pathfinder elements (As, Bi, Pb, Zn, etc.).
- Determine the distribution of potential credit elements (Ag, Mo).
- Determine deleterious elements and allow mitigation procedures to be prepared (S, As, F, Cl, Se, and Ti).
- Support the mapping of deleterious alteration or rock types to allow mitigation procedures to be prepared (Si, K, Na, and Ca).
- Support the mapping of rock types for appropriate logging of litho–types.

Run–of–mine samples from the open pit and concentrator are subject to a separate analytical flowchart at the mine laboratory situated within the concentrator complex on–site.

The QP considers the preparation and analytical protocols used to generate the data to be appropriate for use in the generation of this Mineral Resource estimate.

8.1.5 Dry bulk density determination

There are approximately 52,000 specific gravity determinations in the database relating to the deposits. Details of sampling by deposit are included in Table 8-1. Dry bulk density is measured using the Marcy or immersion method (Dry bulk density = weight in air / (weight in air-weight in water)). Alternatively, measurements were taken using weight in air, weight in water and saturated weight to account for porosity. Quality checks using a caliper method of measuring cylinder lengths and widths is also used.

Table 8-1: Number of density measurements for each deposit

Deposit	Number of measurements	Dry bulk density (g/cm^3)
Hugo North	32,311	2.74
Hugo South	8,101	2.76
Oyut	23,748	2.74
Heruga	2,896	2.82
Others	3,685	2.70
Total	**70,741**	**2.75**

The QP considers the sampling protocols to be appropriate for use in the reporting of Mineral Resource estimates.

8.2 Sample analysis

During 2002 and 2003, the on–site sample preparation facility and analytical laboratory were operated under the name Analabs Co. Ltd. Analabs Co. Ltd was an Australian–based company controlled by Scientific Services Limited, which was acquired by the SGS Group in 2001. SGS is an internationally recognized organization that operates more than 320 laboratories worldwide, many of which have ISO 9002 certification. The operating name of the Mongolian subsidiary was changed to SGS Mongolia in 2004.

Check assays in the early phases of drilling programs were performed by Bondar Clegg and Chemex laboratories. It is not known what certification these laboratories held at the time of the check assay programs.

Until May 2005, SGS Welshpool in Perth, Australia, was designated as the secondary (check) laboratory. This laboratory currently has ISO 17025 accreditation, but whether it did at the time of the analyses is unknown.

After May 2005, the secondary laboratory was changed to Genalysis Laboratory Services Pty Ltd. (Genalysis), also in Perth. The National Association of Testing Authorities Australia has accredited Genalysis to operate in accordance with ISO/IEC: 17025 (1999), which includes the management requirements of ISO 9002:1994.

Check assays were also performed by ActLabs Asia LLC, part of the global ActLabs Group, which has maintained a full–service laboratory in Ulaanbaatar since 2006. The laboratory has sample preparation, weighing, fire assaying, wet laboratory, and instrumentation sections. It maintains an ISO 17025 accreditation and participates in CANMET and Geostats Proficiency Testing programs.

Until September 2011, all routine sample preparation and analyses of the Oyu Tolgoi samples were carried out by SGS Mongolia, which operates an independent sample preparation facility at the Oyu Tolgoi site and an analytical laboratory in Ulaanbaatar. SGS Mongolia, part of the global SGS Group, and predecessors have maintained a full–service laboratory in Ulaanbaatar since the late 1990s. This laboratory was recognized as having ISO 9001:2000 accreditation and conforms to the requirements of ISO/IEC 17025 for specific registered tests. The laboratory performs all fire assay analyses.

Between 2011-2016, the samples were submitted to SGS Mongolia for preparation and gold analysis and ALS (Canada) for multi-element analysis. Since 2016, the sample preparation for exploration and resources estimation has been carried out by SGS Mongolia located in Ulaanbaatar and umpire assay analysis has been performed at ALS laboratory in Perth, Australia and Canada.

Since September 2011, a second pulp has also been sent to the ALS Chemex (ALS) facility in Vancouver, Canada, for inductively coupled plasma and LECO analyses. ALS also acts as the check assay lab for SGS and vice versa. Since 2005, ALS has held ISO/IEC 17025 accreditation.

8.3 Quality assurance measures

8.3.1 QA/QC program outline

Five QA/QC samples are routinely included in every batch of 15 samples to make up a batch of 20 samples. QA/QC samples consist of one duplicate split core sample, one uncrushed field blank, a reject or pulp preparation duplicate, and one or two SRM samples (<2% Cu and >2% Cu if higher grade mineralisation is present based on visual estimates). The SRMs are matrix–matched to ensure consistency with routine analytical samples.

The split core, reject, and pulp duplicates are used to monitor precision at the various stages of sample preparation. The field blank can indicate sample contamination or sample mix–ups, and the SRM is used to monitor accuracy of the assay results.

8.3.2 Standard reference materials

Standard reference materials (SRMs) are prepared from Oyu Tolgoi site material of varying matrices and grades to formulate bulk homogenous samples. Ten samples of this material are sent for round–robin testing by at least seven international laboratories. The resulting assay data are analyzed statistically to determine a representative mean value and standard deviation necessary for setting acceptance/rejection tolerance limits. Blank samples are also subjected to a round–robin program to ensure the material is devoid of any of the elements of interest so they can be confidently used to monitor potential contamination.

The performance of the SRM samples has been monitored throughout the life of the program for this resource statement. The ability of the laboratories to return assay values in the prescribed SRM ranges has steadily improved to greater than 99%. All samples were given a “fail” flag as a default entry in the geological database. Each sample was re-assigned a date-based “pass” flag when assays have passed acceptance criteria. Owing to the change in analytical techniques, recertification of the SRMs was completed in 2012.

8.3.3 Blanks

Field blanks are used for checking whether there is a source of any contamination or sample mix–ups during the sample preparation, ensuring that laboratory instrument and devices are cleaned properly between samples. Field blanks are taken from the pit waste dump quarry in the north–northeast corner the of the mining licence area and re–assayed to ensure the material is barren. Previously, field blanks were granodiorite or granite that are similar to the rocks of the Southwest Oyu area. Currently, field blanks are 1 cm quarry stone and are stored in a big wooden box nearby the open pit office.

The lower detection limits of the gold and copper methods are 0.01 g/t Au and 0.001% Cu and expected value for field blanks are set at 0.06 g/t Au and 0.06% Cu. Batches get automatically failed and sent for re–assay test if these expected values are exceeded.

Evaluation of the blank samples submitted to the laboratory in the period 2009–2019 indicated a low incidence of contamination for the analytical programs. A few cases of sample mix–ups were identified during the review of the blank performance, which were investigated at site and corrected. No evidence of systematic contamination was noted for the review of data from 1 January 2008 to 1 November 2010 (Sketchley, 2011) and from 2011 to 31 December 2018 (Odonchimeg.A, 2013; 2014; 2015; 2016).

8.3.4 Duplicate samples

Duplicates routinely used at Oyu Tolgoi comprise core, coarsely crushed rejects, and pulps. Core duplicates are taken in the field from one-half of core that has been split parallel to the long axis. Coarsely crushed rejects and pulp duplicates are taken in the laboratory by using a riffle splitter. Assays of each type follow the parent sample in a batch.

Duplicates data were plotted using the acQuire™ QA/QC module. The only issue of significance is for gold duplicates where a strong bias is noted for several samples, which is most likely related to sample mix-ups as that pattern is present for core, coarsely crushed, and pulp samples. The remaining data display normal distribution patterns, and the precision is deemed acceptable for the types of material and mineralisation being examined.

Copper generally performed very well with results well within expected limits; gold results are higher than copper but considered acceptable.

8.4 Sample security

Samples are always attended to or locked in a secure sample dispatch facility. Sample collection and transportation were always undertaken by company or laboratory personnel using company vehicles. Chain–of–custody procedures included filling out sample submittal forms that were sent to the laboratory with the sample shipments to ensure that the laboratory received all the samples.

Assay data is returned electronically from the laboratory and uploaded into the Rio Tinto acQuire™ database (RTDB).

The sample chain of custody is managed by Rio Tinto.

The QP considers the QA/QC and security protocols used on the Project to be appropriate in regard to the data used in the generation of this Mineral Resource estimate.

9. Data verification

9.1 Exploration and Mineral Resource verification

Before August 2010, all geological and geotechnical drill hole data were entered into an MS Access relational database that had been developed in-house. Data were exported from the main database to meet end-user requirements.

In August 2010, Oyu Tolgoi LLC elected to migrate the MS Access database to a full Microsoft SQL Server (ODBC) acQuire™ database with links to the end-user software programs. The database is read-only for these programs, preventing accidental overwriting and ensuring up-to-date live and centralized data, rather than distributed databases.

Before August 2010, all drill hole data were initially manually recorded in the field or in the core logging shed on paper logging sheets. The logging geologist then introduced logging information into the MS Access database, which had a series of embedded checking programs to look for obvious errors. Formational names were subsequently assigned according to the accepted geological interpretation and position within the stratigraphic column.

With the move to the acQuire™ database, which instituted direct digital data capture, the design stubs for the logging sheets do not permit any invalid data. No drill hole can be completed and entered into the database until the logging is correctly entered.

Analytical laboratories report results digitally by email and submit signed paper certificates. All hard copy assay certificates are stored in a well-organized manner in a secure location on-site.

Before August 2010, the digital assay results were imported to the MS Access files once the assay data had been received from the laboratory. With the subsequent direct import to the acQuire™ database, none of the assay data are entered manually. Project personnel visually check each assay on the signed paper certificate against the assay entry in the digital database.

Written procedures outline the processes of geological logging and data importing, quality assurance and quality control validation and assay importing. The robust RTDB import process is in place to ensure that any requests to modify existing data go through appropriate channels and approvals, and that changes are tracked by date, time, and user.

Rio Tinto

Field data is logged directly onto field Toughbook laptops using pre-formatted and validated logging templates, with details uploaded to the RTDB daily.

Assay data are only accepted in the RTDB once the quality control process has been undertaken utilising the Batch Analysis tool. Batch Analysis is a module within acQuire™ that enables geologists to assess a batch of assay data received from a laboratory for its accuracy and precision, by way of performance of duplicates and standards inserted within the batch.

All holes are surveyed by qualified surveyors. The drill holes are surveyed in WGS 84 / UTM zone 48N using Differential Global Positioning System (DGPS) which is accurate to 10 cm in both horizontal and vertical directions or in the underground using total station theodolite survey equipment with <1 cm accuracy. Surveyed drill hole coordinates are validated against the planned drill hole coordinates, and then uploaded to the drill hole database.

The historical drill holes were re-surveyed using DGPS; however, not all holes could be located and therefore the survey method for these holes is unknown and presumed to be planned coordinates. This is taken into consideration in the resource classification.

Drill hole collar reduced level (RL) data is compared to detailed topographic maps/as built workings and show that the collar survey data is accurate except where drilled on mined areas. The topographic surface is based on 5 m grid sampling of the most recent Light Detecting and Ranging (LiDAR) survey, including spot heights from DGPS drilling collars and is considered robust.

Downhole surveys are conducted on every hole, with the exception of collapsed or otherwise hazardous holes. Significant, unexpected deviations are investigated and validated. Holes greater than 100 m depth are surveyed with an in-rod gyro tool.

All the drill holes are geologically logged utilising standard Rio Tinto Classification Scheme logging codes. Geological logging is performed on 2 m intervals for all RC drilling and as required for core drilling. All drill holes are logged using downhole geophysical tools for gamma trace, calliper, gamma density, resistivity, and magnetic susceptibility.

In most recent years, acoustic and optical televiewer data are collected at select drill hole locations for geological structural analyses.

The import/exporting process requires limited keyboard transcription and has multiple built in safeguards to ensure information is not overwritten or deleted. These include:

- Data is imported and exported through automated interfaces, with limited manual input.
- Inbuilt validation checks ensure errors are identified prior to import.
- Once within the acQuire™ database, editing is limited, and warning messages ensure accidental changes are not made.
- An audit trail records updates and deletions should an anomaly be identified.
- An export interface ensures the correct tables, fields and format are selected.

The drill hole database used for Mineral Resource estimation is validated. Methods include checking:

- acQuire™ scripts for relational integrity, duplicates, total assay and missing/blank assay values.

- Grade ranges in each domain.
- Domain names and tags.
- Survey data downhole consistency.
- Null and negative grade values.
- Missing or overlapping intervals.
- Duplicate data.
- Drill hole data is also validated visually by domain and compared to the geological model.

Comparison of reverse circulation and twinned diamond core assay data distributions show that both drilling methods have similar grade distributions, verifying the suitability of RC samples for use in the Mineral Resource estimate.

The geological models and Mineral Resource estimates of deposits are created using established industry methods set out in Section 11. Verification of each geological model and Mineral Resource estimate occurs as noted in Section 11.1.9. In addition, a peer review is completed at each step of the modelling process, inclusive of a sign-off by a QP at the completion of major steps. A QP also prepares separate documentation to aid and support the Mineral Resource classification, including information about all factors that may affect the confidence in the final model of the deposit, including, but not limited to, geological complexity, data quality, data quantity, aspects of geological interpretation, grade and geological continuity, and Mineral Resource estimation.

The extracts for Mineral Resource estimation are made for certain periods for boundaries of the deposits and relevant areas. Data for the Oyut estimate was extracted as at 23 February 2016, whereas that of Hugo North were extracted as at 14 February 2014. Hugo South was extracted 1 November 2003. Heruga was extracted 21 June 2009.

The QP considers the current protocols in place for electronic data storage and extraction are in line with industry best practice. The database has been held in one place since inception and the implementation of an industry leading software such as acQuire™ provides a high level of data integrity on importation and security. The QP considers the data importation and storage systems to be adequate.

9.2 Mining and Mineral Reserve verification

Multiple verification steps and processes are in place to verify the Mineral Reserve estimate. Verification applies to the assumptions and inputs into the estimate, as well as the estimation process itself.

Oyu Tolgoi undertakes extensive comparison of actual ore produced to the orebody block model that underpins the Mineral Reserve estimates on a quarterly and annual basis. This reconciliation continually demonstrates that Oyu Tolgoi produces ore in the amount and of the quality as predicted by the orebody block models and is in accordance with the Mineral Reserve estimate. Reconciliations are undertaken for both in situ (head) ore as well as saleable ore product. This allows verification of the in situ ore estimate, as well as the metallurgical assumptions (upgrades, recovery etc.) of the Mineral Reserve estimate.

Verification of the key modifying factors applied to the Mineral Resource is also undertaken as part of the production process during operations. Actual performance for operational mining areas provides a high level of confidence where similar performance can be expected from future mining areas.

In addition to the verification of the modifying factors, the reported Mineral Reserve data itself undergoes several peer review and reconciliation steps prior to publication and release. One key component of the process is a comprehensive comparison between the current-year and prior-year Mineral Reserve estimates on a deposit-by-deposit basis. Any changes in the Mineral Reserve estimate are reconciled and verified against reported production (in cases of operating deposits), any changes to the underlying Mineral Resource estimate (e.g. tonnages, quality, confidence levels), changes to metallurgical assumptions, changes to pit designs and changes to the mine plan underpinning the Mineral Reserve estimate.

Modifying factors for the underground mine were benchmarked against other operating caving mines and the overall recovery is in the range of expected outcomes experienced by operating mines. The underground Mineral Reserves estimates are less sensitive to changes in pricing and operating cost due to the sharp ore to waste contact as the Hugo North mineralisation is bound at the top of planned draw columns by the Contact fault. The QP has only used data deemed to have been generated in line with approved industry standard procedures and that is suitable for use for the purposes of preparing the mine design, schedule and Mineral Reserve estimate.

9.3 Geotechnical verification

Geotechnical data verification processes and safeguards are similar to those implemented for resource verification, except geotechnical drill holes are focused on geological units that will form the walls of the pits and any structures that may impact slope stability or caving parameters. The drill hole data is securely stored in an acQuire™ geoscientific information management system.

Drill hole logging is undertaken by appropriately qualified geotechnical engineers and a minimum of 10% of the core is relogged as part of a QA/QC process. Data goes through two stages of validation before it can be utilised for design purposes.

Geotechnical designs are signed off by suitably qualified and experienced professionals. The number of individuals authorised to sign off geotechnical aspects of designs is limited to ensure quality verification of design data. The QP ensures that there is adequate data of suitable quality to justify the reliance on the information in the final design.

As pits and underground workings are excavated, reconciliation mapping is undertaken in specifically identified areas to assess the reliability of the geotechnical model in predicting actual ground conditions. Based on the reliability of the models, additional data may need to be collected or modifications made to the design.

In the opinion of the QP, the geotechnical data used to inform geotechnical factors of safety parameters is of adequate quality for the Property and its material types and for the purposes used in this TRS.

9.4 Hydrology and hydrogeology verification

Hydrological studies have been conducted continually throughout the life of the Project. They are now the responsibility of the Health, Safety and Environment department of Oyu Tolgoi LLC.

The key objective of water monitoring at the operation is to study the natural hydrological system at and around the mine site and all its major components. This includes all potential

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impacts from the Project's water use, mining activity and technogenic actions. A major part of this work is the measurement and monitoring of water monitoring bores, herders hand wells and springs throughout the Gunii Hooloi, Galbyn Gobi-Gashuun Sukhait road and Undai River and report on the observations of water level fluctuation and water quality composition changes.

This information can be utilised for optimising the future use of groundwater and to evaluate the impacted zone of Project activities and the implementation of mitigation measures to offset negative impacts on the groundwater reserve, quality and natural balance.

The water monitoring program is targeted for specific purposes; methodology and frequency is based on the groundwater general regime and potential negative impacts of the Project activity. The water-monitoring program is undertaken on the groundwater and the surface water monitoring and includes 234 bores, 64 hand wells, 10 springs and totally 308 water points (see Table 9-1).

Table 9-1: Number of water monitoring points

Area	As at 2022		
	Boreholes	Hand well	Springs
Oyu Tolgoi site	59	-	-
Undai River	34	17	7
Gunii Hooloi-Khanbigd	141	47	3
Sub-total	271	64	10
Total of all monitoring points	308		

As of 2022, the water monitoring covers a total of 59 water points in the four main areas: open pit mining, tailing storage facility, Undai riverbeds, and generally in the Oyu Tolgoi Mining Special Licence area. The following activities are under investigation:

- Ore deposit hydrogeological conditions around the Oyu Tolgoi mine site; the modelling for evaluation of underground mine's groundwater flow; open pit mine hydrogeology and the survey for minimizing the pressure impact to the open pit mining slope stability; the piezometer's measurement for control groundwater movement; and 3D modelling of groundwater pressure in rock pores.
- Water drawdown survey after the dewatering of open pit and underground mine.
- Impacts of the Undai River Diversion and Protection project; the water use monitoring of production bores are located in the mine site and to control impacts of mining activity.
- Hydrogeological condition and leakage study at the area of the tailings storage facility (TSF).

In the opinion of the QP, the data used to inform the groundwater models is of adequate quality, supported by historical performance and regular reconciliation. Surface water models are built based on baseline flows and historical observations. In the opinion of the QP, this data is adequate for use in the mine design and production schedules and for the purposes used in this TRS.

9.5 Metallurgical verification

Metallurgical product predictions are verified numerous times through to their application for deposit estimates. Raw metallurgical laboratory results are peer reviewed and double checked through redundant analysis techniques. Following creation of product predictions, a second peer review process is conducted to verify the validity of the predictions across the geological zones and grade ranges. The QP reviews the orebody block model product data and ensures predictions are accurately included in relevant fields. The orebody block model is also reviewed and endorsed by the relevant metallurgical subject matter expert.

Once mining and production data is available, reconciliations are carried out on a quarterly basis, comparing actual mass and grade data to the block model predictions. Reconciliation trends are monitored and where biases are observed over multiple quarters, reasons are investigated and product predictions updated as required.

In the opinion of the QP, the metallurgical data used to inform product predictions are adequate for the purposes used for this TRS.

10. Mineral processing and metallurgical testing

10.1 Nature and extent of mineral processing and metallurgical testing

The Oyu Tolgoi concentrator was designed to initially process ore only from the Oyut deposit (Phase 1) and, after modifications, to process a blend of ore from both the Hugo North and Oyut deposits (Phase 2). Currently, ore from the Oyut is the dominant feed type with Hugo North production ore from underground a minority.

Detailed mineral processing and metallurgical testing has been completed at all stages of the mine development. Testing commenced based on the Oyut open pit development area, but has since changed focus to the development of geometallurgical predictability of the Hugo North area.

10.2 Spatial representivity of metallurgical sampling

10.2.1 Numbers of tests

The number of tests completed on samples from Oyut and Hugo North is summarized in Table 10-1,

Table 10-2, and Table 10-3. The Oyut Southwest zone refers to Southwest, South, Wedge, Bridge, and West zones within the Oyut open pit (see map in Section 6 “Deposit types”, Figure 6-6).

Table 10-1: Number of samples used for metallurgical testwork programs

Deposit/Zone	Years of scheduled production	No. of holes sampled	No. of samples tested
Oyut Southwest zone	0–9, 13–30	77	224
Oyut Central zone	0–20	25	94
Hugo North	0–20	99	299

Table 10-2: Minnovex comminution tests

Deposit/Zone	SPI tests	Modified Bond tests	BWI tests	SPI density (Mt per test)
Oyut Southwest zone	304	295	34	2.6

Deposit/Zone	SPI tests	Modified Bond tests	BWI tests	SPI density (Mt per test)
Oyut Central zone	88	85	7	3.0
Hugo North	253	246	21	1.7
Total	645	626	62	2.3

SPI = SAG mill power index, BWI = bond work index, SPI density = the approximate Mineral Reserve tonnage divided by the number of SPI tests carried out (includes tonnage or ore processed since concentrator commissioning).

Table 10-3: Flotation tests

Deposit/Zone	Rougher tests	Rougher + cleaner tests	Locked cycle tests	Column tests	Pilot plant runs
Oyut Central zone	196	165	4	0	0
Hugo North	214	118	10	2	1
Composites	26	37	7	0	0
Total	669	754	29	10	5

The sampling density in the Oyut open pit Mineral Reserve is two to four times higher in the early production years than for the life of mine. This is consistent with normal open pit mining practice for large orebodies.

For Hugo North Lift 1, the sampling density for the life of mine is approximately double that of the Oyut orebody. This is because of the inability to resample the Lift 1 Mineral Reserve by drilling once caving has commenced.

The QP considers that the samples on which metallurgical testwork has been carried out are representative of the Mineral Reserves that are planned to be mined.

10.2.2 Collection of samples and types of testwork

The initial metallurgical testwork programs on Oyu Tolgoi mineralisation were carried out between 2001 and 2007. The testwork formed the basis for the design of the Phase 1 concentrator.

The testwork programs were carried out on drill core samples from various deposits (Table 10-4). The focus was on the Oyut and Hugo North deposits. The testwork programs identified the mineralogical characteristics and the metallurgical response of the individual deposits and the various blends of ore to be processed through the concentrator at different periods in the planned production schedule.

Table 10-4: Types of metallurgical and mineral processing test work used in characterisation of Oyu Tolgoi mineralisation

Deposit	Test Type	Intended Use of Testwork	Laboratories or Other Providers
Southwest zone Open Pit	Comminution testwork, including SAG pilot plant tests using a 250 t bulk sample of mined rock from the Southwest zone	Comminution	SGS Lakefield

Deposit	Test Type	Intended Use of Testwork	Laboratories or Other Providers
	Gravity concentration	Gold recovery	SGS Lakefield
	Flotation	Copper and gold recovery	SGS Lakefield
	Bench and pilot plant scale flotation	Copper and gold recovery	SGS Lakefield
Heruga	Mineralogical, flotation, comminution	Scoping study	G&T Metallurgical Services
Southwest and Central Ore	Cleaner flotation	Copper and gold recovery	SGS Lakefield
Open Pit + Hugo North Lift 1	Flotation, mineralogy	Copper and gold recovery	SGS Burnaby
Hugo North Lift 1	Comminution, flotation, mineralogy, tailings rheology and thickening characteristics	Throughput estimates, recovery estimates, tailings rheology	ALS, Perth

10.3 Details of analytical or testing laboratories

Details of the internal and external laboratories or other testing facilities used by Rio Tinto to characterise mineralisation within the Property are listed in Table 10-5.

Table 10-5: Details of analytical or testing laboratories

Laboratory	Location	Relationship to Rio Tinto	Certification	Certifying Organisation
SGS Lakefield Research Ltd (SGS Lakefield)	Ontario, Canada	Independent facility	ISO 9001:2015 ISO/IEC 17025:2017	ISO
G&T Metallurgical Services (now ALS)	Kamloops, Canada	Independent facility	(now ALS)	Not applicable
A.R. MacPherson Consultants Ltd	Perth, Western Australia	Independent facility	No longer operating	Not applicable
Terra Mineralogical Services Inc.	Ontario, Canada	Independent facility	None	Not applicable
Ammtec (now ALS in Perth, Australia)	Perth, Western Australia	Independent facility	ISO 9001:2015. ISO/IEC 17025:2017	ISO

Laboratory	Location	Relationship to Rio Tinto	Certification	Certifying Organisation
Minnovex Technologies (now SGS)	Toronto, Canada	Independent facility	No longer operating	Not applicable
Process Research Associates	British Columbia, Canada	Independent facility	No longer operating	Not applicable

10.4 Predictions and assumptions in mineral processing

Results from the testwork were used to generate:

- Throughput rates.
- Predictions for grade deportment between concentrate and tailings.
- Size distributions for feed, products and tailings.
- Mass recovery splits used in plant design.

10.4.1 Processing rate

The target primary grind size for each ore type was determined from a comprehensive series of kinetic flotation tests carried out in 2007 by Process Research Associates in Vancouver. The testwork optimized the P80 feed sizes for the rougher and the cleaner flotation circuits. The rougher testwork was carried out on samples from the Southwest and Central zones and from Hugo North. The testwork formed the basis of the detailed design of the Phase 1 milling and flotation circuits.

Comminution testwork has been used to develop equations and input parameters to predict the primary milling capacity for the Phase 1 concentrator and the Phase 2 modifications. The predictions were for each ore type at the target flotation feed P80.

The following comminution parameters are used in the equations:

- SAG power index (SPI) in minutes).
- Modified bond index (MBI) in kWh/t – a short form of the bond ball mill index test.
- Minnovex crushing index (Ci) – developed from the sample preparation process for the SPI.

The equations have been used to predict circuit throughput in tonnes per hour (t/h) at a nominated P_{80}.

The equations are shown in Table 10-6. The results from the equations compare well with other commonly used equations and reconcile well with the actual performance of the Phase 1 concentrator.

Table 10-6: Processing rate model

$$\textit{Tonnes per operating hour} = z \times r \times SPI^{s} \times MBI^{t} \times Ci^{u}$$

Ore	Z	r	s	t	u
Oyut (SPI ≤ 60)	1.000	32 920	-0.345	-0.07	0.00
Oyut (SPI > 60)	1.000	26 649	-0.208	-0.24	0.00

$$\textit{Tonnes per operating hour} = z \times r \times SPI^s \times MBI^t \times Ci^u$$

Ore	Z	r	s	t	u
Hugo North	1.000	29 320	-0.360	-0.24	0.19

The comminution dataset, used to estimate grinding circuit capacity, contains 645 SPI results and 626 MBI results. The results show a large overlap between the Oyut and Hugo North deposits. Summaries of the datasets for the Oyut Central and Southwest zones and Hugo North are shown in Table 10-7, Table 10-8 and Table 10-9. Throughput values are for the Phase 1 concentrator.

Table 10-7: Oyut Central zone ore comminution indices

Percentile	SPI (min)	MBI (kWh/t)	Ci	Throughput (t/h)
20th percentile	26.0	9.8	33.0	10,053
50th percentile	49.2	13.0	24.7	6,895
80th percentile	65.2	14.7	21.0	6,062

Table 10-8: Oyut Southwest zone ore comminution indices

Percentile	SPI (min)	MBI (kWh/t)	Ci	Throughput (t/h)
20th percentile	90.0	18.3	22.0	5,145
50th percentile	132.4	19.9	16.6	4,158
80th percentile	188.1	21.4	12.8	3,492

Table 10-9: Hugo North ore comminution indices

Percentile	SPI (min)	MBI (kWh/t)	Ci	Throughput (t/h)
20th percentile	61.9	16.4	24.3	5,898
50th percentile	76.4	17.7	16.6	5,063
80th percentile	104.4	20.1	9.7	4,319

For the Central zone samples, there is a strong relationship between ore competence and depth (elevation) below surface. Shallow ore is significantly softer than deeper ore. There is no significant relationship between ore competence and depth for the Southwest zone or the Hugo North deposit (Figure 10-1).

Based on the comminution testwork, the Phase 1 and Phase 2 grinding circuits are expected to have sufficient capacity when processing the planned ore blends.

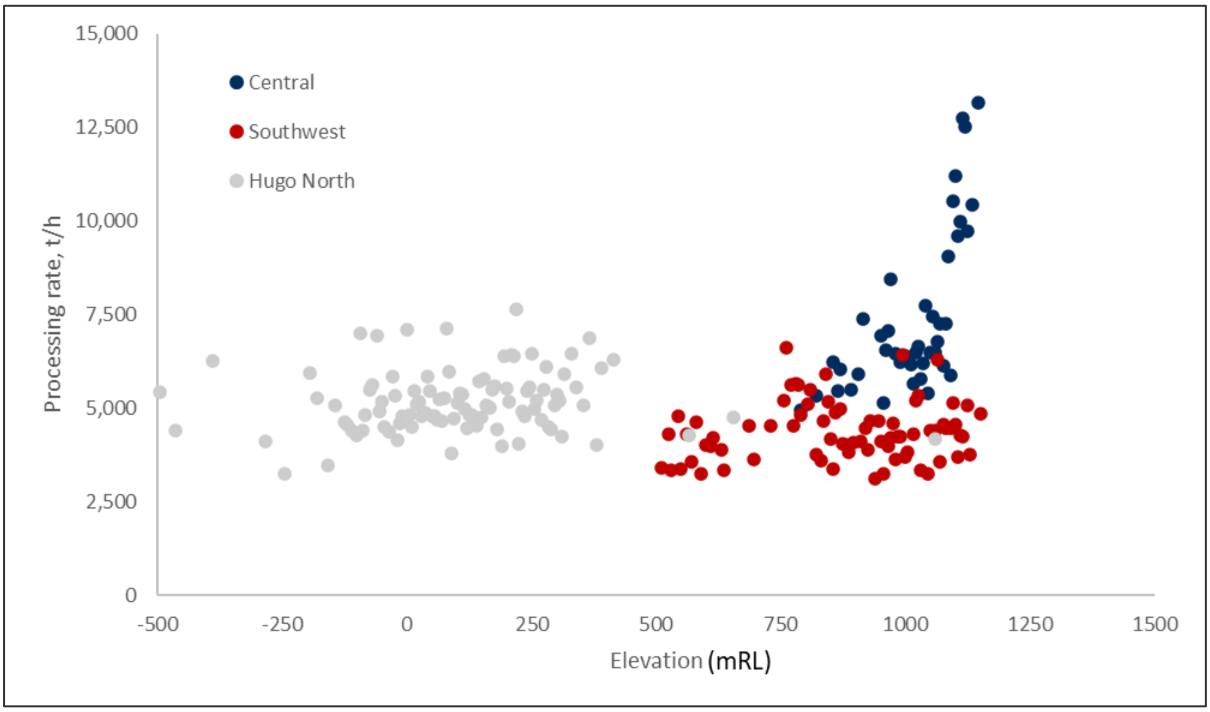

Figure 10-1: Relationship between elevation and predicted processing throughput

10.4.2 Mineralogical assessments

Many mineralogical assessments have been carried out on ore samples and flotation products. The most recent assessments have been carried out by TMS, Blue Coast and ALS.

The assessments included the following:

- Routine assessments of thin sections on intervals of core to qualitatively assess the nature of the copper mineral and gangue mineral assemblage.
- Routine semi-quantitative clay mineral measurements by infrared spectroscopy to assist in alteration classification and to potentially identify rheology-modifying species that could be problematic in processing.
- Mineralogical assessment of ore sections from all deposits. These include analysis of gold association, fluorine deportment in ore and concentrate, copper mineral associations in tailing, and leach residues.
- Visual logging of all core with respect to estimated sulphide mineral totals.
- Diagnostic leach testwork on oxide and secondary copper zones to distinguish between chalcocite, chalcopyrite and covellite.
- Quantitative evaluation by scanning electron microscopy (QEMSCAN) on particulate Southwest zone and Hugo North composites (flotation feed and rougher concentrates).
- QEMSCAN analysis on 20 flotation feed composites from Hugo North and Central zone testwork programs.
- X-ray diffraction and QEMSCAN on flotation tailings to assess the potential for acid generation.

- 48-element inductively coupled plasma mass spectrometry (ICP-MS) assays on 24,000 intervals over all deposits.
- Liberation analysis by conventional particle counts on Heruga.
- QEMSCAN analysis on an additional 40 Hugo North samples.
- QEMSCAN analysis on monthly composites of Phase 1 concentrator key process streams for 2014, 2015, 2017 and 2018, which remain ongoing.

10.4.3 Flotation testwork

Many flotation testwork programs have been undertaken on Oyu Tolgoi ore types. The testwork has been carried out on individual samples of different ore types and on various blended samples. Tests include:

- Rougher flotation tests.
- Rougher and cleaner flotation tests.
- Locked cycle flotation tests.
- Column flotation tests.
- Pilot plant flotation campaigns.

The laboratory testwork has been supplemented by concentrator operating experience. As a result, the characteristics of the processing characteristics of the Oyut ore types are well defined. The characteristics of blends of Hugo North and Oyut ore types have not yet been processed through the concentrator and are therefore based on the findings from the extensive testwork programs.

Kinetic flotation testwork carried out in 2007, resulted in the selected rougher flotation feed sizes shown in Table 10-10. The Phase 1 concentrator was designed on the results of this program. The current target grind size is based on a detailed analysis of the testwork and plant operating experience.

Table 10-10: Primary grind size P_{80} for each ore source

Deposit / zone	2007 testwork P80 (µm)	Current target P80 (µm)	Deposit / zone
Southwest	180	150	Southwest
Central (average)	158-179	180	Central (average)
Hugo North	100-140	140	Hugo North

The regrind size for covellite and chalcocite indicates a preferred P80 of 25–30 µm, although many comparative tests with regrind levels between 30 µm and 40 µm provided similar flotation performance. In most cases, finer regrinds did not provide higher cleaner stage copper recoveries or copper concentrate grades for covellite or chalcocite ore types.

Testwork indicates a preferred regrind P80 for ore from the Southwest zone of 25 µm. The plant has averaged only 72% passing 25 µm, rather than 80%. A finer size could be achieved but the coarser grind is preferred because of concerns with froth-carrying capacity and flotation rates at fine sizes in flotation columns, where bubble–particle contacts have relatively low energy.

The regrind size requirement for Hugo North ore types is different than for Southwest ore types for the following reasons:

- Liberation of copper sulfides is much higher in Hugo North rougher concentrate at all particle sizes.
- Most of the Hugo North orebody is hosted in quartz-rich areas, resulting in lower levels of fluorine-bearing sericite in the final concentrate.
- The copper to fluorine ratio in Hugo North ore is much higher than in Southwest ore, which is also reflected in higher copper to fluorine ratios in the concentrate.
- Considering the large volume of concentrate production, keeping the regrind P80 as coarse as possible allows higher froth loading and better concentrate dewatering. It is still possible, however, to achieve a finer regrind at the same power input by using finer grinding media (12.5 mm rather than 15 mm). This may be required if less liberated zones are encountered.
- In contrast to the open pit, given the large number of drawpoints planned for Hugo North, there will be a high degree of blending but limited opportunity for selective grade control. Fluorine content is expected to be less variable.

Cumulative liberation yield curves for Hugo North ore and the Southwest zone are shown in Figure 10-2. The Cumulative liberation yield curves represent the theoretical grade-recovery curve obtained by recovering all copper sulphide particles in order of declining degree of liberation. Higher liberation is achieved for Hugo North ore in each of three particle size fractions, as well as in the combined product. The normal criterion for final concentrates, 90% liberation, is achieved in the –75 µm to +38 µm fraction for Hugo North cleaner feed, while this is only achieved in the –38 µm fraction for Southwest cleaner feed. It is noted that actual cleaner grade–recovery curves are a few percentage points below the theoretical curves.

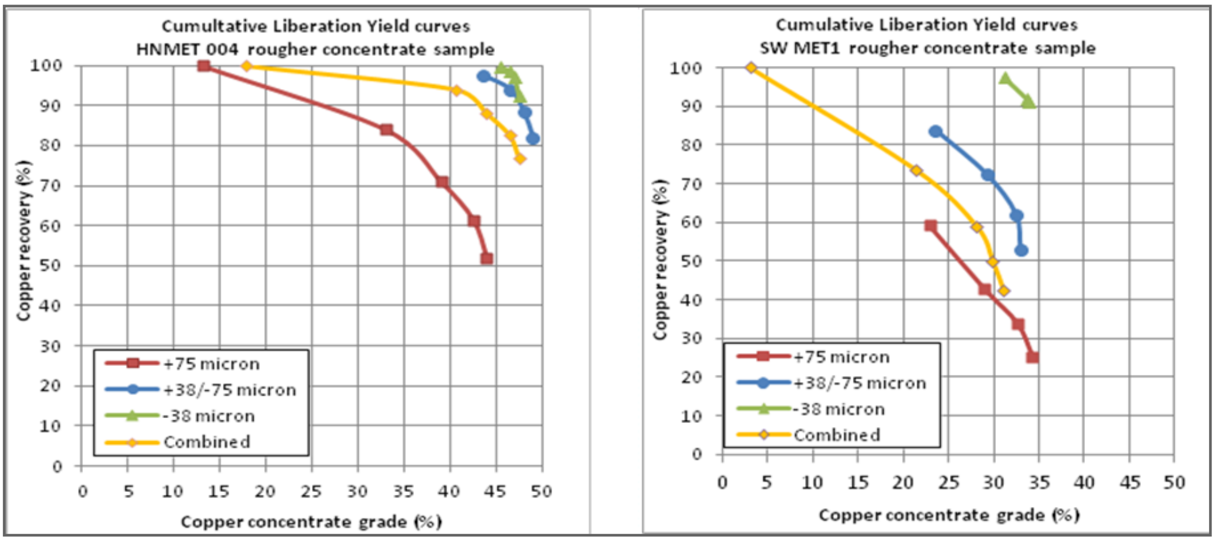

Figure 10-2: Hugo North and Oyut Southwest sample cumulative liberation yield curves for regrind product

A planned regrind P80 of 40 µm results in very high liberation for Hugo North ore and reasonable liberation for Southwest ore types. It is recognized that conditions will be non-optimal for the covellite and chalcocite ore types in the Central zone when blending with Hugo North ore.

10.4.3.1 Testwork for minor elements

10.4.3.1.1 Silver

The assay method used in most testing programs was not sensitive enough to detect silver in test tailings samples, and silver recovery was not measured in the Ammtec-ALS or Blue Coast test programs. A reduced database only including the rougher kinetic test results with silver assays on the tailings has been used to develop a silver recovery model. This database, combined with the database of actual recoveries from plant operations, has been used to estimate average silver recovery for Oyut (52%) and Hugo North (80%).

10.4.3.1.2 Molybdenum

At the Oyut and Hugo North deposits, the molybdenum head grades are considered too low to justify the capital required to add a molybdenum recovery circuit to the Oyu Tolgoi concentrator. Consequently, no significant testwork has focused on molybdenum recovery. No payment or penalty is applied for molybdenum in a copper concentrate.

A common rule-of-thumb is that a molybdenum head grade of 150 ppm is required for economic molybdenum recovery, whereas Hugo North grades are in the order of 27 ppm. The Heruga deposit has grades of around 140 ppm molybdenum, which may be high enough for economic production of a molybdenum flotation concentrate in the future.

10.4.3.2 Testwork on Hugo South, and Heruga deposits

The Hugo South, and Heruga deposits remain in the assessment phase. A metallurgical scoping study was conducted at G&T Metallurgical Services in 2008 for the Heruga deposit. Nine composite samples from the deposit were sent to G&T laboratory for initial scoping testwork programs. These programs assessed the mineralogical characteristics of plant feed and flotation products, the flotation response of each sample, and the bond ball mill work index. These programs also analysed the exit streams from the flotation testwork to identify opportunities for further improvement in metallurgical performance. Overall, the composites responded well to the applied Oyu Tolgoi flowsheet envisaged at the time.

Based on the testwork carried out to date on the Hugo South and Heruga zones, the estimated flotation metal recoveries are summarised in Table 10-11.

Table 10-11: Hugo South and Heruga estimated flotation metal recovery to concentrate

Deposit	Estimated flotation recovery			
	Cu	Au	Ag	Mo
Hugo South	89%	81%	84%	–
Heruga	82%	73%	78%	60%

10.4.4 Geometallurgical characterization of Oyut and Hugo North deposits

The geometallurgical characteristics of the different ore types in the Oyut and Hugo North deposits are based on a reconciliation of a large database of metallurgical testwork completed to date. The database includes seven years of Phase 1 operating data.

In 2018, the geometallurgical ore types were redefined for the Oyut deposit. Nine ore types were identified based largely on the geological domains used to define the earlier five ore types used. The nine ore types provide an increased level of definition relating to ore hardness, flotation recovery and flotation concentrate grade. The geometallurgical ore types for the Oyut deposit are described in Table 10-12.

Five geometallurgical ore types were identified for the Hugo North deposit, compared with the one ore type used prior to 2018. The ore types are based on the observed differences in flotation recoveries from samples with varying chalcopyrite and bornite content and on the influence of pyrite on concentrate grade. The five ore types are summarized in Table 10-13.

Table 10-12: Oyut geometallurgical ore type definitions

Pit zones	Ore type	Abbrev.	Geo metallurgical description
Southwest zone (Southwest, South, Wedge, Bridge, and West)	Hard Gold	HG	Hard, chalcopyrite / bornite, high copper and gold recovery, low arsenic bearing
	Hard	H	Hard, chalcopyrite/bornite, high copper and low to moderate gold recovery, low arsenic bearing
	Moderate Gold	MG	Moderate hardness, chalcopyrite/bornite, high copper and gold recovery, low arsenic bearing
	Moderate	M	Moderate hardness, chalcopyrite/bornite, high copper and low to moderate gold recovery, low arsenic bearing
Central zone	Soft Supergene Enargite	SSE	Soft, chalcocite, low to moderate copper and gold recovery, high copper-arsenic sulfosalts
	Soft Supergene	SS	Soft, chalcocite, low to moderate copper and gold recovery, copper-arsenic sulfosalts
	Soft Hypogene Enargite	SHE	Soft, covellite/chalcopyrite, high copper and low to moderate gold recovery, high copper-arsenic sulfosalts
	Soft Hypogene	SH	Soft, covellite/chalcopyrite, high copper and low to moderate gold recovery, copper-arsenic sulfosalts
	Soft Hypogene Gold	SHG	Soft, covellite/chalcopyrite, high copper and gold recovery, copper-arsenic sulfosalts

Table 10-13: Hugo North geometallurgical ore type definitions

Ore type	Abbrev.	Criteria	Processing characteristics
High arsenic	HI-AS	As ≥ 200 ppm	Potential to produce flotation concentrate with over 2,000 ppm As. Distributed mainly in augite basalt and ignimbrite rock types in the hanging wall of Lift 1 and overprinting BN-CP ore in the core of Lift 2.
High copper grade, high bornite content with little pyrite	BN-CP	Cu ≥ 1.25% Cu:S ≥ 1.2	Soft, strongly phyllic altered quartz monzodiorite and augite basalt at the core of the Hugo North resource. Higher copper and gold head grades and recoveries with potential to produce concentrate with copper grades from 30% to over 50%.
High copper grade, most copper in chalcopyrite, high pyrite	CP-PY	Cu ≥ 1.25% Cu:S < 1.2	Soft, strongly phyllic altered augite basalt and quartz monzodiorite overlying the BN-CP zone. High copper grades with moderate gold grades. High copper recovery and concentrate copper grades ranging from 20% to 40%, variable gold recovery.

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Ore type	Abbrev.	Criteria	Processing characteristics
Lower copper grade, high pyrite, generally has most copper in chalcopyrite	LG-PY	Cu < 1.25% S ≥ 1%	Pyrite rich augite basalt and ignimbrite in the hanging wall of the BN-CP and CP-PY zones. Moderate to poor copper and gold recovery and potential to produce low concentrate copper grades.
Lower Cu grade with little pyrite	LG	Cu < 1.25% S < 1%	Hard, potassic altered low sulphide BiGD and QMD in the footwall of the BN-CP zone. Moderate copper recovery, variable gold recovery with potential to produce concentrate with grades from 20% to 30%.

Note: a. Ore types are assigned in the top-down order shown, e.g. all blocks with As ≥ 200 ppm are assigned as HI-AS, regardless of copper and sulphur grades.

10.4.5 Penalty elements

Arsenic and fluorine are the only penalty elements that have been identified thus far. For arsenic in copper concentrate, a typical penalty rate of 2.00 $/t for every 1,000 ppm above a 2,000 ppm arsenic threshold applies. This applies up to the rejection level of 5,000 ppm, which is based upon the threshold for importation to China from the Chinese regulatory authorities. For fluorine in copper concentrate, penalties apply between the 500 ppm up until the 1,000 ppm rejection level.

10.4.5.1 Arsenic

Enargite is the primary arsenic carrier in all orebodies, although other sulfosalts, tennantite and arsenopyrite are also found. Enargite flotation recovery is almost the same as the flotation recovery of primary copper minerals. Enargite accounts for nearly all the elemental arsenic in the final concentrate.

The Central zone ore types contain moderate to high levels of arsenic sulfosalts and contributes the highest proportion of arsenic in concentrate. The Southwest zone contribution of arsenic in the flotation concentrate is very low, which is due to low arsenic feed grades and a larger portion of arsenic being in arsenopyrite, which can be rejected with high pH in the cleaner flotation circuit. Hugo North samples show that lower arsenic grades are generally associated with an increasing proportion of arsenic in arsenopyrite.

High flotation pH is the primary control on arsenic recovery, but it is only partially effective because of the difficulty in depressing enargite. In addition, high pH has an adverse impact on gold recovery and is therefore not often used. The most robust management approach for arsenic content in Central zone ore types is blending with Southwest and Hugo North ores, which contains lower levels of arsenopyrite.

Projected arsenic levels in concentrate are expected to decline from around 4,000 ppm to a range between 2,000 to 3,000 ppm as ore feed from Hugo North increases.

10.4.5.2 Fluorine

Fluorine is present, primarily as fluorite with lesser amounts of topaz and sericite. It is believed that fluorine in finely intergrown topaz may be more difficult to reject.

Concentrates from locked cycle testwork shows that Central zone concentrates contain higher fluorine levels than concentrates from the Southwest zone. Tests on Hugo North ore show uniformly lower fluorine levels than concentrates from the Southwest zone ore.

Testwork has been carried out to determine the practicality of acid leaching concentrates to remove fluorine. The testwork removed 60% of the fluorine in concentrate produced from

Southwest zone samples, but almost none from Hugo North concentrate. Acid leaching is inappropriate for the secondary copper minerals in Central zone as it will leach the copper.

The concentrator currently produces concentrates containing about 700 ppm fluorine, which is 300 ppm below the rejection level. It is noted that there has been no rejection of concentrate based on fluorine levels to date.

The plan is to manage fluorine levels below the rejection level through ore blending and operational control of the plant.

Fluorine in the Central zone and Hugo North ore shows a roughly linear relationship between fluorine in the feed and fluorine in concentrate. In both cases, the fluorine assay in concentrate is about 15% of fluorine in feed. However, plant performance observed in the first year of operation with Southwest zone brought the ratio up to 30% of the feed grade. This is also expected to apply to other ore types.

In all the months for which discrete data is available, fluorine grades in concentrate have been well below rejection level.

10.4.6 Other testwork

10.4.6.1 Water quality

Testwork was conducted at SGS using bore water collected from the Gunii Hooloi bore field. A simple average of samples from individual wells was used, and Vancouver tap water was used as a control. For the higher grade ore samples from the Southwest zone, this testwork showed that copper recoveries were higher compared to tests using recycled water. At lower grades, the recycle water achieved higher copper recoveries (possibly due to recycled collector). Experience since Phase 1 commissioning has shown no detrimental effects from using process water.

10.4.6.2 Thickening and concentrate filtration

As part of the initial testwork program for the design of the Phase 1 concentrator, large composites of Southwest zone and Hugo North samples were made up from surplus sample at the Ammtec laboratory. These samples were processed through pilot-scale equipment to generate large samples of concentrate and tailings for further testing. Concentrate was used for marketing analysis and to measure the thickening and filtration design parameters. Tailings material was used to confirm the design parameters for the thickeners, pumps and tailings deposition. Tailings were also evaluated to define environmental parameters.

The same thickening and filtration parameters developed for the Phase 1 design have generally been retained for Phase 2 design work, despite the coarser regrind targets. This was the case for the final tailings area, where the dewatering duty for blended Southwest, Central, and Hugo North tailings is similar to those determined for Phase 1.

Some concentrate thickening work was completed on laboratory products from the Hugo North metallurgical testwork in 2016, but the volumes of concentrate and tailings were small and not well suited to thickening and filtration testwork. However, the 2016 testwork program confirmed that the Phase 1 design thickener capacities were appropriate.

10.4.7 Recovery and concentrate grade prediction

Based on the results of the testwork programs the ongoing plant operations, a series of equations have been developed to predict current and future metal recoveries and concentrate grades of the various ore types. The equations for copper gold and silver recovery are shown in Table 10-14 through Table 10-18. The equations for estimating concentrate grade are shown in Table 10-19 and Table 10-20. The ore type definitions are shown in Table 10-12 and Table 10-13. Where:

- a, b, c, d, e, f, g, h, i, j, k, n, o, p, u are constants, which vary by ore type.
- CuF is the feed copper assay in percent (%).
- AuF is feed gold assay in grams per tonne (g/t).
- AgF is feed silver assay in grams per tonne (g/t).
- SF is feed sulphur assay in percent (%).
- CuRec is copper recovery in percent (%).
- AuRec is gold recovery in percent (%).

Table 10-14: Global copper recovery model

$$\boldsymbol{Copper\ recovery}\ (\%) = \boldsymbol{a} \times \frac{\boldsymbol{b} \times \boldsymbol{CuF}}{\boldsymbol{1} + \boldsymbol{b} \times \boldsymbol{CuF}} \times \left(\boldsymbol{1} - \boldsymbol{e}^{(-\boldsymbol{b} \times \boldsymbol{CuF})}\right)$$

Code	Ore Type	a	b
1–4	HG, H, MG, M	98.0	14.5
5–6	SSE, SS	72.0	15.0
7–9	SHE, SH, SHG	80.7	15.0
10, 12–14	CP-PY, LG-PY, LG, HI-AS	96.0	20.0
11	BN-CP	95.0	15.0

Table 10-15: Oyut gold recovery model

AuF < 0.25

$$\boldsymbol{Gold\ recovery}\ (\%) = \boldsymbol{c} \times \boldsymbol{AuF} + \boldsymbol{d}$$

0.25 ≤ AuF < 2.5

$$\boldsymbol{Gold\ recovery}\ (\%) = \mathbf{u} \times \frac{\boldsymbol{f} \times \boldsymbol{AuF}}{\boldsymbol{1} + \boldsymbol{f} \times \boldsymbol{AuF}} \times (\boldsymbol{1} - \boldsymbol{e}^{-\boldsymbol{f} \times \boldsymbol{AuF}}) + \boldsymbol{g} \times \boldsymbol{AuF}$$

AuF ≥ 2.5

$$\boldsymbol{Gold\ recovery}\ (\%) = \boldsymbol{h}$$

Code	Ore Type	c	d	u	f	g	h
1-4	HG, H, MG, M	164	25	79	20	1	80.0
5-9	SSE, SS, SHE, SH, SHG	249	0	70	30	1	71.6

Table 10-16: Hugo North gold recovery model

$$\boldsymbol{Gold\ recovery}\ (\%) = (\boldsymbol{c} + \boldsymbol{d} \times \boldsymbol{CuRec}) \times \frac{\boldsymbol{u} \times \boldsymbol{AuF}}{\boldsymbol{1} + \boldsymbol{u} \times \boldsymbol{AuF}}$$

Code	Ore Type	c	d	u
10	CP-PY	0	0.89	90
11	BN-CP	0	0.89	85
12	LG-PY	0	0.79	260

$$\textit{Gold recovery}\ (\%) = (c + d \times CuRec) \times \frac{u \times AuF}{1 + u \times AuF}$$

Code	Ore Type	c	d	u
13	LG	0	0.86	70
14	HI-AS	0	0.87	120

Table 10-17: Oyut silver recovery model

$$\textit{Silver recovery}\ (\%) = i \times AuRec + j \times \frac{AuF}{AgF} + k$$

Code	Ore Type	i	j	k
1-4	HG, H, MG, M	0.48	16.670	19.49
5-9	SSE, SS, SHE, SH, SHG	0.19	0.001	47.12

Table 10-18: Hugo North silver recovery model

$$\textit{Silver recovery}\ (\%) = (c + d \times CuRec) \times \frac{e \times AgF}{1 + e \times AgF}$$

Code	Ore Type	c	d	e
10	CP-PY	0	0.92	6
11	BN-CP	0	0.98	4
12	LG-PY	0	0.76	25
13	LG	0	0.79	2
14	HI-AS	0	1.00	2

Table 10-19: Oyut concentrate copper grade model

$$\textit{Concentrate copper grade}\ (\%) = n \times \frac{CuF}{SF} + o \times \left(\frac{CuF}{SF}\right)^2 + p$$

Code	Ore Type	n	o	p
1-4	HG, H, MG, M	12.8	–3.6	22.5
5-6	SSE, SS	20.0	2.0	16.0
7-8	SHE, SH, SHG	20.0	2.0	16.5

Table 10-20: Hugo North concentrate copper grade model

$$\textit{Concentrate copper grade}\ (\%) = n \times CuF + o \times \frac{CuF}{SF} + p$$

Code	Ore Type	n	o	p
10	CP-PY	0.1	20.1	14.9
11	BN-CP	1.7	13.8	16.7
12	LG-PY	5.2	20.7	6.5
13	LG	8.6	17.6	5.9
14	HI-AS	0.0	21.0	11.8

The equations are applied to the grades and ore types assigned to the Mineral Resource and Mineral Reserve block models to estimate the metallurgical performance of the ore blend scheduled to be processed in various mill feed schedules, including the schedules underlying the Mineral Reserve estimates.

The average metal recoveries for the Mineral Reserves reported in Section 12 “Mineral Reserves” Table 12-1 are shown in Table 10-21. The average metal recoveries for the Hugo South and Heruga Mineral Resources reported in Section 11 “Mineral Resources” are summarised in Table 10-22.

The annual average copper grade of the concentrate produced from processing the Mineral Reserves varies between 22.3% and 35.7% Cu over the planned life of the Mineral Reserves depending on the mineralogy of the ore being processed.

Table 10-21: Oyut and Hugo North estimated metal recoveries

Deposit	Estimated metal recoveries			
	Cu	Au	Ag	Mo
Oyut	78%	67%	53%	-
Hugo North	92%	80%	81%	-

Table 10-22: Hugo South and Heruga estimated metal recoveries

Deposit	Estimated metal recoveries			
	Cu	Au	Ag	Mo
Hugo South	89%	81%	84%	-
Heruga	82%	73%	78%	60%

10.5 QP’s opinion on adequacy of the data collected

In the opinion of the QP, the data derived from the various sources detailed above is adequate for design of processing facilities and provides suitable product grade/recovery predictions for use in production schedules. Confidence is further increased by historical performance demonstrated through reconciliation.

11. Mineral Resources estimates

11.1 Key assumptions, parameters, and methods

11.1.1 Resource database

All drilling data used in estimates of Mineral Resources is securely stored and validated as described in Section 9.1.

11.1.2 Geological interpretation

Overall, the QP’s confidence in the geological interpretation of the area is good, based on the quantity and quality of data available, and the continuity and nature of the mineralisation.

Geological modelling is undertaken by Oyu Tolgoi geologists. The method involved interpretation of downhole stratigraphy using surface geological mapping, lithological logging data, downhole gamma data, and assay data.

Implicit modelling in Leapfrog Geo software or cross-sectional interpretation in Vulcan of each stratigraphic unit is performed, followed by interpretation of mineralisation and hydration boundaries based on mapping, and drilling data. Three-dimensional wireframes of the sectional interpretations are created to produce the geological model.

The geological model is subdivided into domains defined by stratigraphy and mineralisation and both the composites and model blocks are coded with these domains. Blocks in domains are estimated using composites from the same domain.

The mineralisation continuity is affected by rock type, structure and weathering. The drill hole spacing is sufficient to capture grade and geological changes at a large scale. Mineralisation continuity varies by deposit but typically extends for several hundred of metres along strike and from surface to a maximum depth of 1800 m.

11.1.3 Data preparation

The drill hole assays were composited into fixed-length, down hole composites at a size that was considered appropriate when considering estimation block size, required lithological resolution, and probable mining method. This compositing honoured the domain zones by breaking the composites on the domain boundary. The domains used in compositing were a combination of the grade shells and lithological domains. Composite lengths of 8 m (approximately half the 15 m selective mining unit (SMU) size) were used for the Oyut deposits.

For the Oyut deposits, the following default values were applied to any gaps in the intervals of the assay table during compositing:

- Cu - 0.005%
- Au- 0.005 g/t
- Ag- 0.5 g/t
- As - 25 ppm
- Mo - 2.5 ppm

For the Heruga deposit, the composites included any post-mineralisation dyke material intervals that were deemed too small to be part of a dyke geology model. Any unsampled material included in the composites was set to:

- Cu 0.001%
- Au 0.01 g/t
- Mo 10 ppm

At Hugo North and Hugo North Extension, the composites included any post-mineralisation dyke intervals that were deemed too small to be part of a dyke geology model. Any unsampled material included in the composites for Hugo North was set to:

- Cu 0.001%
- Au 0.005 g/t
- Ag 0.025 g/t
- Mo 0.025 ppm.

Intervals of less than 8 m represent individual residual composites from end-of-hole or end-of-domain intervals. Composites with lengths of less than 2 m were excluded from the dataset used in interpolation.

A post-processing step was applied to adjust negative or null composite values arising from non-assayed intervals. Intervals might not be assayed or logged for a variety of reasons:

- Lack of visible mineralisation.
- Parent portion of a wedged daughter hole.
- “Navi” drill interval.

A separate composite file was created for each of estimated grade elements of Cu, Au, Ag, Mo, F, S, Fe, As, SG, and metallurgical parameters. Composites were not broken at intersections of the drill hole with the interpreted lithologies, dykes or overburden triangulations (i.e., compositing honoured logged lithology rather than lithology wireframes).

High grade outlier analysis was completed for all elements and SG. Histograms and probability plots were used to devise capping strategies.

At Oyut, capping was applied during the estimates using the Upper Grade Cut Value function in Vulcan. The predicted metal removed for each element by capping, excluding blocks above the oxide surface and within Measured and Indicated classes, is as follows: Au = 3.0%, Ag = 5.0%, As = 7%, C = 1.7%, Cu = 0.8%, F = 0.6%, Fe = 0.1% and S = 1.1%.

At Hugo North and Hugo North extension a combination of outlier restriction and grade capping was applied during grade estimation. In most cases, an outlier restriction of 50 m was used to control the effects of high grade samples within the domains, particularly in the background domains where unrestricted high grade composites tended to result in blowouts from extreme grade composites.

11.1.4 Exploratory data analysis

To determine the grade distribution and appropriate parameters for estimation, domains are created based on the deposit’s rock types, structural controls and grade shells. Gold, copper and other metals, as well as specific gravity values are analyzed for each domain using histograms and accumulated probability graphs and box diagrams were used to compare statistical values of separate domains whereas the accumulated probability graph is used to establish the range of the domain-wide high grade and to produce an overview of the distribution of the grade. X-Y dependency plots are used to describe the relationship between different metals in the entire domain.

A strategy of soft, firm, and hard boundaries are used to account for domain boundary uncertainty (dilution) and to reproduce the input grade sample distribution in the block model. Soft boundaries allowed full sharing of composites between domains during grade estimation; firm boundaries allowed sharing of composites from within a certain distance of the boundary; and hard boundaries allowed no composite sharing between domains.

Spatial analysis is undertaken using a conventional directional variography approach. Semi-variograms (correlograms) are calculated and modelled for all grade elements plus SG in Snowden Supervisor software. The variograms are modelled with either exponential models, spherical models, or a combination of exponential and spherical models. Two structures are typically used to model the variograms with a few exceptions where a single structure or, rarely, three structures, are used. The orientations of multiple structures are typically ‘locked’ in the same direction to aid visualization and for checking against geologic reasonableness. Practical ranges are used (‘practical range’ being the range at which 95% of the sill is reached, with this value being three times longer than the ‘traditional range’ used in some software). The nugget values are generally determined from down hole variograms. Directional variograms are typically calculated in at least 30 degree increments both horizontally and vertically to determine the orientation, consistent with geological interpretation and understanding.

A variety of strategies was applied where it was not possible to calculate robust variograms. These strategies included:

- Recalculating variograms using larger lags.
- Combining data from adjacent domains of reasonably similar properties. In some cases data were pooled to achieve reasonably robust variograms even where a hard or firm estimation boundary was likely to be used.
- Adopting the variogram model from a well-informed domain that was considered to have similar properties.
- Using the correlograms instead of variograms.
- Transforming variograms to Normal Scores (normal data distribution) before variogram calculation to improve the experimental variogram. The variograms and models were back-transformed to real space before being used for block grade estimation.

The deposits displayed mineralisation controls that were considered to be related to the intrusive history and structural geology (faults). The patterns of anisotropy demonstrated by the various correlograms tended to be consistent with geological interpretations, particularly to any bounding structural features (faults and lithological contacts) and quartz + sulphide vein orientation data.

The nugget effects tended to be low to moderate in all of the estimation domains.

11.1.5 Bulk density

Dry bulk density is derived from immersion methods on drill core. Dry core densities are generated via the following process:

- The core volume is measured in the split and the mass of the core is measured and recorded.
- Wet core densities are calculated by the split and by the tray.
- Core recovery is recorded.
- The core is then dried and dry core masses are measured and recorded.
- Dry core densities are then calculated.

11.1.6 Block models

The Property is divided into individual deposits for practical modelling purposes, each with its own block model. Each block model is created in Vulcan. A parent block size is selected, based on the local nominal drill hole spacing. Typically the parent block size is half the drill hole spacing, at 20 m (X) by 20 m (Y) by 15 m (Z) for Oyut, Hugo South and Heruga. 15 m (X) by 15 m (Y) by 15 m (Z) is used for Hugo North.

Sub-blocking is used to achieve acceptable resolution with geological boundaries, based on a block size as small as a fifth of the parent lateral and vertical block generally 5 m (X) by 5 m (Y) by 5 m (Z).

Variable codes are added to the block model reflecting various attributes such as zone, lithological domain, and grade shell. Post-mineral dykes and the late quartz-monzodiorite are assumed to represent zero-grade waste cutting the mineralised lithologies.

The geological block models are validated by visual checks in section and plan view, for both zone and grade shell, with numerical checks to identify and address incorrectly assigned variables.

11.1.7 Grade interpolation parameters

At Oyut, semivariograms (correlograms) were calculated and modelled for all grade elements plus SG in Snowden Supervisor software. The variograms were modelled with either exponential models, spherical models, or a combination of exponential and spherical models. Two structures were typically used to model the variograms with a few exceptions where a single structure or, rarely, three structures, were used. The orientations of multiple structures were typically 'locked' in the same direction to aid visualization and for checking against geologic reasonableness. Practical ranges were used ('practical range' being the range at which 95% of the sill is reached, with this value being three times longer than the 'traditional range' used in some software). The nugget values were generally determined from down hole variograms. Directional variograms were typically calculated in at least 30 degree increments both horizontally and vertically.

A variety of strategies was applied where it was not possible to calculate robust variograms. These strategies included:

- Recalculating variograms using larger lags.
- Combining data from adjacent domains of reasonably similar properties. In some cases data were pooled to achieve reasonably robust variograms even where a hard or firm estimation boundary was likely to be used.
- Adopting the variogram model from a well-informed domain that was considered to have similar properties.
- Using the correlograms instead of variograms.
- Transforming variograms to Normal Scores (normal data distribution) before variogram calculation to improve the experimental variogram. The variograms and models were back-transformed to real space before being used for block grade estimation.

At Hugo North, the deposit displayed mineralisation controls that were considered to be related to the intrusive history and structural geology (faults). The deposit is separated into two parts by the Eroo fault around 4,767,600mN. The patterns of anisotropy demonstrated by the various correlograms tended to be consistent with geological interpretations, particularly to any bounding structural features (faults and lithological contacts) and quartz + sulphide vein orientation data. The variography was examined outside of a 0.6% Cu grade shell, within the 0.6% Cu grade shell, and internal to the 2% Cu grade shell.

The nugget effects tended to be low to moderate in all of the estimation domains. Copper variograms generally had nugget effects of between 15% and 20% of the total variation except in Biotite granodiorite (BiGd) dykes, where the nugget is 38% of total variation. The nugget effects for gold variograms varied from 5% to 25%.

At Hugo South, variograms indicated a north-easterly trend. The deposit displayed a consistent steep easterly dip with a flat plunge. Ranges were longest along strike of the respective trend for Cu and a mixture of along-trend and down-dip of the trend for gold. Ranges tended to be less than 75 m for the first structure in all metals and less than 200 m for the second structure.

At Heruga, although data are limited, an attempt was made to model directional variograms for Au, Cu, and Mo. Cu and Au showed relatively low nuggets of 25% to 35% of the total variance, whereas Mo was moderate to high at 40% of the sill. All three metals showed relatively short first structures and long second structures of 250 m to 300 m.

11.1.8 Grade estimation

Grade estimation is undertaken using linear estimation methods using Vulcan software. Twelve grade attributes (Cu, Au, Ag, As, F, Fe, Mo, S, C, SG, SPI, and MBI) are estimated into the block model.

The following comminution parameters are estimated and used in the throughput equations:

- SAG power index (SPI) in minutes).
- Modified bond index (MBI) in kWh/t – a short form of the bond ball mill index test.
- Minnovex crushing index (Ci) – developed from the sample preparation process for the SPI.

The grade estimation was performed using ordinary kriging (OK) of grade composites into a sub-blocked Vulcan block model. The block model was tagged from wireframe models of deposits, grade shells, and lithologies which form a variety of soft, firm, and hard domain boundaries during estimation.

The SG of the major lithologies, dykes, and overburden was estimated using simple kriging (SK). The metallurgical parameters (SPI and MB) were estimated using the OK and SK estimators in two passes. The stationary means for the SK runs were developed from the mean composite grades for each estimation domain.

Component domain codes were merged into the ultimate DOMAIN code variable. Search ellipsoid orientations for the grade elements were based on the variogram models which typically reflect the geological settings of the mineralised zones.

A three-pass kriging strategy was used to estimate the block grades. Grade estimations were run one domain at a time. The first and second estimation pass kriging neighbourhood approximately corresponds to blocks expected to satisfy Measured and Indicated classification criteria. The kriging neighbourhood was expanded and relaxed with each successive pass while maintaining the same axial ratios for samples searches as in the first pass. The second pass was executed on blocks that did not receive an interpolated grade in the first pass, and the third pass was executed on blocks that did not receive an interpolated grade in the first and second passes.

A block discretization of 4 by 4 by 2 was used when estimating block grades. Capping of composites or a high grade restriction was applied during the estimation depending on the element, domain, and clustering characteristics. If the highest grades were clustered, a high grade restriction was used to reduce the impact. If the highest grades were not clustered a capping value was applied to reduce the coefficient of variation. The capping was applied using the upper grade cut value function in Vulcan.

For all elements, for the first and second block estimation passes, a minimum of six composites and maximum of nine composites were required, as well as a maximum of three composites per drill hole. To ensure that at least three boreholes were used to estimate blocks in pass 1, the number of composites from a single drill hole was restricted to three. Similarly, Pass 2 required a minimum of two boreholes to generate an estimate. For the third pass, a minimum of two composites and a maximum of eight composites were required, as well as a maximum of five composites per drill hole. A single estimation pass was used to estimate dyke blocks, requiring a minimum of three composites, a maximum of eight composites, and a maximum of five composites per drill hole.

SG variable and metallurgical parameters were estimated by two passes. For the SG variable, the first and second block estimation passes, a minimum of five composites and maximum of eight composites were required, as well as a maximum of three composites per drill hole. For the metallurgical parameters, a minimum of one composite and maximum of five composites were required for the first and second block estimation passes. No restriction was used to limit the number of composites per drill hole due to the limited number of testworks that have been used. No capping has been applied.

During the estimation of the sub-blocked model, the estimated grade of the parent cells is assigned to each sub cell. Not all unsampled intervals are assigned values during compositing so grade composites flagged as less than zero grades were excluded from sample selection. Grade composites less than 2 m in length were also excluded. The composites were length-weighted during estimation. Composites were weighted by OK according to variogram parameters with the exception of dyke grades, which were estimated using inverse distance weighting at a power of two (ID2).

Estimated block grades in blocks coded as air, Cretaceous clay, or Quaternary cover were set to zero.

The blocks in the supergene zone were estimated with OK as a separate domain distinct from the other structural domains. No distinction or domaining was used for grade estimation for blocks above and below the limit of oxidation.

These methods are deemed appropriate by the QP for estimating the tonnes and grade of the reported Mineral Resources.

11.1.9 Model validation

The estimated model is validated using a combination of visual and statistical methods to check that the estimates had performed as expected and showed acceptable conformance to the input samples.

The overall validation process typically included:

- Visual validation, typically involving sectional review of the model with drill holes in cross section, long-section and plan for select variables.
- Global comparison between the block model and composite statistics to assess for global average grade conformance by domain.
- Swath plot comparisons by domain for cross-section, long-section and elevation slices.

- Correlation coefficient comparisons for composites vs blocks between Cu and all other estimated assay variables.
- The SG and metallurgical fields Ci, MBi and SPi were assessed using summary statistics by domain. No outliers or restrictions were placed on these estimates.
- Where production data is available, reconciliation is carried out as part of the model validation process.

11.2 Mineral Resources classification

According to Subpart 1300 of Regulation S-K, to reflect geological confidence, Mineral Resources are sub-divided into the following categories based on increased geological confidence: Inferred, Indicated, and Measured, which are defined under Subpart 1300 of Regulation S-K as:

"Inferred Mineral Resource is that part of a mineral resource for which quantity and grade or quality are estimated on the basis of limited geological evidence and sampling. The level of geological uncertainty associated with an inferred mineral resource is too high to apply relevant technical and economic factors likely to influence the prospects of economic extraction in a manner useful for evaluation of economic viability. Because an inferred mineral resource has the lowest level of geological confidence of all Mineral Resources, which prevents the application of the modifying factors in a manner useful for evaluation of economic viability, an inferred mineral resource may not be considered when assessing the economic viability of a mining project, and may not be converted to a mineral reserve."

"Indicated Mineral Resource is that part of a mineral resource for which quantity and grade or quality are estimated on the basis of adequate geological evidence and sampling. The level of geological certainty associated with an indicated mineral resource is sufficient to allow a QP to apply modifying factors in sufficient detail to support mine planning and evaluation of the economic viability of the deposit. Because an indicated mineral resource has a lower level of confidence than the level of confidence of a measured mineral resource, an indicated mineral resource may only be converted to a probable mineral reserve."

"Measured Mineral Resource is that part of a mineral resource for which quantity and grade or quality are estimated on the basis of conclusive geological evidence and sampling. The level of geological certainty associated with a measured mineral resource is sufficient to allow a QP to apply modifying factors, as defined in this section, in sufficient detail to support detailed mine planning and final evaluation of the economic viability of the deposit. Because a measured mineral resource has a higher level of confidence than the level of confidence of either an indicated mineral resource or an inferred mineral resource, a measured mineral resource may be converted to a proven mineral reserve or to a probable mineral reserve."

Mineral Resources are classified by Oyu Tolgoi in accordance with the above guidance and in consideration of other relevant factors including, but not limited to, geology, continuity of mineralisation, grade continuity, sample spacing, data quality, and reconciliation.

11.2.1 Open Pit classifications

The Oyut open pit block classification confidence is based on the copper grade variable. A single-pass NN estimation of Cu composites was used to capture distance from block centroid to the nearest composite. A classification category was assigned to each estimated block using the classification criteria summarized in Table 11-1.

The Oyut deposit's geological and grade continuity support mineral confidence classifications of Measured, Indicated, and Inferred Mineral Resources.

Table 11-1: Oyut Mineral Resources initial classification parameters

Initial classification	Deposit	Minimum number of drill holes	Minimum number of composites	Composite spacing (m)	Closest composite (m)
Measured	All deposits	3	3	50	30
Indicated	Southwest Oyu	2	2	75	55
Indicated	Other deposits	2	2	65	45
Inferred	All deposits	1	1	150	

The first pass resource classification based on the rules defined for each category typically resulted in regions where a spotty pattern of a few isolated higher confidence blocks are surrounded by lower confidence blocks and vice versa. Consequently, a manual smoothing step followed where the copper composite database was back-tagged by the first-pass block model classification and imported into Leapfrog Implicit modelling software. The grade-shelling algorithm was used to create wireframes of the classes. If a small volume of a particular class was created inside another class it was switched to the surrounding class. Review of vertical section and bench classification maps from the results have been completed through the Oyut area. Plan view of the bench maps of the initial classification model and the corresponding smoothed classification model are shown in Figure 11-1 and Figure 11-2.

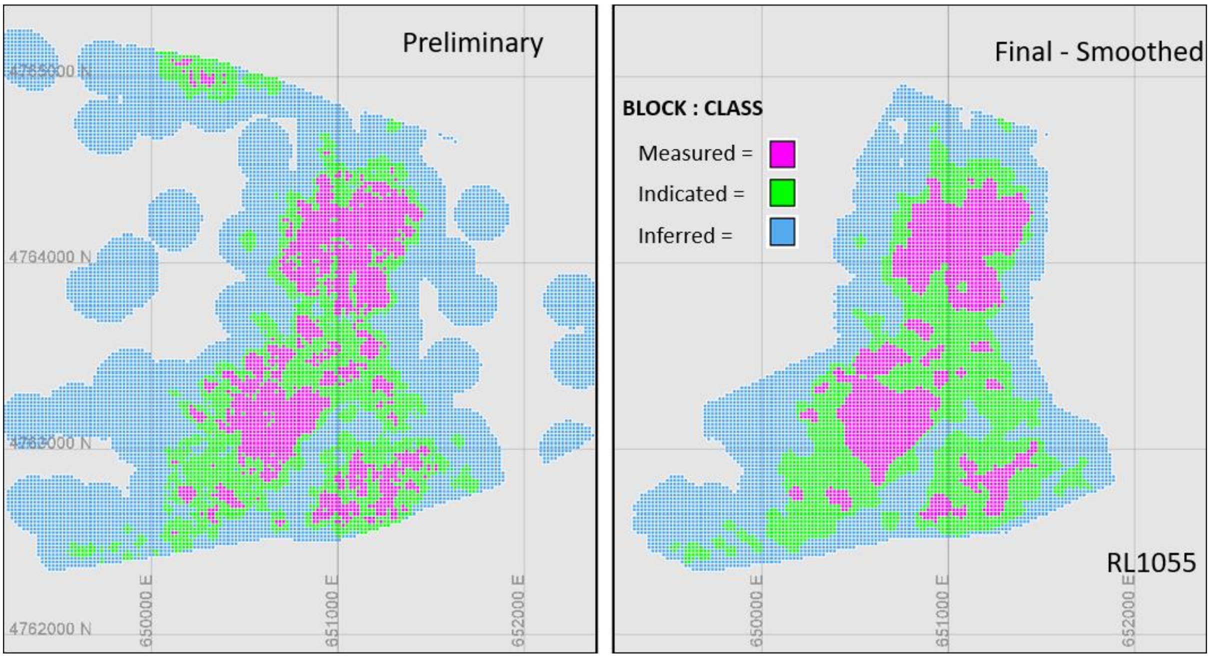

Figure 11-1: Oyut comparison of the initial and final smoothed Mineral Resources classification maps at 1055 RL (plan)

RioTinto

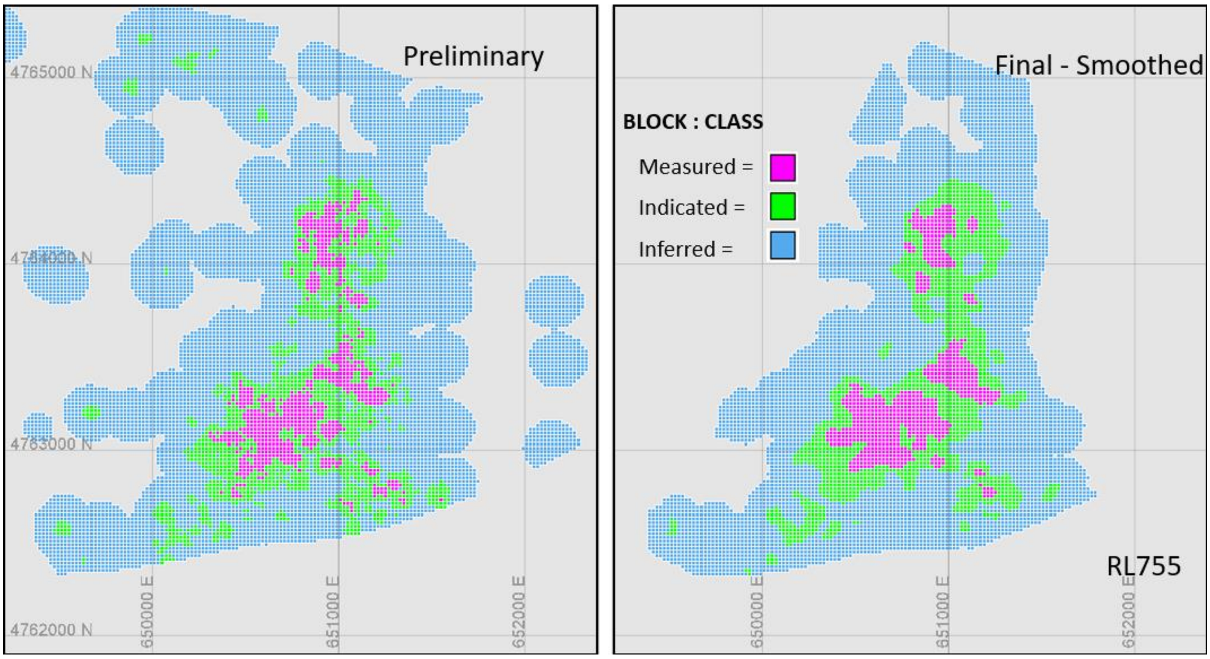

Figure 11-2: Oyut comparison of the initial and final smoothed Mineral Resources classification maps at 755 RL (plan)

11.2.2 Underground classifications

Underground Mineral Resources classifications are based on the details included in Table 11-2.

Table 11-2: Underground (Hugo North, Oyut Underground, Hugo South, Heruga) Mineral Resources initial classification parameters

Initial classification	Deposit	Minimum number of drill holes	Minimum number of composites	Number of Octants	ID2 pass number	Composite spacing (m)	Closest composite (m)
Measured	All deposits	3	3	3	1	50	35
Indicated1 or	All deposits	3	3		1		50
Indicated2 or		3	3		2		150
Indicated3		2	2		2		150 and
		1	1		2		75
Inferred	All deposits	1	1		3		150

The block must be contained within the relevant classification solid generated using sectional interpretation and block probabilities. That is, the block must meet both the required statistical confidence (or be higher confidence) and be within the adjusted (smoothed) classification zone to have that zone classification.

11.2.3 QP statement

At the completion of the resource estimation process, the QP for Mineral Resources conducted a final review of the amount and quality of data, assays, structural complexity, continuity of mineralisation and grade, estimation technique and reconciliation performance as well as consideration of any other aspect of the deposit that may affect how it could be economically mined, such as social, environmental, approvals, government, licences, contaminants, depth of mineralisation etc. The purpose of the review is to identify the risks and opportunities within the deposit and assign the appropriate classification.

11.3 Mineral Resources estimate

The basis of the Property's Mineral Resources estimate and how it is generated are summarised below. The Mineral Resources estimate for the Property is reported here in accordance with the requirements detailed in Subpart 1300 of Regulation S-K. For estimating the Mineral Resources, the following definition as set forth in Subpart 1300 of Regulation S-K, are applied.

Under Subpart 1300 of Regulation S-K, a Mineral Resource is defined as:

"… a concentration or occurrence of 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 economic extraction. A mineral resource is a reasonable estimate of mineralisation, taking into account relevant factors such as cut-off grade, likely mining dimensions, location or continuity, that, with the assumed and justifiable technical and economic conditions, is likely to, in whole or in part, become economically extractable. It is not merely an inventory of all mineralisation drilled or sampled."

The Mineral Resource estimate for the Property is presented by deposit in Table 11-3. Mineral Resources are estimated by Rio Tinto for the operating mine and development projects within the Property. The effective date of the Mineral Resource estimate is 31 December 2022.

The Mineral Resource estimate is based on the following assumptions:

- Exclusive of Ore Reserves – Mineral Resources are reported exclusive of Ore Reserves.
- Moisture – All Mineral Resource tonnages are estimated and reported on a dry basis.
- Mineral Resources are provided as in situ estimates.
- Mining Factors or Assumptions – Open pit load and haul mining operations will be used by Oyu Tolgoi for the mining of Mineral Resources ore at Oyut. Underground cave mining operations will be used by Oyu Tolgoi for the mining of Mineral Resources ore at Hugo North. It is assumed underground cave mining operations will be used by Oyu Tolgoi for the mining of Mineral Resources ore at Hugo North extension, Hugo South and Heruga; and underground stope mining operations for Oyut Underground.
- Metallurgical Factors or Assumptions – It is assumed that crushing, milling and flotation processes used by Oyu Tolgoi will be applicable for the processing of Mineral Resources. Predicted yield and upgrade are deposit specific and are based on metallurgical test work conducted on representative samples collected from those deposits or adjacent analogous deposits.
- Environmental Factors or Assumptions – Extensive environmental studies and surveys will be completed during the Project study phases to determine if the project requires formal Government of Mongolia environmental assessment and approval.
- Heritage Factors or Assumptions - Extensive cultural heritage studies, surveys and engagement with traditional owners will be completed during the project study phases to determine if the project requires additional assessment, monitoring, or exclusion areas to be maintained during mining, to manage potential impacts to sites.

Table 11-3: Oyu Tolgoi Property Rio Tinto Ownership Basis Reported Mineral Resources as at 31 December 2022

	Likely mining method[1]	Measured Mineral Resources as at 31 December 2022					Indicated Mineral Resources as at 31 December 2022					Total Measured and Indicated Mineral Resources as at 31 December 2022				
		Tonnage	Grade				Tonnage	Grade				Tonnage	Grade			
Copper[2]		Mt	% Cu	g/t Au	g/t Ag	% Mo	Mt	% Cu	g/t Au	g/t Ag	% Mo	Mt	% Cu	g/t Au	g/t Ag	% Mo
Oyu Tolgoi (Mongolia)[3]																
- Heruga ETG	U/G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Heruga OT	U/G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Hugo Dummett North[4]	U/G	38	1.90	0.50	4.30	-	251	1.39	0.35	3.24	-	289	1.46	0.37	3.38	-
- Hugo Dummett North Extension	U/G	-	-	-	-	-	48	1.62	0.55	4.21	-	48	1.62	0.55	4.21	-
- Hugo Dummett South	U/G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Oyut Open Pit	O/P	11	0.41	0.38	1.10	-	61	0.33	0.30	1.13	-	72	0.34	0.31	1.12	-
- Oyut Underground	U/G	6	0.48	0.91	1.31	-	33	0.38	0.61	1.18	-	39	0.40	0.66	1.20	-
Total		**55**	**1.44**	**0.53**	**3.33**	**-**	**393**	**1.17**	**0.39**	**2.86**	**-**	**448**	**1.20**	**0.41**	**2.91**	**-**

	Inferred Mineral Resources as at 31 December 2022					**Total Mineral Resources as at 31 December 2022**					Rio Tinto Interest[5]	Total Mineral Resources as at 31 December 2021				
	Tonnage	Grade				**Tonnage**	**Grade**					Tonnage	Grade			
Copper[2]	Mt	% Cu	g/t Au	g/t Ag	% Mo	**Mt**	**% Cu**	**g/t Au**	**g/t Ag**	**% Mo**	%	Mt	% Cu	g/t Au	g/t Ag	% Mo
Oyu Tolgoi (Mongolia)[3]																
- Heruga ETG	841	0.41	0.40	1.44	0.012	841	0.41	0.40	1.44	0.012	56.0	442	0.41	0.40	1.44	0.012
- Heruga OT	71	0.42	0.30	1.58	0.011	71	0.42	0.30	1.58	0.011	66.0	36	0.42	0.30	1.58	0.011
- Hugo Dummett North[4]	474	0.83	0.29	2.47	-	763	1.07	0.32	2.82	-	66.0	388	1.06	0.32	2.80	-
- Hugo Dummett North Extension	90	1.05	0.37	2.85	-	137	1.25	0.43	3.32	-	56.0	72	1.24	0.43	3.31	-
- Hugo Dummett South	483	0.83	0.07	1.87	-	483	0.83	0.07	1.87	-	66.0	245	0.83	0.07	1.87	-
- Oyut Open Pit	215	0.29	0.19	1.01	-	287	0.30	0.22	1.04	-	66.0	149	0.30	0.22	1.05	-
- Oyut Underground	95	0.41	0.42	1.25	-	135	0.40	0.49	1.23	-	66.0	68	0.40	0.49	1.23	-
Total	**2,269**	**0.60**	**0.28**	**1.76**	**0.005**	**2,716**	**0.70**	**0.30**	**1.95**	**0.004**		1,401	0.69	0.30	1.94	0.004

(1). Likely mining method: O/P = open pit/surface; U/G = underground.

(2) Mineral Resources are stated on an in situ dry weight basis and Mineral Resources are reported EXCLUSIVE of Mineral Reserves.

(3) Oyu Tolgoi Mineral Resource valuations are based on commodity prices of US c 320.30 /lb for copper, US$ 1,479.82 /oz for gold, US$ 19.23 /oz for silver and US$ 9.29 /lb for molybdenum. These represent July 2021 consensus prices sourced from the average forecasts from ten brokers/banks (Barclays, BoAML, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, JP Morgan, Macquarie, Morgan Stanley and UBS) and two analysts (CRU and Woodmac).

(4). The Hugo Dummett North Mineral Resources include approximately 0.9 million tonnes of stockpiled material at a grade of 0.35% copper, 0.11 g/t gold and 0.85 g/t silver. The Hugo Dummett North underground mine is currently under construction.

(5) As reported to the market on 16th December 2022, Rio Tinto completed its acquisition of Turquoise Hill Resources Ltd and the Rio Tinto Interest % reflects this change. 2021 figures are reported using the previous ownership %.

11.4 Derivation of cut-off grades

To assess the value of the total suite of minerals of economic interest in the mineral inventory, formulae were developed to calculate copper equivalency (CuEq) based on given prices and recoveries. The formula used to calculate the CuEq grade was initially developed in 2003 for Hugo North and Oyut and continues to be used for Oyu Tolgoi deposits. There have been several versions of the formula used over the years and metal pricing was updated for this report.

The base of the copper equivalent formula incorporates Cu, Au, Ag, and Mo (Mo only estimated at Heruga). The assumed metal prices are $3.20/lb for Cu, $1,479.82/oz for Au, $19.23/oz for Ag, and $9.29/lb for Mo. Cu is expressed in block grade in the form of percentages (%). Au and Ag are expressed in block grades in the form of grams per tonne (g/t). Mo is expressed in block grades in the form of ppm. Metallurgical recovery for Au, Ag, and Mo are expressed as percentage relative to copper recovery.

A base formula of: CuEq = Cu+((Au*AuRev)+(Ag*AgRev)+(Mo*MoRev))/CuRev

Where:

- CuRev = (3.20*22.0462)
- AuRev = (1479.82/31.103477*RecAu)
- AgRev = (19.23/31.103477*RecAg)
- MoRev = (9.29*0.00220462*RecMo)
- RecAu = Au recovery/Cu recovery
- RecAg = Ag recovery/Cu recovery
- RecMo = Mo recovery/Cu recovery

Different metallurgical recovery assumptions lead to slightly different copper equivalent formulas for each of the deposits; these are outlined in the following sections for Oyut, Hugo North, Hugo North Extension, Hugo South, and Heruga.

In all cases, the metallurgical recovery assumptions are based on metallurgical testwork. For Oyut, actual mill performance has been used to further refine the recovery assumptions over the life of mine. Recoveries are relative to Cu because Cu contributes the most to the equivalent calculation.

All elements included in the copper equivalent calculation have a reasonable potential to be recovered and sold except for Mo. Mo grades are only considered high enough to support construction of a Mo recovery circuit at Heruga, and hence the recoveries of Mo are zeroed out for the other deposits.

11.5 Cut-off grade, price, and justification

The cut-off grade for open pit Mineral Resources based a marginal cut-off grade of 0.25% CuEq, which includes provision for processing and general and administrative (G&A) costs, was used to tabulate open pit Mineral Resources. An estimated marginal copper equivalent cut-off of 0.25% CuEq is a direct conversion of Net Smelter Return (NSR) to CuEq. Material is assessed at the pit rim to determine if it is economic to send to the mill (i.e. above the marginal cut-off grade) rather than to the waste dump. That is, the material is considered “ore” if its value is greater than the cost of processing it.

Cut-off grades for Oyut underground Mineral Resources were determined using assumptions defined for Hugo North underground mine. The NSR per tonne of ore needs to equal or exceed the production cost of a tonne of ore for the mine to break even or make money.

For the underground mine, the break-even cut-off grade needs to cover the costs of mining, processing, and G&A. An NSR cut-off for a tonne of ore for Hugo North underground mine is different for each geomet ore type but on an average an NSR of $20.79 per tonne would be required to cover costs of $8.48 for mining, $8.10 for processing, $2.93 for G&A and $1.287 for Rio Tinto management cost. This translates to a CuEq break-even underground cut-off grade of approximately 0.47% CuEq for Hugo North. However, with the exclusion of high arsenic ore type and low grade pyrite ore type, which in general sit in the top part of the cave (Figure 11-3), the CuEq break-even underground cut-off grade becomes approximately 0.46% and this cut-off grade has been used for tabulating Mineral Resources for Hugo North in this report.

A cut-off grade of 0.41% copper equivalence has been used in stating underground Mineral Resources at Hugo South and Heruga. Although the assumptions for metal prices have been updated, there was no update to cost assumptions for Hugo South and Heruga that mainly trigger the change in cut-off grade.

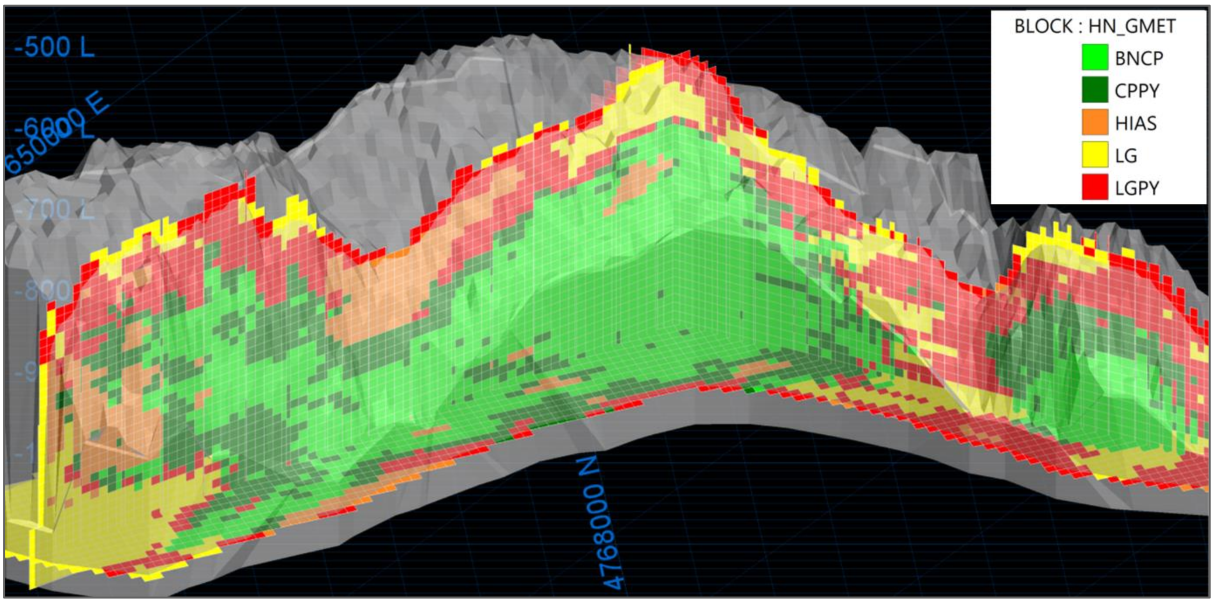

Figure 11-3: Hugo North geometallurgical domains within Lift 1 cave shape

Mineral Resources are typically tested for economic viability from a combined Mineral Reserve and Mineral Resource schedule and using the same consensus price used for Mineral Reserves. Section 16.3 sets out commodity price projections used for Mineral Reserves, and the analysis on which the commodity price is based.

11.6 Uncertainty in the estimates of Inferred, Indicated, and Measured Mineral Resources

The QPs are satisfied that the stated Mineral Resources classification reflects the appropriate level of confidence and takes into account relevant factors of the deposits. The application of resource categories appropriately considers the relevant factors used in the classification process.

Some examples of specific factors that can influence the risk and uncertainty of the Mineral Resources estimates that are considered in the resource classification include:

- Interpretation of the mineralisation boundary. Areas of complex or discontinuous mineralisation is typically assigned one category lower that the main mineralisation.
- Drill hole spacing and adequacy in defining geology, mineralisation, structure, and grade.
- Quality of samples, assays and geological information.
- Domains or regions within domains where grades are more variable are typically assigned lower levels of resource classification.
- Reconciliation performance, in instances that the deposit or similar deposit/domains have been mined.

The Mineral Resources have addressed reasonable prospects of economic extraction and have considered a range of mining, metallurgical and environmental factors.

Mineral Resources confidence is also assessed via independent reviews and internal peer reviews conducted at key stages of the Mineral Resources estimation process with no material issues identified.

The Mineral Resources data collection and estimation techniques used are consistent with those applied at deposits where mining has commenced. Reconciliation of actual production with the Mineral Resources estimates for individual deposits is generally accurate to within 10% for tonnes on an annual basis. This result is indicative of a robust process and provide a high level of confidence in the Mineral Resources estimate used as the basis of Mineral Reserves for the operations.

The Mineral Resources presented are not Mineral Reserves and do not reflect demonstrated economic viability. The level of geological uncertainty associated with the reported Inferred Mineral Resources is considered too high to apply relevant economic and technical factors to have the economic considerations applied that would enable these to be categorised as Mineral Reserves. There is no certainty that all or any part of the Inferred Mineral Resources will be converted into Mineral Reserves. All figures are rounded to reflect the relative accuracy of the estimates and totals may not sum exactly as a consequence.

11.7 QP's opinion on factors likely to influence the prospect of economic extraction

The main factors likely to influence the prospect of economic extraction include:

- Commodity pricing.
- Interpretations of fault geometries.
- Effect of alteration as a control on mineralisation.
- Lithological interpretations on a local scale, including dyke modelling and discrimination of different quartz monzodiorite phases.
- Pit slope angles.
- Geotechnical assumptions related to the proposed block cave design and material behaviour.
- Metal recovery assumptions.
- Dilution considerations.

- The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, socio-political, marketing, or other relevant issues including risks set forth in this document.

In the QP's opinion, all these factors are adequately considered for the Mineral Resources reported. Based on the body of technical studies completed across the Property, it is the QP's opinion that the Mineral Resources have reasonable prospects of economic extraction.

12. Mineral Reserves estimates

12.1 Key assumptions, parameters, and methods

12.1.1 Geological model

Orebody block models developed for the Mineral Resources reporting within each mining area form the basis of the Mineral Reserves estimates. Orebody block models are derived from the geology model (outlined in Section 11) and are extended by:

- Undergoing regularisation to a selective mining unit, with dilution and recovery from the regularisation taken into consideration.
- Addition of approved pit designs and cave shapes.
- Integration of actual and planned mined surfaces.
- Addition of non-recoverable zones.
- Binning of chemistry grades.
- Application of grade binning to support scheduling.
- Assigning of moistures to in situ material.

12.1.2 Moisture

Geology models contain tonnage estimates on a dry in situ basis. During generation of the orebody block models, the estimated water content (moisture) for each block model block is added. The moisture estimate includes consideration of material physical properties and hydrogeology. By including both dry tonnes and water content in the block models, estimates for dry and wet tonnages can be determined from the block models as required for planning, reporting or any other purpose.

Metallurgical regressions are applied to dry material. From this, expected water content is predicted for each product, allowing reporting of wet product tonnes by combining the dry tonnes and moisture content.

12.1.3 Metallurgical and processing recoveries

Metallurgical and processing recovery estimates are applied to crusher feed tonnages based on the comminution and flotation characteristics determined from material type (refer Section 14.1).

12.1.4 Methodology

A mining schedule that fully consumes the scheduling inventory is developed from the prepared orebody block models. To demonstrate economic viability of the Mineral Reserves, economic modelling is completed. Material is only reported as Mineral Reserve if the level of geological certainty is sufficient to allow a QP to apply the modifying factors in sufficient detail to support detailed mine planning and economic viability of the deposit.

12.2 Modifying factors

Modifying factors are applied to mineralised material within the Measured and Indicated Resources classifications in the Mineral Resources to establish the economic viability of Mineral Reserves. QPs consider mining, processing, metallurgical, economic, marketing, legal, environmental, infrastructure, social, and governmental factors that are applicable to each mining area within the Property.

Key modifying factors considered when converting Mineral Resources to Mineral Reserves include:

- Geotechnical Parameters: Geotechnical models are prepared for each deposit based on drilling, mapping, and other data. These models form the basis for slope stability analysis and development of pit design parameters to ensure pit walls meet an acceptable factor of safety.
- Surface Water (Hydrology) Assessments: Hydrological modelling techniques are used to assess the potential impact of ephemeral water courses and flooding due to surface water runoff post rain events. Pit designs are either modified, or appropriate surface water control measures are included in the pit design.
- Groundwater (Hydrogeology) Assessments: In case of orebodies extending below the water table, groundwater models are developed, accounting for geological assessments, drill holes, test pumping and monitoring bores. Groundwater models form the basis for assessing the technical feasibility of pit dewatering and are necessary for design of an adequate dewatering strategy, inclusive of location, number and capacity of dewatering bores, discharge requirements and projected drawdown of the groundwater table. Projected drawdowns are used to constrain mine plans as appropriate.
- Pit designs are developed based on the geotechnical and hydrogeological assessment, incorporating access and any other technical requirements. Only material contained inside a designed pit is converted to a Mineral Reserve.
- Metallurgical tests on appropriate samples form the basis for prediction of throughput rates, as well as metallurgical recoveries. These metallurgical predictions are incorporated into the orebody block models that underpin mine plans and schedules. Plans and schedules are developed to maximise the cost recovery and are the basis for estimation of the Mineral Reserve.
- Part of a Mineral Resource is only converted to a Mineral Reserves if it is within the life of mine plan, or if a pre-feasibility study has been completed establishing the technical and economic feasibility of establishing a mining operation. Studies consider all aspects of production, requirements for workshops and offices, workforce accommodation, access to water and power, and other required facilities.
- Only parts of deposits where all statutory and regulatory requirements for mining have been satisfied, or where previous experience shows there is a reasonable expectation of obtaining all required permits and authorisations prior to scheduled mining, are converted to Mineral Reserves.

12.3 Cut-off grade estimate

The key determinant for the classification of material into ore and waste is the NSR value of a block within an extractable area. Whether a particular parcel of material has economic value or not does not depend on the characteristics of the parcel itself, but on its potential contribution to a material blend. Target concentrate grade specifications determine the ore that can be economically extracted from the orebodies, and thus the reported Mineral Reserve.

The economic viability of the reported Mineral Reserves is assessed by generating a production schedule that fully consumes the Mineral Reserves with all other material treated as non-revenue generating. Ensuring that a positive NPV is achieved using specific economic assumptions for costs and revenues. Further details on price, costs, and time disclosure are provided in Section 19.

12.4 Mineral Reserves estimate

The Mineral Reserves for the Property is presented by area in Table 12-1. Mineral Reserves are estimated by Rio Tinto for operating mines and development projects within the Property that have reached or surpassed pre-feasibility stage. The effective date of the Mineral Reserves estimate is 31 December 2022.

Mineral Reserves are reported as the economically mineable portion of a Measured and/or Indicated Resources after consideration of modifying factors. Measured Resources could be reported as Proved Reserves, however uncertainty in one or more modifying factor may result in it being classified as Probable Reserves. Indicated Resources are reported as Probable Reserves in order to reflect the level of confidence in the Mineral Resources estimate in the Mineral Reserves estimate. All stockpile Mineral Reserves are classified as Probable Reserves due to the inherent variability of stockpiled material.

Mineral Reserves are stated as dry tonnes, excluding moisture content. The only payable minerals are copper, gold, and silver. All figures are rounded to reflect the relative accuracy of the estimates and rounded subtotals may not add to the stated total.

Table 12-1: Oyu Tolgoi Property Rio Tinto Ownership Basis Reported Mineral Reserves as at 31 December 2022

	Type of mine[1]	Proven Mineral Reserves as at 31 December 2022					Probable Mineral Reserves as at 31 December 2022					**Total Mineral Reserves as at 31 December 2022**					Average mill recovery %				Rio Tinto Interest[5]	**Rio Tinto share Recoverable Metal**				Total Mineral Reserves as at 31 December 2021				
		Tonnage	Grade				Tonnage	Grade				**Tonnage**	**Grade**													Tonnage	Grade			
Copper[2]		Mt	% Cu	g/t Au	g/t Ag	% Mo	Mt	% Cu	g/t Au	g/t Ag	% Mo	**Mt**	**% Cu**	**g/t Au**	**g/t Ag**	**% Mo**	Cu	Au	Ag	Mo	%	**Mt Cu**	**Moz Au**	**Moz Ag**	**Mt Mo**	Mt	% Cu	g/t Au	g/t Ag	% Mo
Oyu Tolgoi (Mongolia)[3]																														
- Hugo Dummett North[4]	U/G	-	-	-	-	-	271	1.54	0.30	3.18	-	**271**	**1.54**	**0.30**	**3.18**	-	92	79	81	-	66.0	**3.856**	**2.077**	**22.296**	-	138	1.55	0.30	3.19	-
- Hugo Dummett North Extension	U/G	-	-	-	-	-	21	1.61	0.56	3.82	-	**21**	**1.61**	**0.56**	**3.82**	-	92	81	83	-	56.0	**0.311**	**0.306**	**2.132**	-	12	1.55	0.54	3.68	-
- Oyut open pit	O/P	163	0.53	0.39	1.30	-	265	0.41	0.25	1.14	-	**427**	**0.45**	**0.30**	**1.20**	-	78	67	53	-	66.0	**1.507**	**2.747**	**8.771**	-	238	0.44	0.29	1.19	-
- Oyut stockpiles	S/P	-	-	-	-	-	36	0.32	0.12	1.04	-	**36**	**0.32**	**0.12**	**1.04**	-	71	52	51	-	66.0	**0.082**	**0.074**	**0.616**	-	17	0.31	0.13	0.96	-
Total		**163**	**0.53**	**0.39**	**1.30**	-	**592**	**0.96**	**0.28**	**2.16**	-	**755**	**0.87**	**0.30**	**1.98**	-						**5.755**	**5.204**	**33.815**	-	405	0.84	0.29	1.93	-

(1) Type of mine: O/P = open pit, S/P = stockpile, U/G = underground.

(2) Copper Mineral Reserves are reported as dry mill tonnes.

(3) Oyu Tolgoi Mineral Reserve valuations are based on commodity prices of US c 350.80/lb for copper, US$ 1,496.75/oz for gold and US$20.43/oz for silver. These represent January 2022 consensus prices sourced from the average forecasts from ten brokers/banks (Barclays, BoAML, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, JP Morgan, Macquarie, Morgan Stanley and UBS) and two analysts (CRU and Woodmac).

(4) The Hugo Dummett North Mineral Reserves include approximately 1.4 million tonnes of stockpiled material at a grade of 0.51% copper, 0.16 g/t gold and 1.25 g/t silver. The Hugo Dummett North underground mine is currently under construction.

(5) As reported to the market on 16th December 2022, Rio Tinto completed its acquisition of Turquoise Hill Resources Ltd and the Rio Tinto Interest % reflects this change. 2021 figures are reported using the previous ownership %.

12.5 QP's opinion on risk factors that may materially affect the Mineral Reserves estimates

Mineral Reserves estimates are reviewed annually or when new information becomes available that may impact the respective modifying factors. Modifying factors for the underground caving mine were benchmarked against other operating caving mines and the overall recovery is in the range of expected outcomes experienced by operating mines. The underground Mineral Reserves estimate is less sensitive to changes in pricing and operating cost due to a sharp ore to waste contact because the Hugo North mineralisation is bound at top of planned draw columns by the Contact fault. The geotechnical risks with potential to alter modifying factors used in converting Mineral Resources to Mineral Reserves include:

- Stability of a subset of drawpoints that have the highest risk of collapse due to known faults and poor rockmass condition.
- Failure of the drawpoints located within the Lower Fault Zone due to major apex pillar strength loss.
- The drilling program is ongoing to improve the understanding of the geological and geotechnical properties of the orebody and structures.

Other risks inherent to caving that are likely to impact Mineral Reserves recovery include interruptions to undercutting, drive closure for extensive rehabilitation and cave underbreak. The Mineral Reserves estimate is risk adjusted for geotechnical risks, the QPs are not aware of other risk factors that may materially affect the Mineral Reserves estimates.

13. Mining methods

13.1 Introduction

The initial investment decision to construct Phase 1 of Oyu Tolgoi was made in 2010. Mining of the Oyut deposit started in 2012 using open pit mining methods. The Oyut open pit mine currently has an ore production rate of about 35 Mtpa in 2022.

Continued investment into the development of the Hugo North underground mine as a block caving operation commenced in July 2016. Development of Lift 1 is continuing with the first drawbell blasted in mid-2022.

Concept studies have been carried out on developing Hugo North Lift 2, Hugo South, and Heruga deposits. The studies envisage that the Hugo South and Heruga deposits will be mined by underground caving methods similar to Hugo North. No mining or underground development is currently taking place at either Hugo South or Heruga.

13.2 Current mining operations

The planned production schedule for Oyu Tolgoi is shown in Figure 13-1. The current production rate from the Oyut open pit is progressively reduced as production builds up from underground. Open pit mining will continue in parallel with Hugo North Lift 1 to keep the Oyu Tolgoi concentrator operating at its design capacity. Following depletion of Lift 1, production from the Oyut open pit will be increased to meet mill capacity.

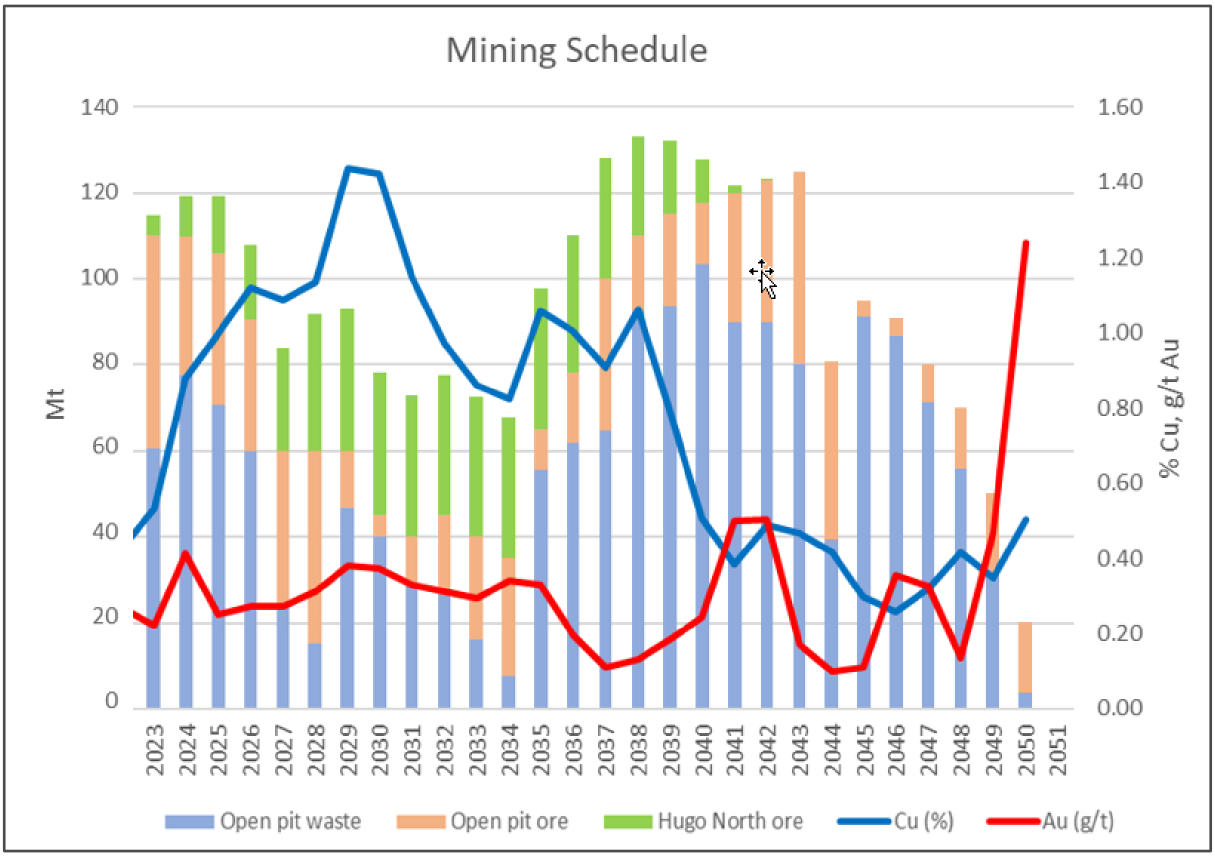

Figure 13-1: Planned Oyu Tolgoi mining schedule bar chart

13.3 Oyut open pit mining

13.3.1 Geotechnical considerations

The development of a realistic ground model with an understood degree of confidence plays a critical role in the design of optimised and stable pit slopes. Ground models used for designs and schedules incorporate:

- Structural geology – Orientation of weak shale bands associated with folding and fault orientation.
- Rockmass conditions – RQD, joint spacing, orientation, conditions, and intact rock strength.
- Porewater pressure during the life of the operation.

Data is collected and analysed to create the ground model. This includes:

- Surface mapping.
- Orientated diamond drill holes.
- Downhole televiewer.
- Geology model.
- Groundwater model.

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Validation of the ground model is conducted through the operating life the mine. Geotechnical monitoring and reconciliation of mapping allows for continuous improvement and adaption of the ground control models.

A degree of contingency is mandated in designs through a design acceptance criteria (DAC). DAC is applied based on the risk profile of the design sector or area. If slope instability in a particular sector impacts critical infrastructure, it will be assigned a higher DAC than if that same instability were to impact non-critical infrastructure, which in turn is assigned a higher DAC than if there were only a minor impact on production.

Due to the varying nature of conditions at Oyut, several analytical tools are deployed to analyse slope stability:

- 2D and 3D Limited equilibrium slope stability analysis (Slide 2 and Slide 3).
- 2D and 3D Finite element modelling (RS2, RS3 and FLAC).
- Rocfall and RocTopple for natural slopes and rock toppling mechanisms.

The inter-ramp angles vary with the geotechnical domain and the dip and strike direction of the pit wall. The inter-ramp angle in fresh rock domains range from 33º to 49º, with an average of about 44º. The range of inter-ramp angles for each geotechnical domain are summarized in Table 13-1.

Table 13-1: Range of inter-ramp angles for each geotechnical domain

Geotechnical domain names	Range of inter-ramp angles
Fresh rocks	
1_5 West (Combined)	33º to 47º
2_2 East (Volcanic)	41º to 46º
2_3 East (Intrusive)	38º to 48º
2_4 East (Sediment)	36º to 49º
3_2 South (Volcanic)	38º to 49º
3_3 South (Intrusive)	38º to 49º
3_4 South (Sediment)	35º to 49º
4_5 Solongo (Combined)	42º to 49º
5_5 Southwest (Combined)	33º to 49º
6_5 Northwest (Combined)	37º to 48º
7_5 Middle (Combined)	33º to 47º
Weathered rocks	
Overburden	25º
Solongo Fault	45º
West	38º
East	42º
South	42º

Solongo	42º
Southwest	37º
Northwest	37º
Middle	42º

Monitoring of slopes is conducted to improve understanding and increase safety and efficiencies of designs. High risk slopes are monitored through continuous monitoring systems measuring slope movement. Moderated and low risk slopes utilise prism monitoring. Action and response plans are created and updated depending on risk profiles for slopes.

13.3.2 Hydrogeological considerations

Mathematical (numerical and analytical) modelling, of both surface water and groundwater provides essential information for decision making in support of existing and proposed mining operations in the Property. Models are designed to inform risk during all stages of pit and underground development, spanning from operational mine dewatering to closure obligations.

In operational mining, groundwater models are used to support scheduling for each mining area and inform bench progressions on a pit-by-pit basis. The mine and dewatering plan are synchronised for increased efficiency. This is achieved via an iterative process undertaken between the mine planner and the hydrogeologist to confirm mine rates are commensurate with the ability to dewater the surrounding groundwater systems and to ensure dry and safe mining conditions in a pit is achieved.

Groundwater models are also used to:

- Devise dewatering strategies (number of bores, pump specification, expected yields, schedule of implementation and volumes) to meet the mine plan.
- Estimate site water balances over the life of the mine; including water management to accommodate periods of excess or deficit.
- Assess impact to environmentally sensitive receptors pre and post mining.

The following documents form the basis with which to feed the groundwater model:

- Bore completion reports providing lithologies, water bearing intersections, water quality, bore yields and initial standing waters.
- Hydrogeological assessments detailing groundwater occurrence, aquifer characteristics, hydraulic gradients, dewatering or water supply.
- Groundwater modelling reports explaining algorithms applied to represent natural processes within a groundwater flow system and how the model is calibrated to temporal stress events.
- Annual aquifer reviews contrasting groundwater pumping against licenced allocation.
- Groundwater operating strategy detailing parameters to be monitored over the operational life of bore fields and used to assess impacts against the allocation licence.

Flood estimation techniques and hydraulic modelling are used to simulate flood events and define floodplain extent and design flows for new and existing mines. The approach follows industry guidelines for application of direct rainfall, Monte Carlo simulations and ensemble modelling techniques.

Development flooding is evaluated for design storm events between 1:2 and 1:200 Annual Exceedance Probabilities (AEPs). Hydrological and hydraulic modelling inform assessment of development on hydrology regime by considering differences in peak flow rates and flood volumes for pre- and post-development scenarios. Closure surface water and landform stability risks are evaluated using regional modelling of rare to extreme flooding, including the 1:1000 and 1:10,000 AEP design flood events.

The following surface water information forms the basis of the hydrological models:

- Surface water management plans providing overviews of rainfall and catchment characteristics, storm runoff, drainage, environmental impacts, and closure requirements.
- Flood risk assessments, describing inherent flood risks associated with operational activities.
- Design reviews, summarising surface water management impacts and surface water risks of pits, dumps, and stockpiles.
- Flood plain assessments, outlining the impact of developments on flood flows and hydrological regimes.
- Baseline hydrology assessments describing natural hydrological conditions.

13.3.3 Mining model

A three-dimensional block model (mining block model) is used for long-term planning and scheduling of the open pit mining operation. The model has a block size of 20 m by 20 m by 15 m. Each block includes the Mineral Resources data, the geometallurgical rock types, metallurgical indices, and an NSR value.

The NSR value is the revenue paid for the concentrate at the mine gate, and excludes costs for the mining process and G&A. The NSR value represents the in situ (before mining) value of the mineralised block after allowing for metallurgical recovery to concentrate, smelter deductions, transportation of concentrate, smelter treatment and refining charges, and royalties. NSR values are based on long-term forecasts for metal prices, smelter and refinery terms, and off-site charges and costs.

The NSR value is used as a proxy for cut-off grade to rank parcels of mineralisation and classify parcels as ore or waste, such that a parcel of mineralisation is defined as waste where the cost of processing and general administration exceeds the NSR cut-off value. For the Oyut open pit, the NSR cut-off values vary between 7.18 $/t and 10.14 $/t for the different geometallurgical ore types.

Some allowance is made for ore loss and contact dilution in the resource estimation procedure. To date, there has been no detailed assessment of the impacts of ore loss and dilution on planned tonnes and grades. Ongoing reconciliation in the transfer of Mineral Reserves to actual production suggests that these impacts are not large.

13.3.4 Pit phases

The current open pit design utilized an industry standard Lerchs-Grossmann (LG) pit optimization approach to produce a nested set of pit shells, which represent the best economic sequence of pit phase development. The nested pit shells are used to guide the design of practical pit phases and the sequence of mining. The pit optimization process used Measured and Indicated Resources classification blocks only for potential revenue generation. Inferred Mineral Resources were treated as waste.

A plan showing the planned phases of the Oyut open pit is shown in Figure 13-2. Sections through the pit design are shown in Figure 13-3 and Figure 13-4. The sections show the outline of the currently planned phases superimposed on the Mineral Resource block model. The individual phase designs are shown in Figure 13-5. The tonnage and grade of ore contained in each phase is summarized in Table 13-2.

Phases 1 to 4a (excluding 3b) were extracted prior to 31 December 2019. Using the nested pit optimization shells and the slope design criteria, practical pit designs were prepared for the remaining 12 pit phases (3b, 4b, 5a, 5b, 6b, 7, 8, 9, 10, 11, 12, 13). The outlines of the practical pit phase designs correspond well with the LG optimization shells. The final phase (phase 13) is the 2020 Mineral Reserve pit and is based on the LG pit shell with a LG revenue factor of 1. The use of this factor maximises the life of the pit but does not necessarily maximise the NPV.

The 2022 Mineral Reserves reported in Section 12 uses the same final phase (phase 13). The pit phases and the Mineral Reserves pit outline may vary in future with changes in revenue factors, costs, and revised slope design criteria.

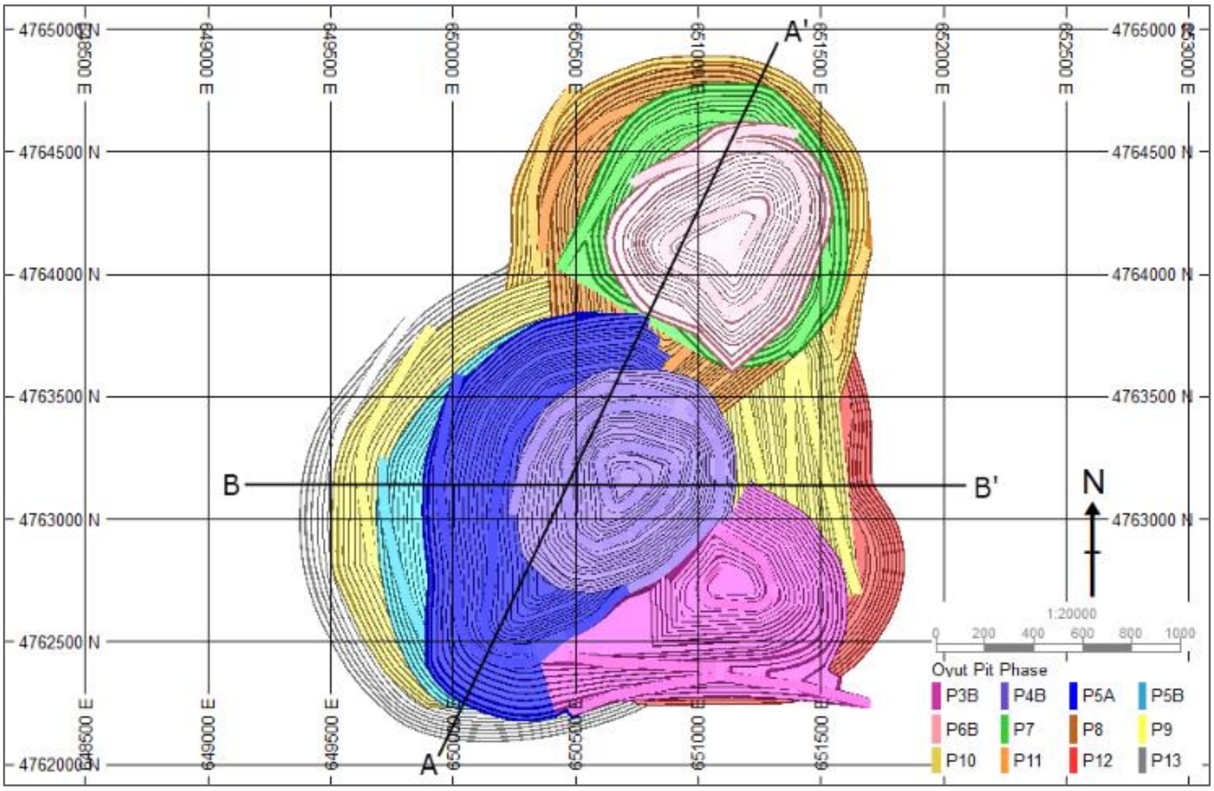


Figure 13-2: Planned Oyu Tolgoi mining schedule

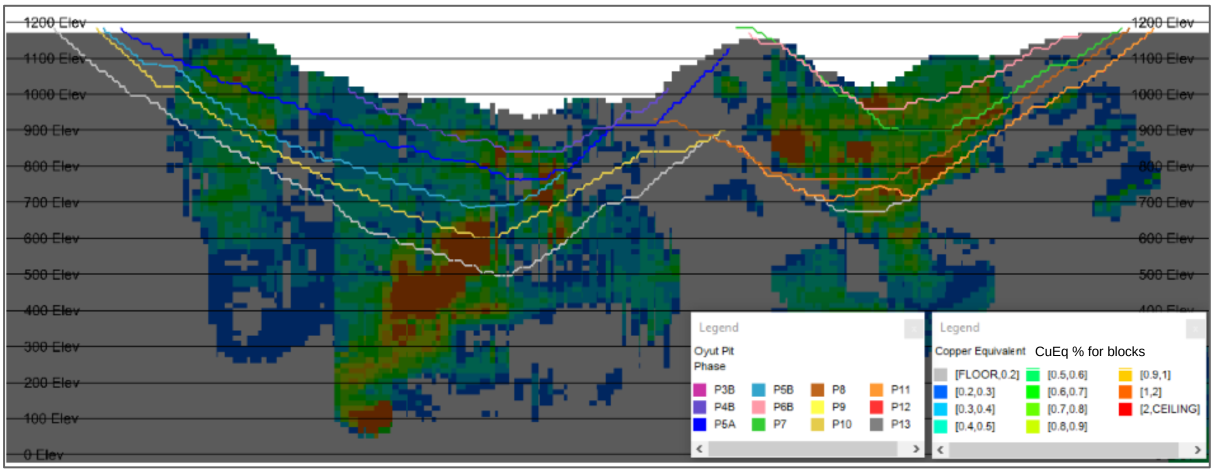


Figure 13-3: Oyut open pit design – Section A-A’

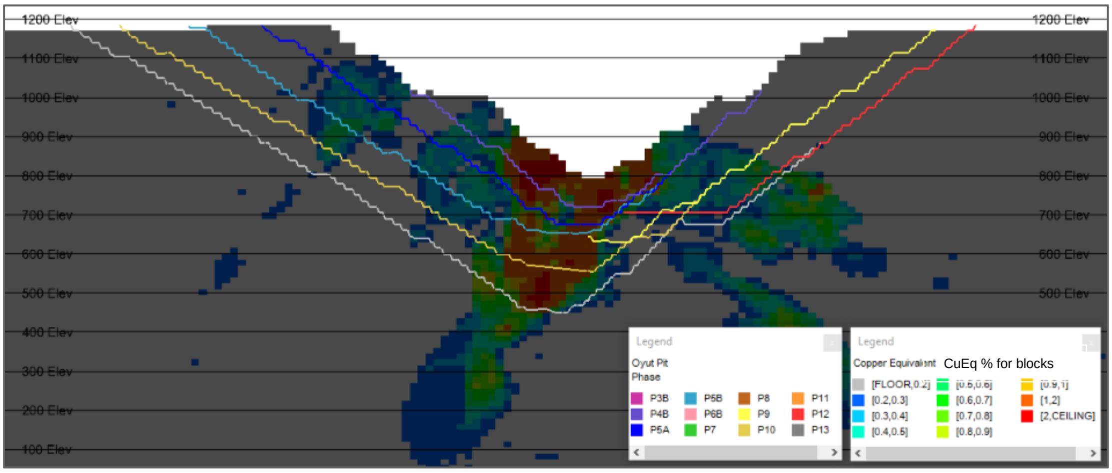


Figure 13-4: Oyut open pit design – Section B-B’

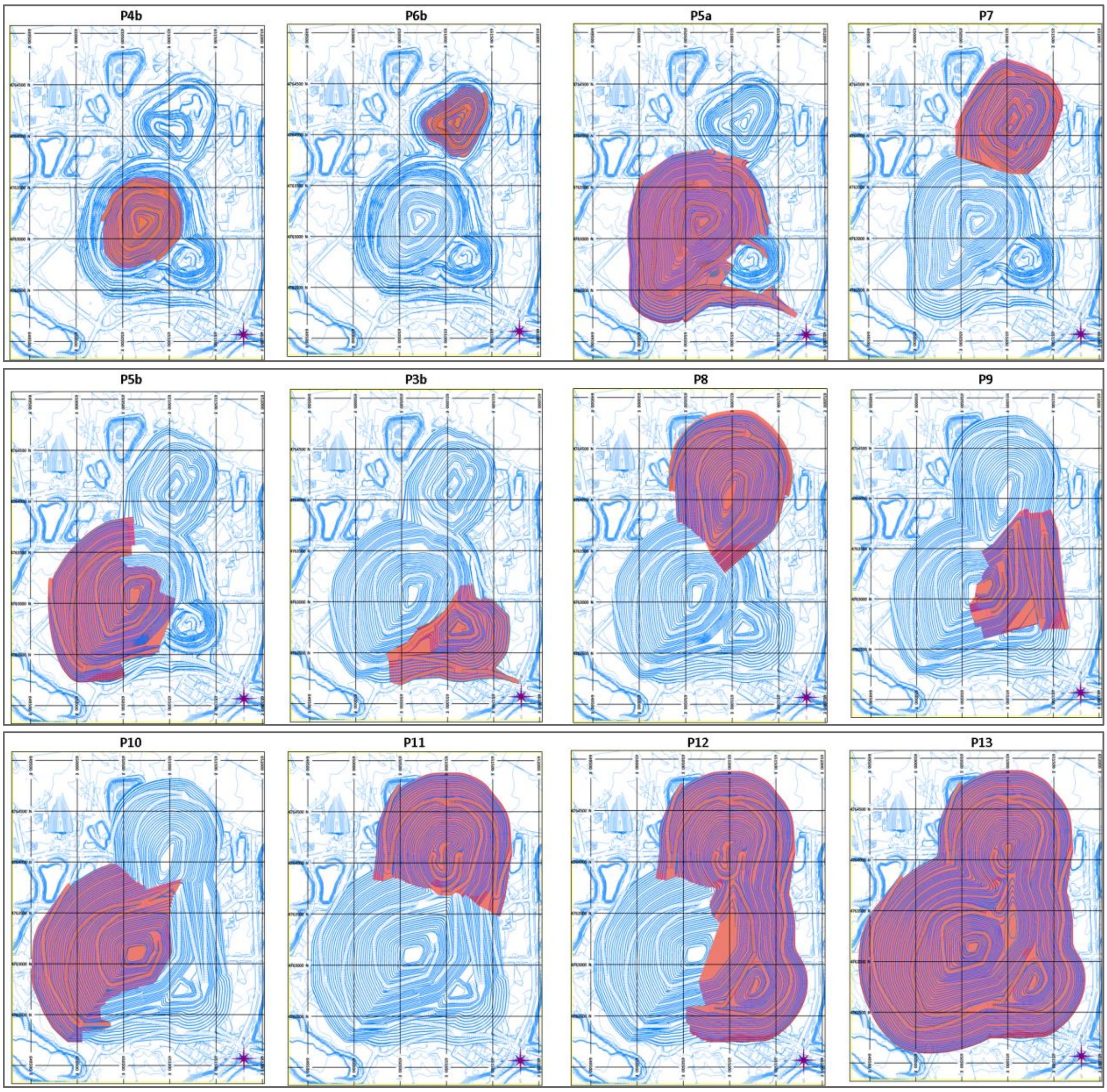


Figure 13-5: Oyut open pit phases (grid lines are at 500 m intervals)

Table 13-2: Oyut tonnage and grade of material in pit phases (on an RR20 basis)

Mining phase	Strip ratio	Waste (Mt)	Ore (Mt)	Cu (%)	Au (g/t)	Ag (g/t)
P4b	0.5	28	63	0.45%	0.48	1.29
P5a	2.0	194	75	0.38%	0.39	1.21
P3b	1.9	11	30	0.44%	0.17	1.66
P5b	1.7	178	101	0.35%	0.36	1.14
P6b	0.2	-3	35	0.60%	0.08	1.57
P7	1.6	53	38	0.62%	0.10	1.23
P8	1.5	201	124	0.54%	0.18	1.16
P9	1.6	138	79	0.40%	0.12	0.96
P10	4.9	277	56	0.38%	0.62	1.27

Mining phase	Strip ratio	Waste (Mt)	Ore (Mt)	Cu (%)	Au (g/t)	Ag (g/t)
P11	3.5	141	40	0.52%	0.20	0.94
P12	2.2	171	80	0.39%	0.10	1.20
P13	6.2	383	62	0.39%	0.57	1.36
Total	**2.3**	**1,771**	**783**	**0.44%**	**0.29**	**1.21**

Note: Phases 1 to 4a were extracted prior to 31 December 2019.
Totals may not match due to rounding.

Short-term mine planning is guided by an ore control model that uses the results of blasthole sampling to manage the final selection of ore and waste. The ore control model also guides the delivery of ore directly to the concentrator or to stockpiles, which are used to blend the feed to the concentrator.

13.3.5 Waste dump and stockpile design

The location of the waste dumps and stockpiles is shown in Figure 13-6. The design capacity of the dumps and stockpiles is summarized in Table 13-3 and Table 13-4, respectively. Including the waste rock in the TSF embankments, the total waste storage capacity is approximately 1,600 Mt.

Waste Rock Storage (WRS) and stockpiles are designed to incorporate 30% swell, 10% natural compaction, and a 37° angle of repose. The dumps are built in 15 m lifts to establish 30 m benches to a maximum height of 90 m. Haul roads are 40 m wide at a 10% gradient.

Potentially Acid Forming (PAF) waste is selectively placed and encapsulated within the dump to migrate any risk from Acid Rock Drainage (ARD). PAF is encapsulated with a minimum 10 m distance from the final recontoured surface slope and 1.5 m on the top of the final landform. In areas where the land surface does not contain clay, a 3 m thick lift of Non-Acid Forming (NAF) waste is placed and compacted at the base of the dumps.

The high grade, (HG), medium grade (MG) and low grade (LG) stockpiles are part of the mine planning strategy to optimise Project value and are categorized as Mineral Reserves. The stockpiles will continue to grow over the Life of Mine (LOM). As the higher grade ore from the pit is depleted, the stockpiles will be drawn down and fed to the concentrator. The high grade stockpile will also be used as an operating buffer if required.

The final mine outline areas are shown in Figure 13-7.

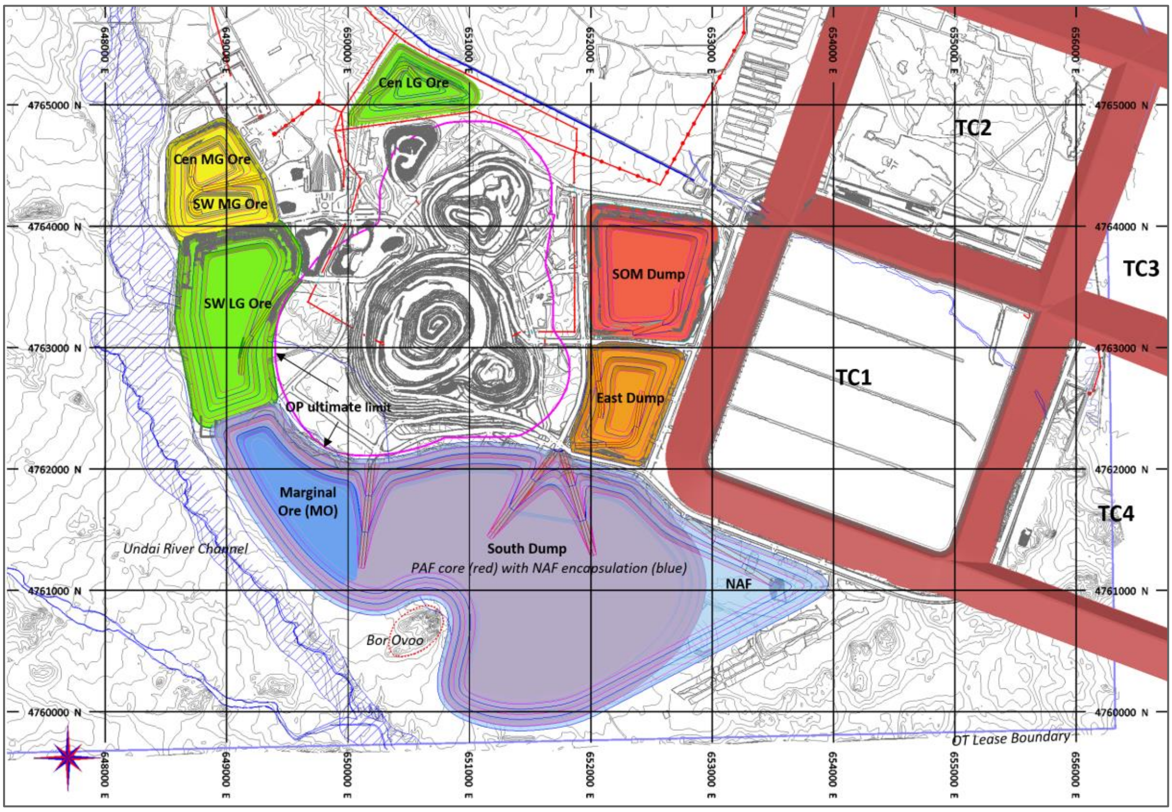


Figure 13-6: Location of waste dumps and stockpiles

Table 13-3: Waste dump design capacities as at 2019 Q3

Dump	Final capacity (Mt)
East dump	40
South dump (PAF)	615
South dump (NAF)	210
SOM dump	60
Tailings Cell 1	115
Tailings Cell 2	200
Tailings Cell 3	220
Tailings Cell 4	140
Total	**1,600**

Note: Totals may not match due to rounding.

Table 13-4: Stockpile design capacities as at 2019 (Q3)

Stockpiles	Final capacity (Mt)
Medium grade stockpile (Southwest and Central)	45
Low grade stockpile (Southwest and Central)	130
Marginal ore stockpile	40
Total	**215**

Note: Totals may not match due to rounding.

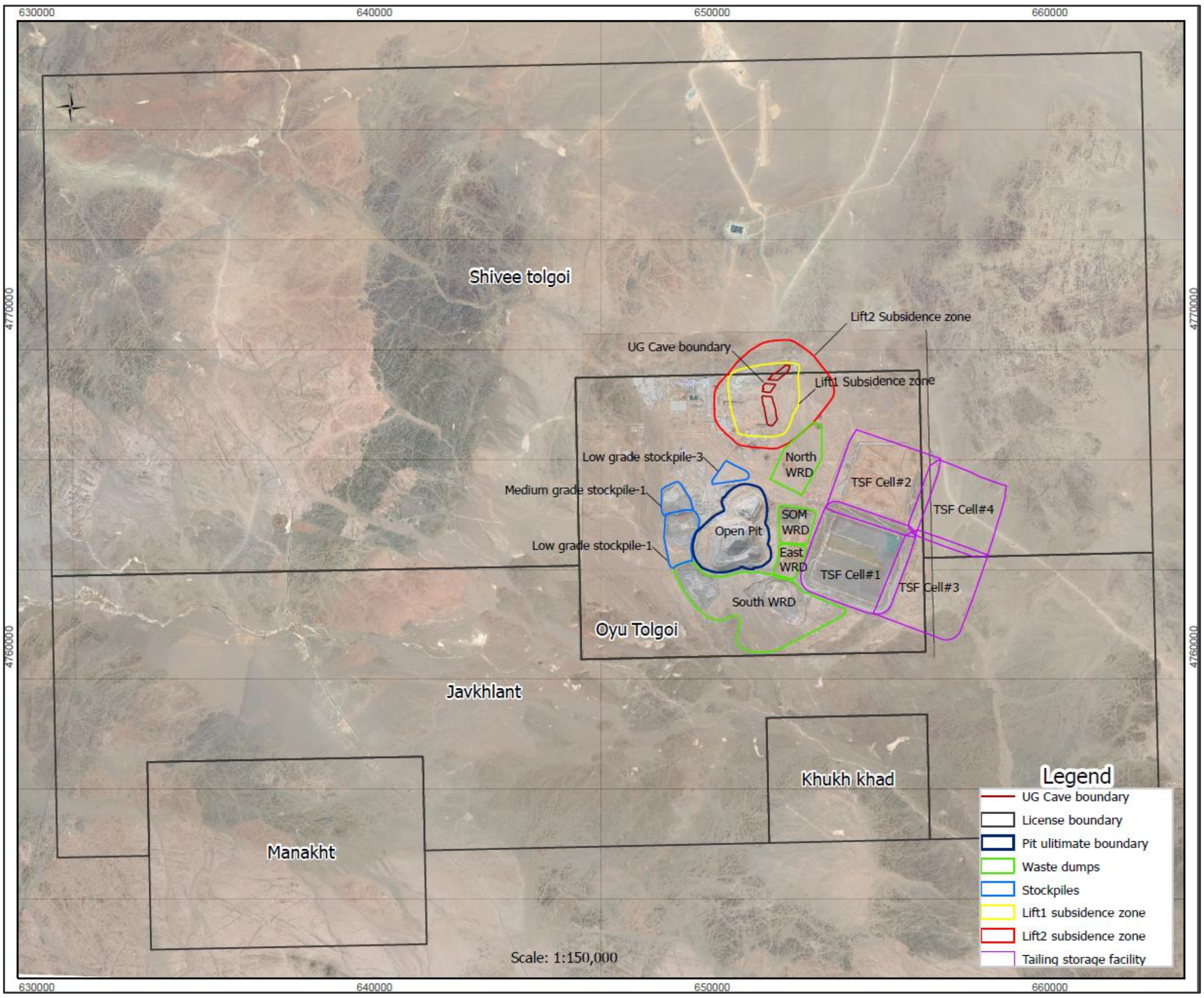


Figure 13-7: Location map showing footprint of final mine outline

13.3.6 Mining fleet, machinery, and personnel requirements

The mining fleet productivity and utilisation assumptions used as the basis for the mine production schedule are shown in Table 13-5. Shovel productivities shown are tonnes per direct operating hour when the shovel is loading.

Table 13-5: Property mining fleet and machinery (October 2021)

Equipment type	Units	Trucks (930E)	Electric shovels (495HR)	Hydraulic shovels (RH350)	Support excavator (L9400)	FELs (WA1200
Initial fleet size	units	30	2	2	2	2
Service life	kh	125	170	85	80	80
Productivity	t/h	305	7,500	4,550	2,873	2,800
Payload	t	295	–	–	–	–
Availability	%	87.6%	85.0%	77.1%	74.7%	79.6%
Use of availability	%	92.5%	91.0%	90.0%	87.0%	83.0%
Operating efficiency	%	91.0%	56.0%	59.5%	61.0%	69.0%
Effective utilization	%	73.7%	43.3%	41.3%	40.3%	44.9%

Equipment type	Units	Trucks (930E)	Electric shovels (495HR)	Hydraulic shovels (RH350)	Support excavator (L9400)	FELs (WA1200
Mining rate per unit	Mtpa	-	28.5	16.3	12.0	9.4
Initial fleet size	units	30	2	2	2	2

The anticipated labour requirements for the open pit operation are shown graphically in Figure 13-8.

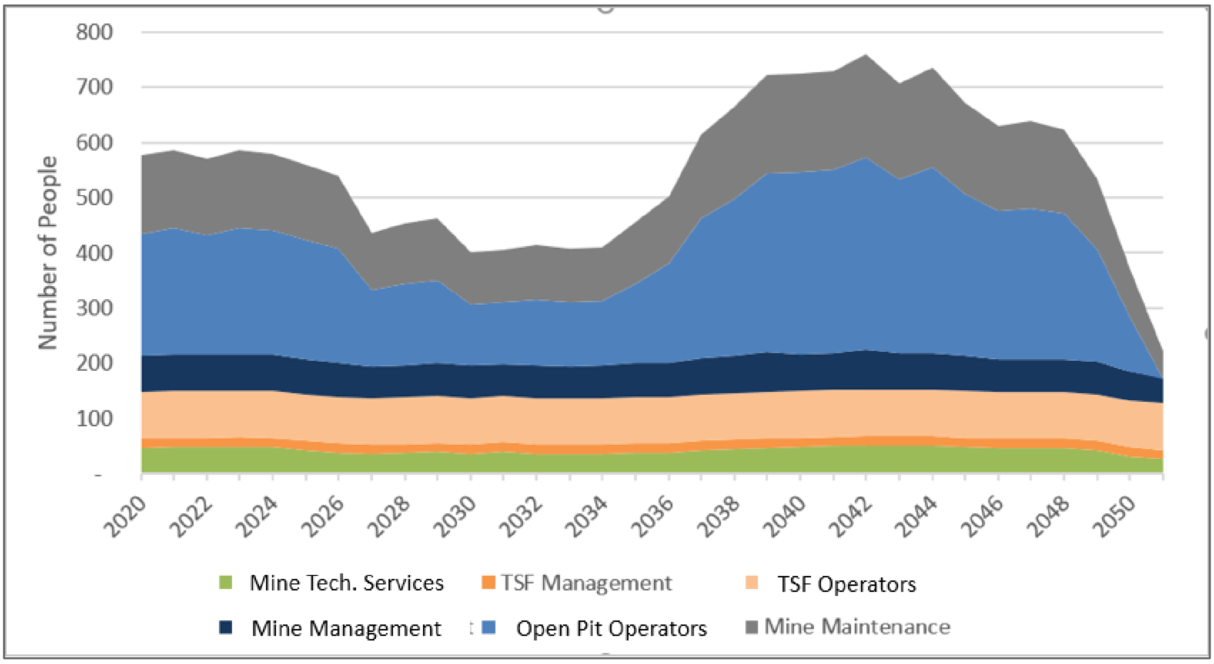


Figure 13-8: Open pit labour requirements

13.4 Underground mining

13.4.1 Background

An isometric view of the planned Hugo North Lift 1 underground mine is shown in Figure 13-9. The surface infrastructure and the relative location of the underground mine is shown in Figure 13-10. The Lift 1 footprint is approximately 1,300 m below surface, 2,000 m north-south, and 280 m east-west.

Sinking of a multipurpose shaft (Shaft 1) to access the Hugo North deposit began in February 2005 and reached its final depth in January 2008. A total of 15 km of lateral development was completed from Shaft 1 by August 2013, when the Underground Project was placed into care and maintenance.

The Phase 2 commenced with sinking activities in Shaft 2 (a multipurpose shaft) and Shaft 5 (an exhaust ventilation shaft) and development of accesses to the Lift 1 footprint. Shaft 2 sinking and installation of fixed guides and other equipment was completed in October 2019 and became operational in December 2019. Shaft 2 is now the main access for personnel and materials and for rock hoisting. Previously, all personnel, materials, and rock hoisting were carried out through Shaft 1. Sinking of Shaft 5 was completed in early 2019. Work on construction of ventilation shafts Shaft 3 and 4 continues following a period of care and maintenance as a result of the COVID-19 pandemic. The declines for the conveyor to surface are being driven down from the surface.

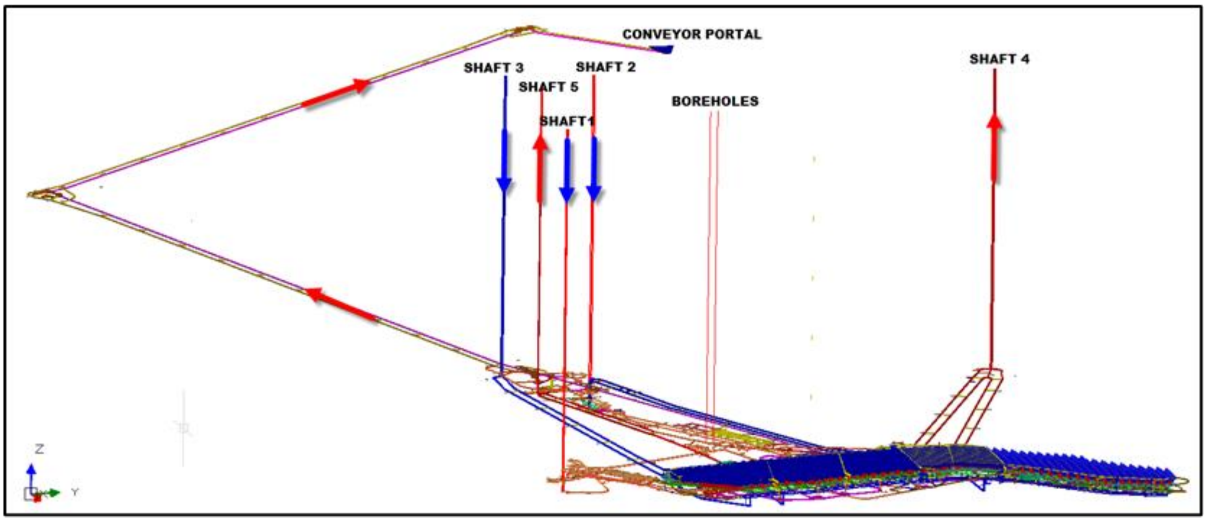


Figure 13-9: Hugo North isometric view of planned mine development arrangements.

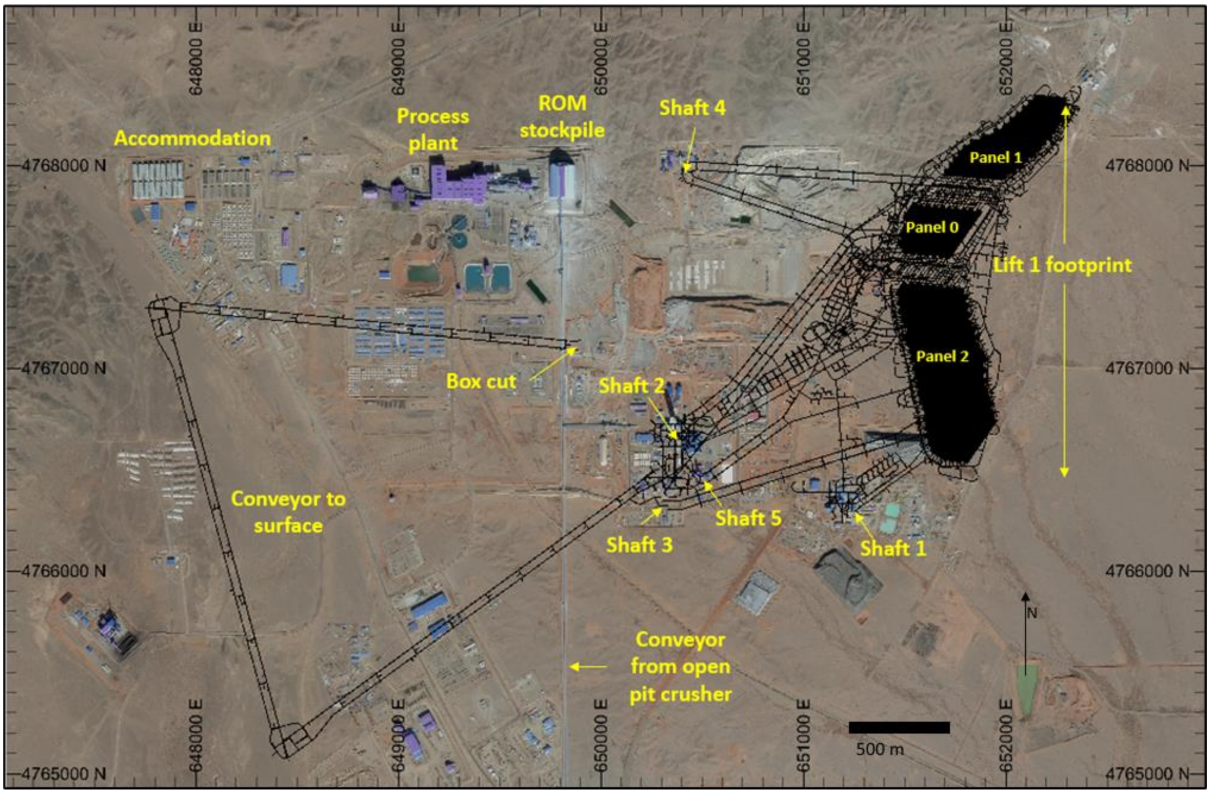


Figure 13-10: Hugo North surface infrastructure arrangements.

The Hugo North mine plan envisages construction of a block cave operation with a nameplate production rate of 33 Mtpa. Lift 1 is planned to be extracted in three panels (Panel 0, Panel 1, and Panel 2). Mining is planned to start in Panel 0 followed by Panel 2 and Panel 1. Hugo North Lift 2 is currently planned as a block cave operation with the footprint approximately 400 m below Lift 1. Development of Lift 2 is at a conceptual stage and is not yet in Mineral Reserves.

Mine development commenced as envisaged in the 2016 Feasibility Study design. Development of the extraction, undercut, and apex levels for Panel 0 were well developed.

In 2018, a detailed review of geological and geotechnical data was carried out. The review highlighted several critical stability risks with aspects of the 2016 feasibility study design of Panel 0. As a result, a new footprint design has been adopted for Panel 0, and changes have been made to aspects of Panels 1 and 2.

13.4.2 Geotechnical considerations

The caving mining method is well suited to the geological and geotechnical characteristics of the Hugo North deposit. The moderate to high stress conditions, a fractured rock mass, and a large caving footprint minimise risks associated with cave propagation. However, the high stress environment and fractured rock mass will present challenges for excavation stability during construction and operations. Fragmentation analysis indicates fine fragmentation for all geotechnical domains. No significant natural surface features will be impacted by subsidence, and no critical mine infrastructure is planned within the likely subsidence area.

Geotechnical data for Hugo North was collected and analyzed during several geotechnical work programs over the past decade.

An initial program of geotechnical data collection and analysis was carried out prior to 2009, including 613 UCS tests, in situ stress measurements, and collection of a range of geotechnical data from orientated drill core logs.

Between 2009 and 2016, significant additional data was collected by extensive surface and underground drilling programs. This included approximately 32 km of drilling and sampling from five underground drill sites. The data collected was used to estimate rock mass quality, stress gradients and orientations, and to identify and characterize fault systems in Hugo North Lift 1.

From 2016 to 2019, development advanced from off-footprint infrastructure areas to the west and east sides of Panel 0 onto the footprint of Panel 0. Diamond drilling from surface and underground drill sites recommenced in 2017. The underground drilling aimed initially to increase the understanding of faulting near the planned off-footprint infrastructure and to further characterize faulting in Panel 0. Surface drilling predominantly focused on gaining additional orebody knowledge and to establish the cave monitoring system above Panel 0.

The diamond drilling for geotechnical purposes carried out between 2017 and 2019 is summarized in Table 13-6. The geotechnical parameters logged from drill core include:

- Down hole interval location (from-to).
- Core recovery.
- RQD.
- Lithological code.
- Intact rock strength/hardness.
- Degree and nature of rock weathering.
- Total number of discontinuities.
- Surface condition of discontinuities, including roughness, wall alteration and infilling.
- Non-rock mass rating interval – (soil or fault) including fault type (gouge, sheared or broken).

- Comments – lithology and rock mass.

Table 13-6: Underground and surface geotechnical diamond drilling from 2017 through 2019

Year	Holes drilled	Footprint drilling (m)	Off-footprint drilling (m)	Seismic monitoring holes (m)	Holes drilled	Hole length (m)
2017	4	-	-	-	24	16,484
2018	34	1,315	2,930	120	57	38,862
2019	90	5,265	3,706	222	28	18,159

In 2018, as part of the normal progression to execution level design for Panel 0, a detailed review of underground drilling indicated the presence of significant fault zones in the Panel 0 area that were not fully apparent at the time of the 2016 feasibility study. Of concern was the extent and ubiquity of the faulting in a zone known as the lower fault splay, where it was proposed to install critical infrastructure, including the Panel 0 ore-handling system.

In September 2018, three holes were drilled into the main section of the Lower Fault Zone, approximately perpendicular to the strike of the fault. This drilling program increased the understanding of the significance of the fault zone identifying multiple anastomosing splays and varying amounts of gouge.

In 2019, further drilling was conducted to further characterize the other major faults within Panel 0. An extra hole was added to the 2019 drilling program to define the ground conditions of a proposed alternative ore-handling system in the northern part of Panel 0.

As the understanding developed of the characteristics of the Lower Fault Zone via data collection and analysis, including numerical modelling, the implications for mine design and operations were assessed and work commenced to investigate how the impact could be minimized via increased ground support or design modifications.

In 2019, SRK Consulting and geoscientists from the Oyu Tolgoi study team updated the structural model of the faults impacting Panel 0. To develop the updated model, all diamond drill hole core photographs were scrutinized in conjunction with available mapping of underground development. Three-dimensional shapes were created from the drill hole data and cross checked against core photographs. Dip and dip direction were used where data was available for fault orientation and projection.

A formal review of the new structural model of the Panel 0 area was carried out by Oyu Tolgoi LLC, which concluded that the modelled faults were geologically reasonable and compatible with the available data. The new model does not represent all the fault structures within Panel 0, and the process of investigating the major faults in Panel 0 and Panels 1 and 2 is ongoing.

The new structural model identified significantly more structure than had previously been identified in the 2016 feasibility study.

Numerical assessment of cave propagation has been carried out by Itasca using a coupled FLAC3D-CAVESIM model. The aim was to investigate the first 50 months of production, with focus on the period from cave initiation to surface breakthrough. The sensitivity of propagation to rock mass strength was assessed for P30 and P50 material properties (lower percentile values for UCS, mi and GSI).

In addition to the rock mass properties, the rate of propagation depends on the start point and direction and rate of undercutting and the production rate. Using the planned undercut sequence and production rate, the cave is predicted to propagate to surface with no significant airgaps formed nor significant intermittent caving events.

Using P50 material properties and a bulking factor of 115%, surface breakthrough is predicted after 42 months of production (i.e. 30 months after cave initiation or 15 months after full undercutting). Using P30 material properties and a bulking factor of 108%, surface breakthrough is predicted to occur around 10 months earlier. However, the relatively high draw ramp up rate, combined with critical hydraulic radius, results in a narrow, conical shaped cave at breakthrough. The formation of a conical cave is heavily influenced by the relatively low rock mass strength and large-scale structures that act as cave propagators, especially the Kharaa fault in the southeast corner of the footprint and the Bumbat and Wbat faults in the northwest.

After breakthrough, some cave sidewalls, particularly the northeast sidewall, have substantial overhangs. For P30 properties, these overhangs gradually collapse as draw progresses. For P50 material properties, a final state overhang or hang-up is predicted in the northeast cave sidewall. Also, a lower caving rate is predicted above the northeast corner of the footprint. The formation of the overhang is also influenced by the corner in the cave footprint. Based on the properties provided, the models indicate the risks of significant overhangs forming are low.

The predicted subsidence fracture limit (determined as the point of having a notable impact on key infrastructure) at the end of mining Lift 1 is shown by the blue outline in Figure 13-11. The subsidence angles are predicted to be near-vertical at the northern and southern limits of the cave, where confinement is highest, and approximately 55° in the east and west directions, where confinement is lowest.

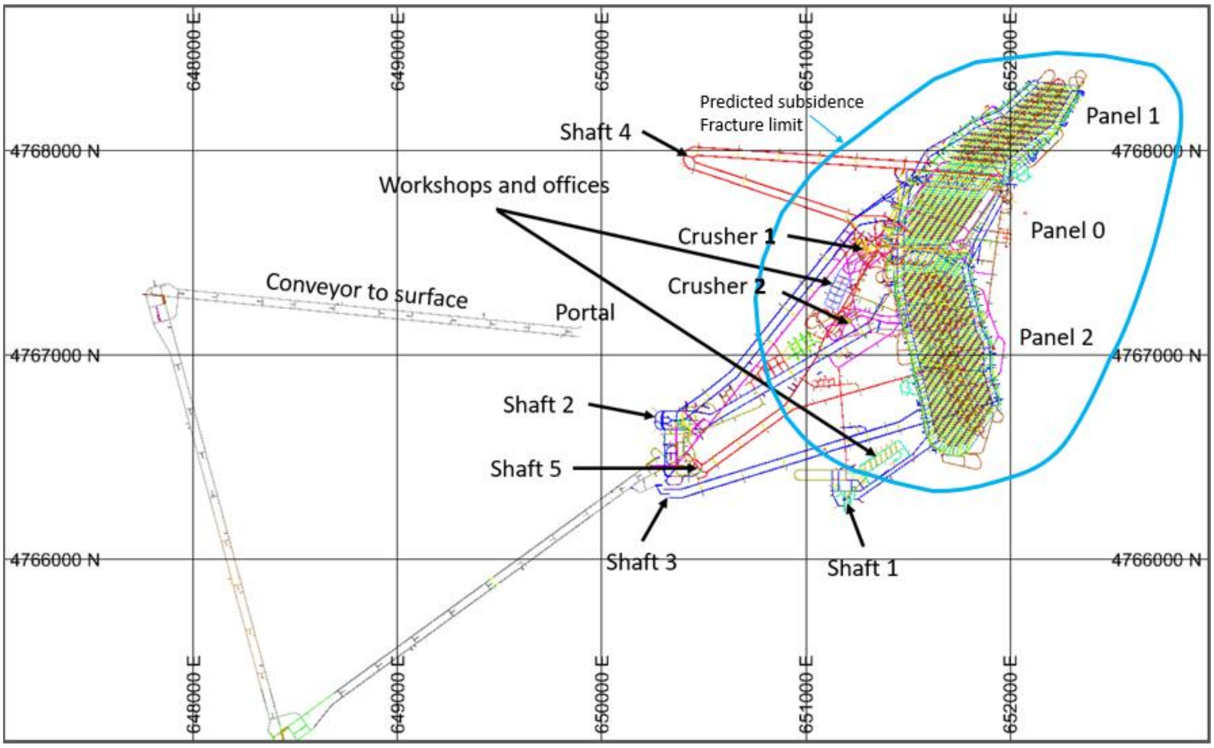


Figure 13-11: Hugo North predicted subsidence fracture limit

In the QP's opinion, the geotechnical factors are adequately considered for the Mineral Reserve reported.

13.4.3 Hydrogeological considerations

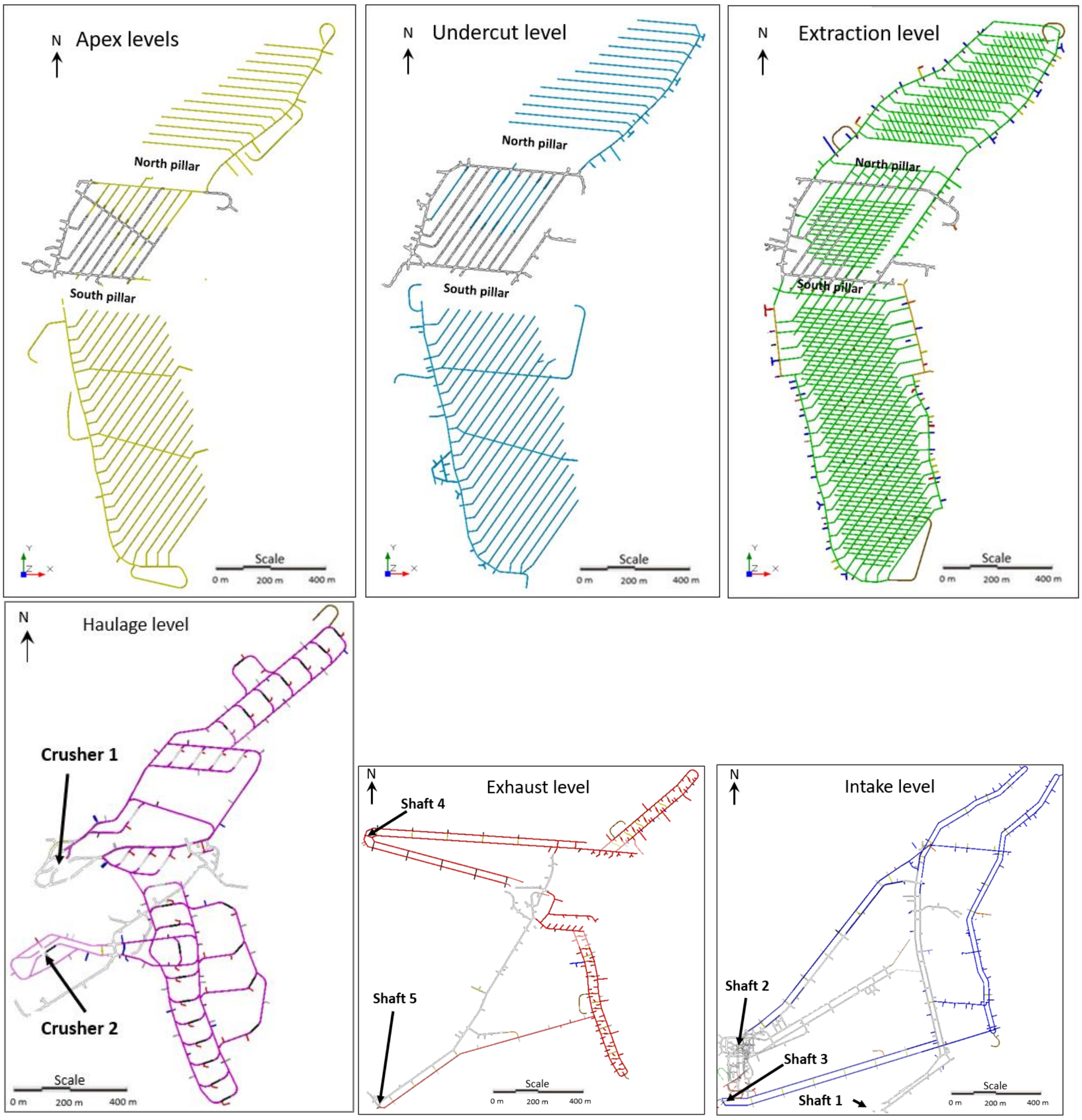
As the block cave propagates up the cave column it will become a preferential flow path for ground water. As the cave continues to grow up the cave column and eventually breaks through to the surface, hydraulic connectivity will occur and surface water can also potentially drain into the cave column. Strategies for surface water management will be developed and updated regularly with new information. The block cave impacts on ground and surface water, as a result of cave growth and surface connectivity, are required to be assessed incrementally as more studies are completed and site data is collected.

13.4.4 Mining model

The mine design consists of 211 km of lateral development, five shafts, and two decline tunnels from surface. The primary life of mine ore-handling system will transport ore to surface by a series of conveyors to surface. An overview of the planned Lift 1 development is shown in Figure 13-11.

The Lift 1 mining levels are approximately 1,300 m below surface. Six distinct levels will be developed to mine Lift 1. The levels are shown in Figure 13-12. The Apex and undercut levels are shown in the left same image (the left-hand image). The apex level is 17 m above the undercut level, which in turn is 17 m above the extraction level (floor to floor). The haulage level is 44 m below the extraction level. In the footprint area, the exhaust ventilation level lies between the extraction and haulage levels.

Over 73 km of lateral development and over 5 km of vertical development have been completed since the Project commenced.



Completed development is coloured grey

Figure 13-12: Hugo North mine levels

13.4.5 Mining phases

The Hugo North mine production schedule was developed using PCBC, a cave modelling software package. The development, undercutting, and construction schedules were coordinated with the production ramp-up schedule to ensure that planning for all facilities support the requirements for the planned production build-up.

In 2012 and 2016, discrete-event simulation model of the ore-handling system was developed and used to estimate the overall capacity of the ore-handling system and its ability to achieve the target production rate of 95 kt/d. This model was used to establish the baseline production capacity for the default ore-handling layout shown on the material handling flowsheet.

No changes have been made to the ore truck haulage, crushing and conveying system that would materially impact the capacity of the ore-handling system. The maximum production rate for Panel 0 has been reduced from approximately 40 kt/d in the 2016 feasibility study to 30 kt/d, the current mine design capacity.

The following is a summary of the key scheduling constraints applied to the production schedule:

- A maximum undercut advance of 10 m per month (four rings in each undercut drive).
- Maximum of five drawbells per month blasted per undercut face.
- Undercut mucking rates scheduled at 1,350 t/d.
- Undercut faces in Panel 1 and Panel 2 initiated once Panel 0 is operating sustainably and development, undercutting and construction resources can be relocated from Panel 0.
- After undercutting is complete, the maximum production rates from each panel are limited to 30 kt/d from Panel 0, 35 kt/d for Panel 1, and 95 kt/d from Panel 2.
- The production rate curve (PRC) used to control the initial rate of draw from individual draw points was updated is in line with practice at similar caving operations.

After achieving sustainable cave propagation, which is estimated to occur after firing approximately 60 drawpoints, the production rate will ramp up between 2023 and 2029, to reach a steady-state rate of 95 kt/d (33 Mtpa).

The annualized production profile for Hugo North Lift 1 is shown in Figure 13-13. The profile of the planned production ramp-up is similar to the ramp-up envisaged in the 2016 feasibility study. The production schedule does not reflect the impacts of the COVID-19 pandemic which are ongoing and continue to be assessed.

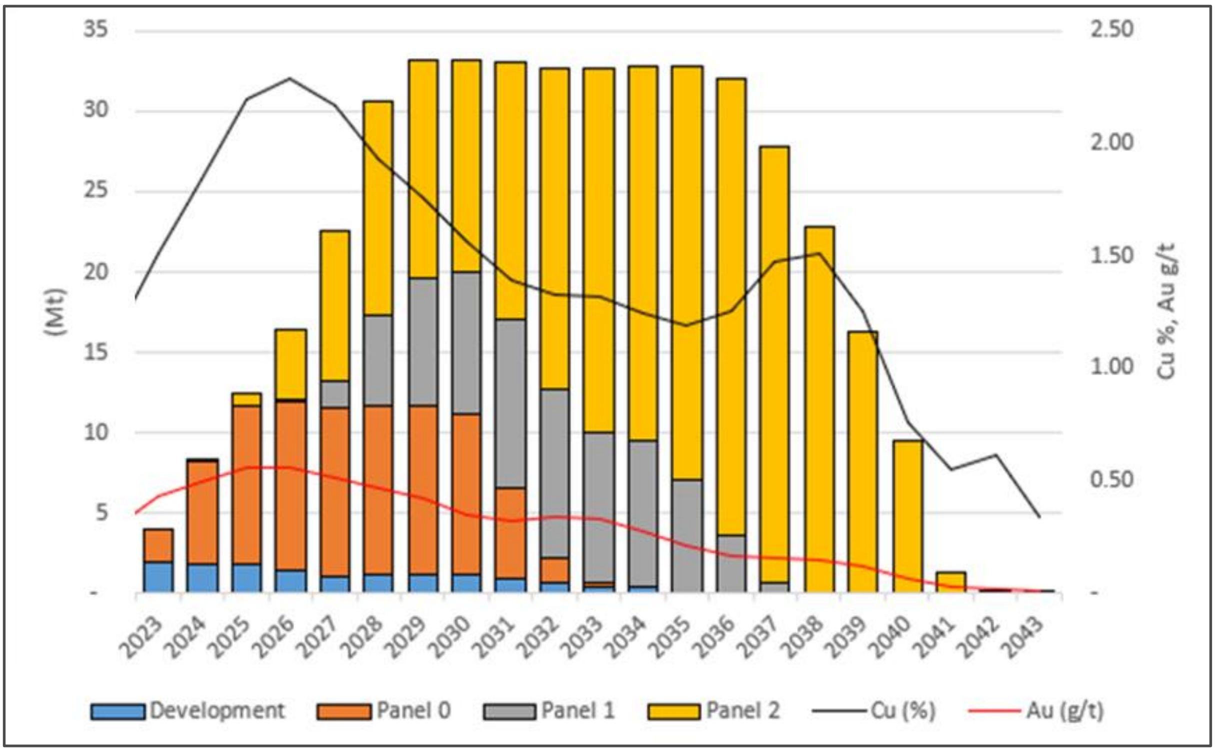


Figure 13-13: Hugo North Lift 1 mine production schedule by panel

13.4.6 Mining fleet, machinery and personnel requirements

The underground mobile equipment fleet is more than 300 units at present. Fleet size and composition will fluctuate with demand and changes in the work requirements. The make-up of the planned mobile equipment fleet by main categories is shown in Figure 13-14. Equipment will meet Tier IV emission standards or be outfitted with a diesel particulate filter.

The equipment is planned to be provided by four primary vendors:

- Sandvik – mucking and development hauling.
- Epiroc – drilling and ground support.
- Normet – utility and service.
- Scania – production haulage.

A production fleet of 26, 14-tonne diesel load-haul-dump (LHD) machines is required to achieve the peak planned production rate of which 21 will be operating at a time. Three longhole rigs and two boxhole machines will be used to maintain the drawbell construction rate of up to nine drawbells per month. The equipment fleet sizes and vendors are subject to further review as part of operational readiness planning.

Hang-ups will be managed by a secondary breaking crew equipped with water cannons and a single-boom medium-reach drill rig equipped with a self-indexing charging arrangement for automated charging. Blasting will be done at the scheduled end of shift but could be done at mid-shift if needed. Non-explosive rock breaking technology will be used for oversize rocks removed from the drawpoint to secondary breaking locations.

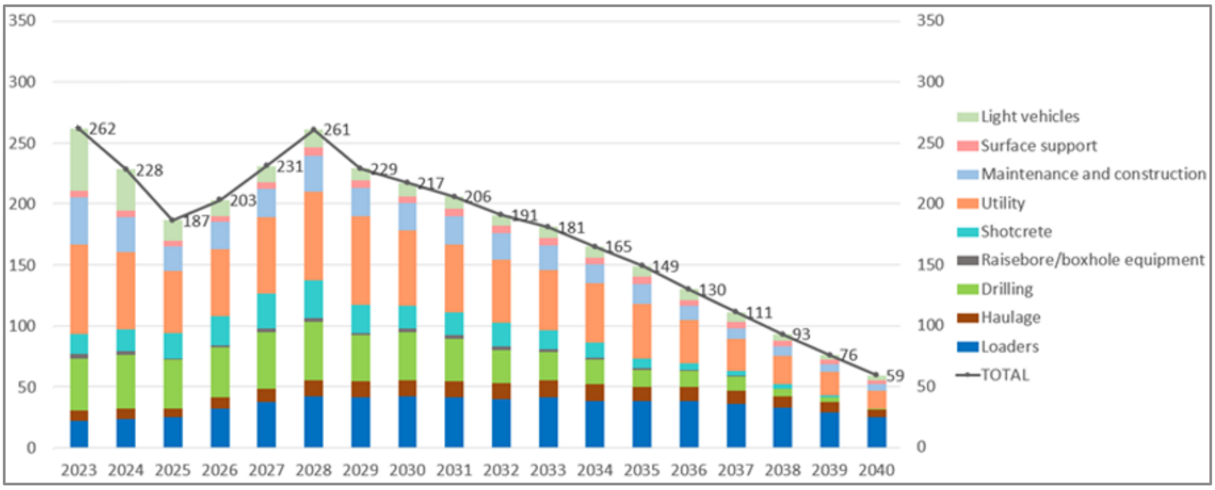


Figure 13-14: Hugo North mobile equipment fleet by main category

The underground mine operates 24 hours per day, 365 days per year. Current and planned working arrangements are based mainly on working two 12-hour shifts. Work schedules are aligned to support the continuous non-stop operations for the operational roles.

The region in which the Project is locate does not have a tradition of underground mining or heavy industry. Consequently, the current workforce includes a significant number of expatriate personnel who provide many of the specialist skills required for mine construction. The composition of the current underground workforce is summarized in Table 13-7.

Oyu Tolgoi LLC has developed and operates a training facility and program to train miners, mechanics, plant operators, and technicians. The training combined with the reduced need for specialist skills as mine construction is completed will lead to a progressive reduction in expatriate personnel.

Table 13-7: Composition of the current underground workforce

Project Stage	Mongolian (%)	Expatriates (%)
Mining contractor	75	25
Construction contractor	60	40
Oyu Tolgoi LLC operations	90	10

13.5 Production schedule

13.5.1 Scheduling process

At the time of reporting, the Property comprises total Mineral Reserves of 755 Mt, and total Mineral Resources of 2.7 Bt, on a Rio Tinto owned basis. The conversion of material from a Mineral Resources to Mineral Reserves category occurs on a progressive basis. The timing of the conversion is dependent on completion of technical studies to a minimum of pre-feasibility level including application of Modifying Factors.

To estimate the Mineral Reserves inventory, life of mine schedules are created for each mining area to achieve the relevant product(s) specifications. The individual schedules form the basis of the Property's Mineral Reserves inventory and provide guidance on development sequence, scale of operation, remaining mine life and the contribution of each mining area to meet business and customer requirements for product quantity and quality. The main constraints for the schedules are:

- Product quality specifications.
- Processing plant throughput capacity.
- Permitting dates for future deposits.

To demonstrate economic viability of the Property's Mineral Reserves at the time of reporting, a Mineral Reserves production schedule is created. This schedule utilises only material classified as Mineral Reserves as revenue generating, removing revenue generated from Mineral Resources and therefore providing a standalone economic assessment.

The amount of Proven and Probable Mineral Reserves used in this schedule does not necessarily represent the amount of material utilised for extraction and production within the Property's mining operations, in practice.

As a result of this approach, the production rates scheduled may not align with production guidance, previously demonstrated production rates and system capacity.

13.5.2 Scheduling results

The planned production schedule for Oyu Tolgoi is shown in Figure 13-15 and Table 13-8. The current production rate from the Oyut open pit continues until 2023, after which it will be progressively reduced as production builds up from underground. Open pit mining will continue in parallel with Hugo North Lift 1 to keep the Oyu Tolgoi concentrator operating at its design capacity. Following depletion of Lift 1, production from the Oyut open pit will be increased to meet mill capacity.

Mining rates in the Hugo North panel cave are determined by cave propagation, drawpoint productivity, and ultimately ore transfer capacity to surface. The peak underground production is forecast at 95,000 t/d for 350 operating days per year (33.25 Mt/a). Mining rates in the Oyut open pits are determined by the overall material movement and are sufficient to present up to 54 Mtpa of ore to either the concentrator or run-of-mine stockpiles. During underground production, however, Oyut open pit ore production is throttled back to only make up the balance between underground ore production and the concentrator capacity.

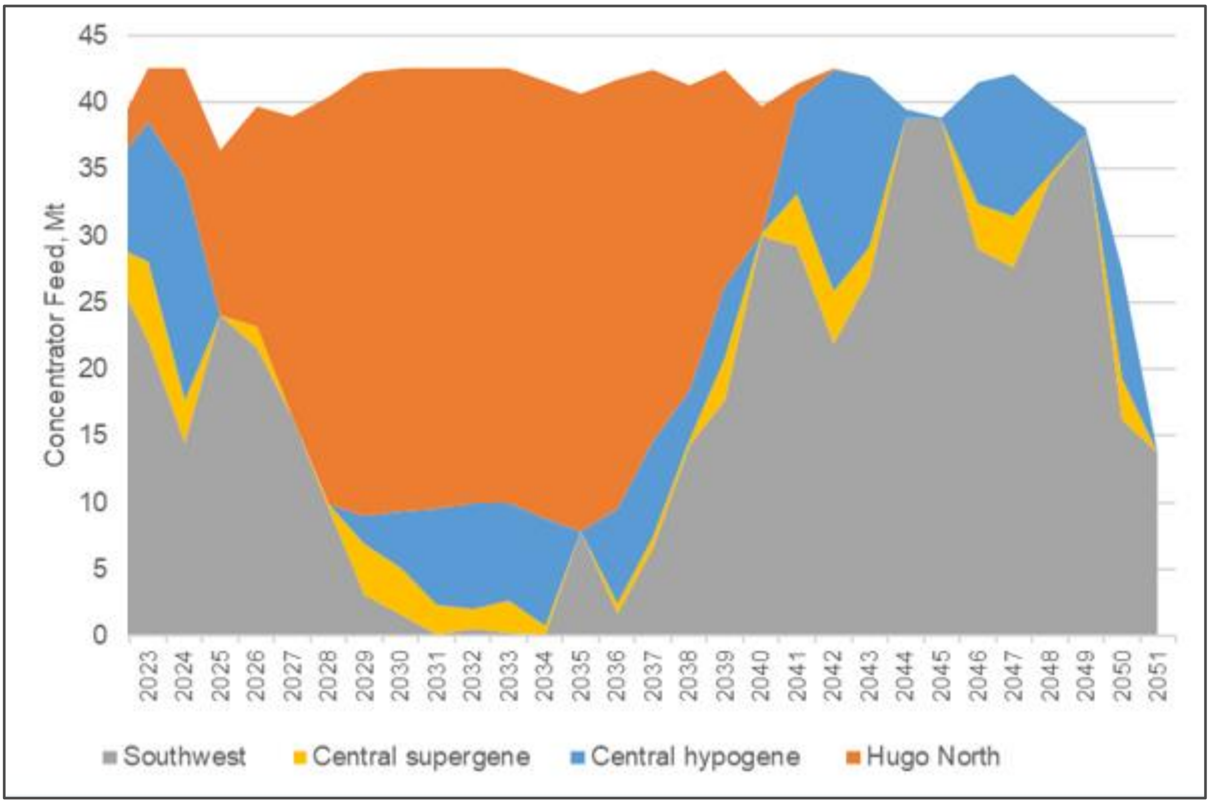


Figure 13-15: Life of mine Mineral Reserve processing schedule

Table 13-8: Planned Oyu Tolgoi mining schedule

	Oyut open pit				Hugo North ore mined			Total ore mined		
Year	Waste (Mt)	Ore (Mt)	Cu (%)	Au (g/t)	Ore (Mt)	Cu (%)	Au (g/t)	Ore (Mt)	Cu (%)	Au (g/t)
2023	61	46	0.39	0.21	4	1.5	0.43	50	0.48	0.23
2024	61	35	0.57	0.38	8	1.8	0.49	43	0.81	0.40
2025	66	24	0.35	0.23	12	2.2	0.56	36	0.98	0.34
2026	48	32	0.31	0.26	16	2.3	0.56	48	0.99	0.37
2027	19	31	0.33	0.40	23	2.2	0.52	53	1.11	0.45
2028	45	14	0.49	0.76	31	1.9	0.47	45	1.47	0.56
2029	54	11	0.43	0.09	33	1.8	0.42	45	1.42	0.33
2030	29	16	0.50	0.15	33	1.6	0.35	50	1.22	0.28

Year	Oyut open pit				Hugo North ore mined			Total ore mined		
	Waste (Mt)	Ore (Mt)	Cu (%)	Au (g/t)	Ore (Mt)	Cu (%)	Au (g/t)	Ore (Mt)	Cu (%)	Au (g/t)
2031	21	24	0.49	0.15	33	1.4	0.32	57	1.02	0.25
2032	24	26	0.57	0.17	33	1.3	0.34	59	1.00	0.26
2033	12	33	0.66	0.22	33	1.3	0.33	66	0.98	0.28
2034	27	18	0.66	0.24	33	1.2	0.27	50	1.04	0.26
2035	49	21	0.45	0.14	33	1.2	0.21	53	0.90	0.18
2036	63	12	0.40	0.16	32	1.3	0.17	44	1.02	0.16
2037	89	18	0.40	0.06	28	1.5	0.16	46	1.06	0.12
2038	116	4	0.38	0.11	23	1.5	0.15	26	1.36	0.14
2039	88	37	0.38	0.12	16	1.3	0.12	53	0.65	0.12
2040	90	30	0.34	0.18	10	0.8	0.07	40	0.44	0.15
2041	89	28	0.34	0.39	1	0.6	0.03	29	0.35	0.37
2042	74	49	0.51	0.62	0	0.6	0.02	49	0.51	0.62
2043	78	38	0.45	0.16	0	0.3	0.01	38	0.45	0.16
2044	78	42	0.42	0.10	–	–	–	42	0.42	0.10
2045	89	1	0.22	0.26	–	–	–	1	0.22	0.26
2046	66	10	0.31	0.19	–	–	–	10	0.31	0.19
2047	67	8	0.32	0.31	–	–	–	8	0.32	0.31
2048	56	14	0.42	0.13	–	–	–	14	0.42	0.13
2049	31	19	0.35	0.47	–	–	–	19	0.35	0.47
2050	4	16	0.50	1.24	–	–	–	16	0.50	1.24
2051	–	–	-	-	–	–	–	–	–	–
Total	1,771	783	0.44	0.29	440	1.51	0.32	1,223	0.83	0.30

Note: Ore mined from the Oyut open pit excludes ore recovered from surface stockpiles.
Amounts are rounded and exclude any impacts of COVID19 and are subject to further study and assessment as part of Oyu Tolgoi LLC's cost and schedule estimation update which is expected later in 2023 and subject to further study and analysis on Panels 1 and 2.

13.5.3 Mining unit dimensions

13.5.3.1 Open pit

A three-dimensional block model (mining block model) is used for long-term planning and scheduling of the open pit mining operation. The model is based on, and has the same block size, as the 2018 Oyut Mineral Resource block model (20 m x 20 m x 15 m). Each block includes the Mineral Resource data, the geometallurgical rock types, metallurgical indices, and an NSR value.

The NSR value is the revenue paid for the concentrate at the mine gate and excludes costs for the mining process and G&A. The NSR value represents the in situ (before mining) value of the mineralised block after allowing for metallurgical recovery to concentrate, smelter deductions, transportation of concentrate, smelter treatment and refining charges, and royalties. NSR values are based on long-term forecasts for metal prices, smelter and refinery terms, and off-site charges and costs.

The NSR value is used as a proxy for cut-off grade to rank parcels of mineralisation and classify parcels as ore or waste, such that a parcel of mineralisation is defined as waste where the cost of processing and general administration exceeds the NSR cut-off value. For the Oyut open pit, the NSR cut-off values vary between 7.18 $/t and 10.14 $/t for the different geometallurgical ore types.

Some allowance is made for ore loss and contact dilution in the resource estimation procedure. To date, there has been no detailed assessment of the impacts of ore loss and dilution on planned tonnes and grades. Ongoing reconciliation in the transfer of Mineral Reserves to actual production suggests that these impacts are not large.

13.5.3.2 Underground

Caveability assessments were conducted using three different analysis methods:

- Laubscher mining rock mass rating (MRMR) rock mass classification system combined with the Laubscher's (2000) MRMR stability graph.
- Extended Matthew's stability chart, based on the Matthews N value (a derivative of the NGI Q system).
- A coupled cave propagation simulation method described in Hebert and Sharrock (2018).

The Laubscher stability graph approach indicated a hydraulic radius (HR) to sustain continuous caving of between 20 m to 23 m (for median rock mass conditions). The extended Mathews stability chart indicated slightly larger range 25 to 35 m; however, the Lift 1 cave lies outside the range of experience captured by the chart.

The coupled cave propagation simulation method implements a detailed and numerical approach to simulate cave propagation based on strong bidirectional coupling between FLAC3D (Itasca 2019) and CAVESIM. Production advance is simulated in CAVESIM, where material is drawn from the drawpoints based on the input draw schedule. Material flow is simulated within CAVESIM, and the resulting air gap volume and volumetric flow rate in the cave are communicated to the FLAC3D model.

Using a range of properties, cave initiation is predicted at a HR between 25 and 29 (minimum span of 100 to 115 m) depending on the design and starting location. The caveability analysis indicates that faulting will significantly influence and promote caving and cave propagation.

13.5.4 Mining dilution and recovery factors

A strategy of soft, firm, and hard boundaries has been used during estimation to account for domain boundary uncertainty (dilution) and to reproduce the input grade sample distribution in the block model. Soft boundaries allowed full sharing of composites between domains during grade estimation; firm boundaries allowed sharing of composites from within a certain distance of the boundary and hard boundaries allowed no composite sharing between domains. Comparative basic statistics, such as mean grade, was carried out for each set of adjoining domains to establish the boundary as soft, firm, or hard. Contact plots and visual inspection of grade distributions were also used in cases where results were unclear or were contrary to geologic expectation.

Approximately 5% of the tonnage included in the Oyut Mineral Reserve is dilution originating from Inferred Mineral Resources. The grades of this material have been set to zero to ensure that only metal originating from Measured and Indicated Mineral Resources is included in the Mineral Reserve estimate.

Inferred blocks within the Lift #1 block cave shape are assigned a zero grade and treated as dilution in the Mineral Reserve.

To date, there has been no detailed assessment of the impacts of ore loss and dilution on planned tonnes and grades. Ongoing reconciliation in the transfer of Mineral Reserves to actual production suggests that these impacts are not large.

14. Processing and recovery methods

14.1 Processing methodologies and flowsheets

The existing process plant at Oyu Tolgoi (Phase 1) commenced production in 2013 with a nameplate capacity of 95 kt/d, though this has often been exceeded when processing less competent and softer ores, with the limitation being largely volumetric. Figure 14-1 provides a schematic representation of the existing concentrator. Table 14-1 provides a summary of major equipment installed in the concentrator.

Table 14-1: Summary of existing major equipment

Equipment Unit	Number of Units	Description	Installed Unit Power (kW)
Primary Crusher	1	60” x 113” Fuller-Traylor gyratory	750
SAG Mill	2	FLSmidth 11.6 m diameter x 6.9 m EGL with Siemens gearless mill drive	20,000
Pebble Crusher	3	Metso MP 1000 cone crusher	750
Ball Mill Cyclone Cluster	4	Weir Cavex 8 x 800CVX cyclones	
Ball Mill	4	FLSmidth 7.3 m diameter x 11 m EGL, GE twin pinion drives	11,400
Tailings Thickener	2	In-ground high rate, 80 m diameter	
Rougher Flotation	4	8 x 160 m^3 Wemco tank cell bank	187
Cleaner Flotation Cells	3	4 x 160 m^3 Wemco tank cell bank	187
Cleaner-scavenger Flotation Cells	3	4 x 160 m^3 Wemco tank cell banks	187
Regrind Cyclone Cluster	3	Weir Cavex 18 x 500CVX cyclones	
Regrind Mill	6	Metso Vertimill VTM-1500-WB	1,119
Recleaner Column Cell	4	CPT 5.5 m diameter x 16.0 m high	
Concentrate Thickener	2	23 m diameter, high rate	7.5
Concentrate Pressure Filter	2	Larox PF tower press, 144 m2 filter area	110

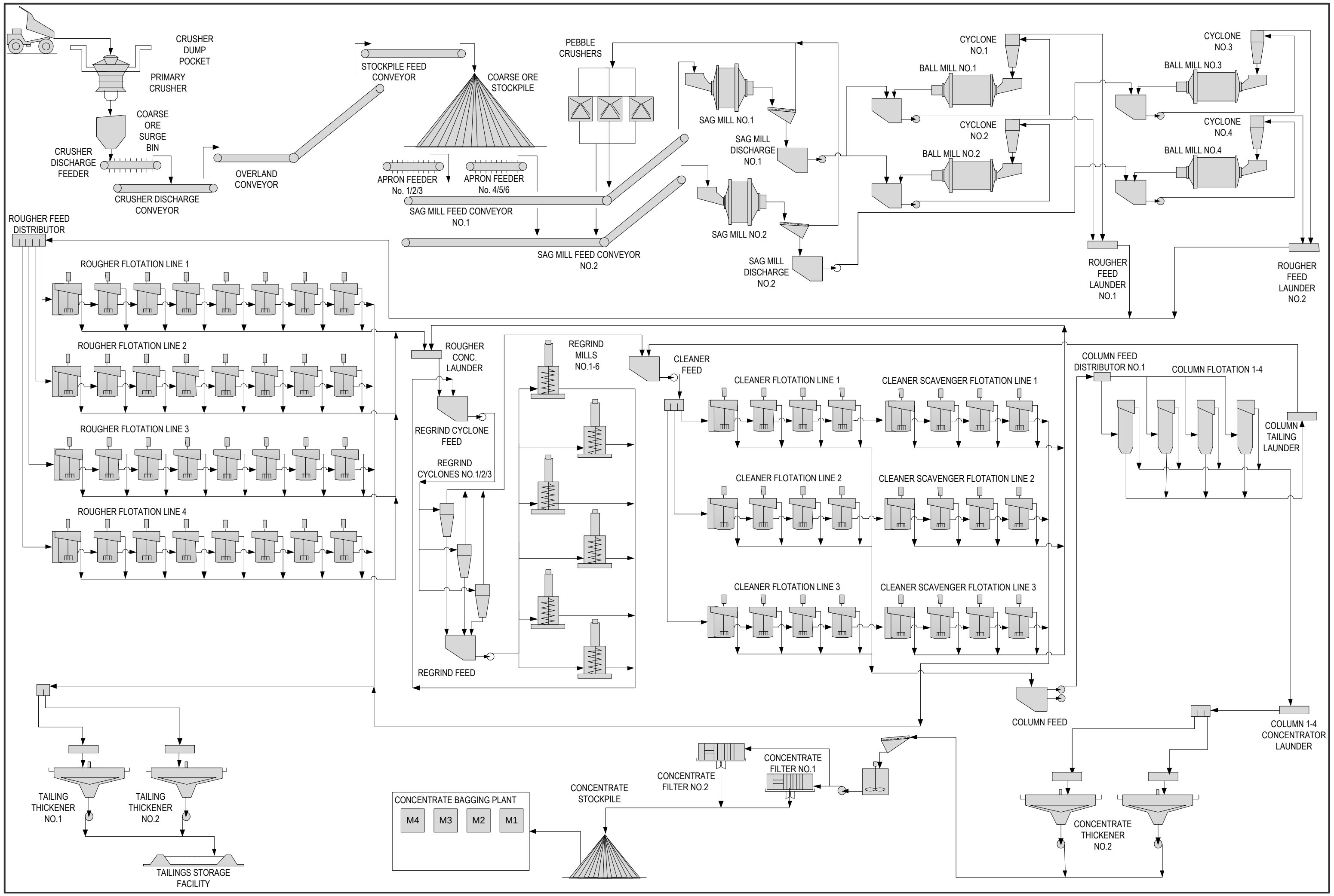


Figure 14-1: Schematic of the existing concentrator

Planned changes to increase throughput from the concentrator include an upgrade of major equipment installed in the Oyu Tolgoi concentrator as listed in Table 14-2 and illustrated in Figure 14-2.

Table 14-2: Summary of major additional equipment required for the concentrator conversion

Equipment Unit	Number of Units	Description	Installed Unit Power (kW)
Ball mill cyclone cluster	1	10 x 800 CVX cyclones	
Ball mill	1	7.3 m diameter x 11 m EGL	11,400
Rougher flotation bank	1	8 x 160 m^3 Wemco tank cell bank	187
Column cell	6	5.5 m diameter x 16.0 m high	
Concentrate thickener	1	23 m diameter high rate	7.5
Concentrate pressure filter	2	Tower press, 144 m^2 filter area	110

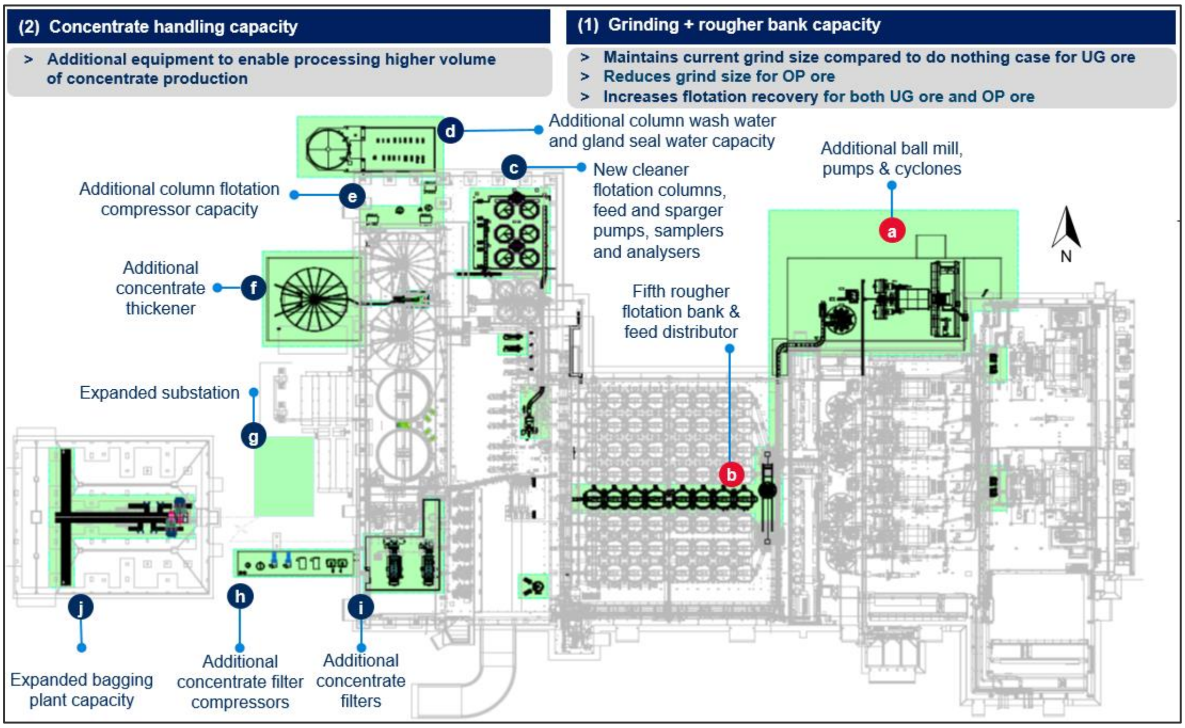


Figure 14-2: Location of new facilities relative to Phase 1 installation

14.2 Processing plant throughput and characteristics

The maximum throughput achieved through the Phase 1 concentrator was at the end of March 2016, when five successive days processed an average of 139,000 t/d (5,800 t/h). The comminution predictions have been validated by power modelling completed by the Concentrator Conversion Feasibility Study engineering team, from Wood PLC, and JKSimMet simulations completed on surveys completed in 2017 and 2018. The comminution predictions have also been validated by comparison of predicted and actual performance of the Phase 1 concentrator grinding circuit. The comminution dataset contains 645 SPI results and 626 MBI test results on the Oyut and Hugo North deposits. The results show a large overlap between Oyut and Hugo North deposits.

Table 14-3: Ore comminution indices

Zone	Percentile	SPI (min)	MBI (kWh/t)	Ci	Tonnes processed per operating hour (t/h in Phase 1)
Oyut Central	20th percentile	26.0	9.8	33.0	10,053
	50th percentile	49.2	13.0	24.7	6,895
	80th percentile	65.2	14.7	21.0	6,062
Oyut Southwest	20th percentile	90.0	18.3	22.0	5,145
	50th percentile	132.4	19.9	16.6	4,158
	80th percentile	188.1	21.4	12.8	3,492
Hugo North	20th percentile	61.9	16.4	24.3	5,898
	50th percentile	76.4	17.7	16.6	5,063
	80th percentile	104.4	20.1	9.7	4,319

In 2018 an additional 40 samples were taken from the Oyut deposit to increase density of comminution information in the short-medium term. The results of these tests were compared to those in the block model at the time and showed generally good agreement with one apparent outlier. A comparison between the measured and predicted SPI results comparison is shown in Table 14-4. There is good agreement between the measured and previously estimated SPI values, the measured results were more competent on average. The effect on the measured samples is a reduction in expected processing rate of 2.2%. The results were used to update the resource model underlying the Mineral Reserves and mine plan, with the exception of the apparent outlier.

Table 14-4: Prediction of comminution properties - measured for 40 comparison samples

Dataset	SPI (min)	MBI (kWh/t)	Processing rate (t/h)
Existing Prediction	128.3	18.8	5,008
Measured	143.5	20.1	4,897
Difference (%)	11.8	6.9	-2.2

The throughput and specific equipment in use at the plant and the current range of throughputs on both an annual and an hourly basis are shown in Table 14-5.

Table 14-5: Throughput and equipment characteristics of processing plants within the Property

Throughput Range	Equipment Characteristics	Specifications
3600 to 5300 tonnes of ore processed per operating hour (10th to 90th percentile, median 4700 t/h). Annual tonnes of ore processed 28 to 41 Mtpa.	1 of 60 in x 113 in Primary Crusher (1 MW) 2 of 38 ft x 23 ft SAG Mills (20 MW ea) 3 of 750 kW pebble crushers 4 of 24 ft x 36.5 ft Ball Mills (11.4 MW ea) 4 of 8 x 800 mm hydrocyclone packs 4 rows of 8 x 160 m^3 rougher flotation cells 3 rows of 4 x 160 m^3 cleaner flotation cells	Design and equipment specifications used by Rio Tinto include: Australian Standards ISO Rio Tinto Major Project Standards Rio Tinto internal HSES and Major Hazards standards

Throughput Range	Equipment Characteristics	Specifications
900 to 2600 tonnes of concentrate produced per operating hour (10th to 90th percentile, median 1500 t/h). Annual tonnes of concentrate produced 400 to 800 ktpa.	3 rows of 4 x 160 m^3 cleaner scavenger flotation cells 6 of 1500 HP vertimills 3 of 18 x 500 mm hydrocyclone packs 4 of 5.5 m x 16 m flotation columns 2 of 23 m concentrate thickeners 2 of 144 m^2 pressure filters 1 of bagging plant including 4 x bagging modules 2 of 80 m tailings thickeners	Rio Tinto Engineering Standards

The processing methods, plant designs and other parameters used by Rio Tinto for current and future plant feed types are in use commercially both within the Property and more generally within the copper processing industry. Measurement and reconciliation of predicted processing properties including mass recovery (yield) is routinely completed and used to inform existing predictions and those for future plants.

14.3 Energy, water process materials and personnel requirements

The power, water and process materials requirements are shown in Table 14-6. Energy consumption rates are supplied as a range depending on ore type.

Concentrator unit power consumption was 28.5 kWh/t in 2015. It is projected to remain at similar levels when Hugo North ore forms the majority of feed from 2024 to 2037. The acceleration of the Central mining phases has reduced the unit power consumption to 25.6 kWh/t in 2018, but this is expected to increase as equipment utilisation increases for Hugo North processing.

The raw water requirement is defined as the amount of water that is consumed per tonne of ore processed. The water consumption rate in the July 2016 to June 2017 hydrologic cycle was 0.35 m^3/t of ore, which is below design levels. The raw water consumption has dropped due largely to site efforts to reduce water consumption and increasing throughput on the softer Central ores. The mass and water balances developed for the OTFS20 show specific raw water consumption throughout the Hugo North Lift #1 mine life similar to current operation.

There is still some potential for reduction through TSF management strategy. Ninety percent of the raw water used at Oyu Tolgoi is lost to the TSF. Most of this is interstitial water in the settled solids; the remainder is primarily through evaporation. Increasing tonnage therefore has a direct and linear impact on water requirements.

Approximately 350 employees are directly assigned to the processing plants within the Property.

Table 14-6: Typical energy, water and process materials for Oyu Tolgoi processing operations

Plant Type	Process Energy Requirement per Tonne of Ore Processed (kWh/t)	Process Water Requirement per Tonne of Ore Processed (m^3/t)	Process Materials
Dry crushing and screening	~0.1	~0.0	Minimal
Milling and Flotation	28.4	0.35	Major process consumables, with ranges depending on ore type, are: • SAG grinding medium 0.30 to 0.50 kg/t ore processed • Ball mill grinding medium 0.30 to 0.55 kg/t ore processed • Regrind mill grinding medium 0.06 to 0.13 kg/t ore processed • Lime 0.50 to 1.80 kg/t ore processed • Collector 18 to 32 g/t ore processed • Frother 15 g/t ore processed • Flocculant 20 g/t ore processed
Total	28.5	0.35	

14.4 QP's opinion on risk factors that may materially affect the Processing estimates

The main factors likely to affect the processing estimates relate to:

- The successful construction of and performance of the Concentrator Conversion scope:
- The Concentrator Conversion scope has been engineering according to applicable standards by an experienced engineering service provider to comply with Rio Tinto design standards.
- Fluorine and arsenic limits for copper concentrates being imported to China.

It is the QP's opinion that the factors that materially affect the processing estimates have been adequately reflected in the processing estimates.

15. Infrastructure

15.1 Tailings

Currently, Oyu Tolgoi operates its first cell (TC1), a 2 km by 2 km TSF, planned to accommodate approximately 360 Mt of tailings. The TC1 facility has been designed to store tailings produced from a concentrator designed to process 100,000 t/d and has been operating since 2013. TC1 has almost reach 50 m height and plans to achieve its final height (70 m) in 2023.

The existing facility uses thickened tailings deposition and the thickeners produce tailings with an average solid content (by weight) of 60%. TC1 is separated into four sub-cells (A through D). Tailings are spigotted from the west embankment into the sub-cells to promote water runoff toward the reclaim pond at the downstream corner for water recovery. Water is reclaimed from the pond by a floating barge and pumped back for re-use in the process plant.

The estimate of tailings production over the life of mine is 1.24 Bt. The capacity of the TSF will therefore have to be increased for continuing mine operations after the first two tailings deposition cells have been complete. Currently, an update in TC2 design is being undertaken to include lessons learned from TC1. Future facility expansion beyond TC2 has not been completed to a feasibility level design and will be deferred until further operational experience is obtained from TC1 and TC2 and can be incorporated into the expansion designs. Additional details for Rio Tinto's tailings storage facilities, Rio Tinto's approach to management of tailings and the Rio Tinto standard for management of tailings and water storage facilities are publicly available on the Rio Tinto website (www.riotinto.com/sustainability/environment/tailings).

15.2 Roads

Oyu Tolgoi maintains a set of gravel roads internal to the Property as well as a 35.1 km long gravel road to the Khanbogd Soum (Figure 15-1) and a 105 km long sealed road from Oyu Tolgoi to China (Figure 15-2).

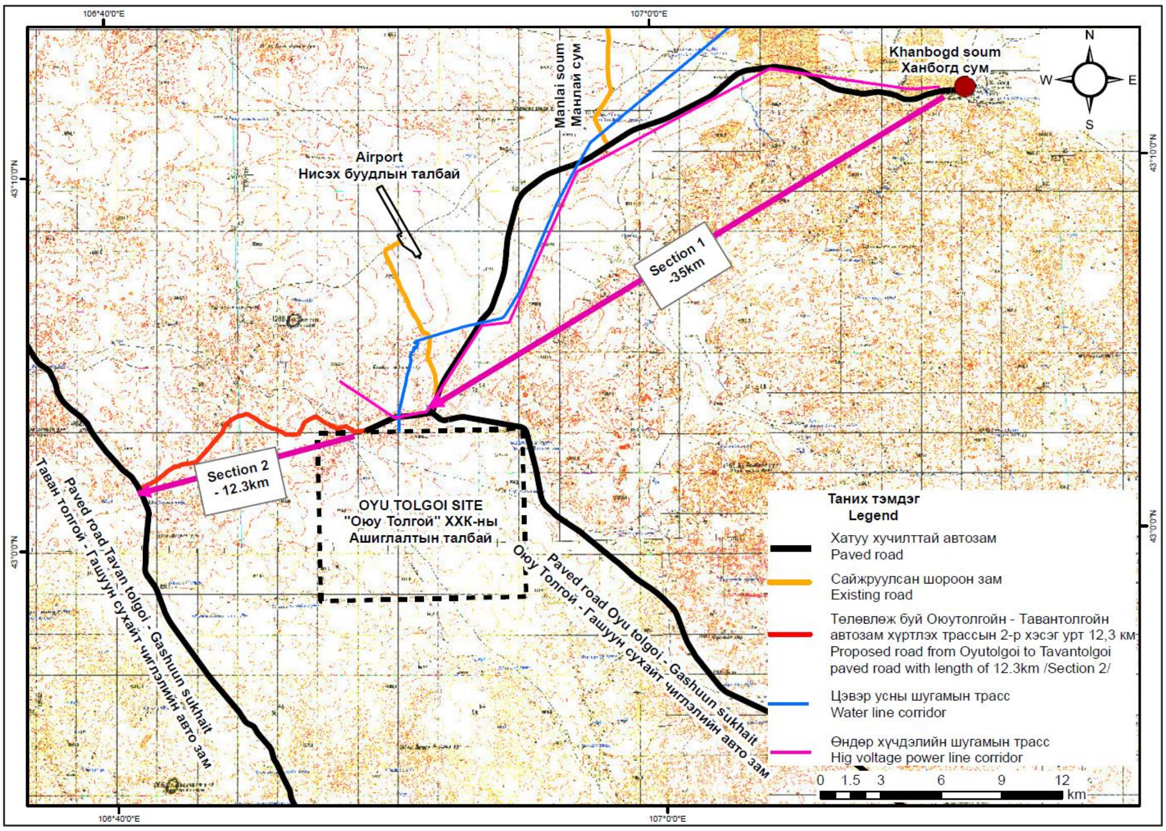


Figure 15-1: Oyu Tolgoi to Khanbogd Road

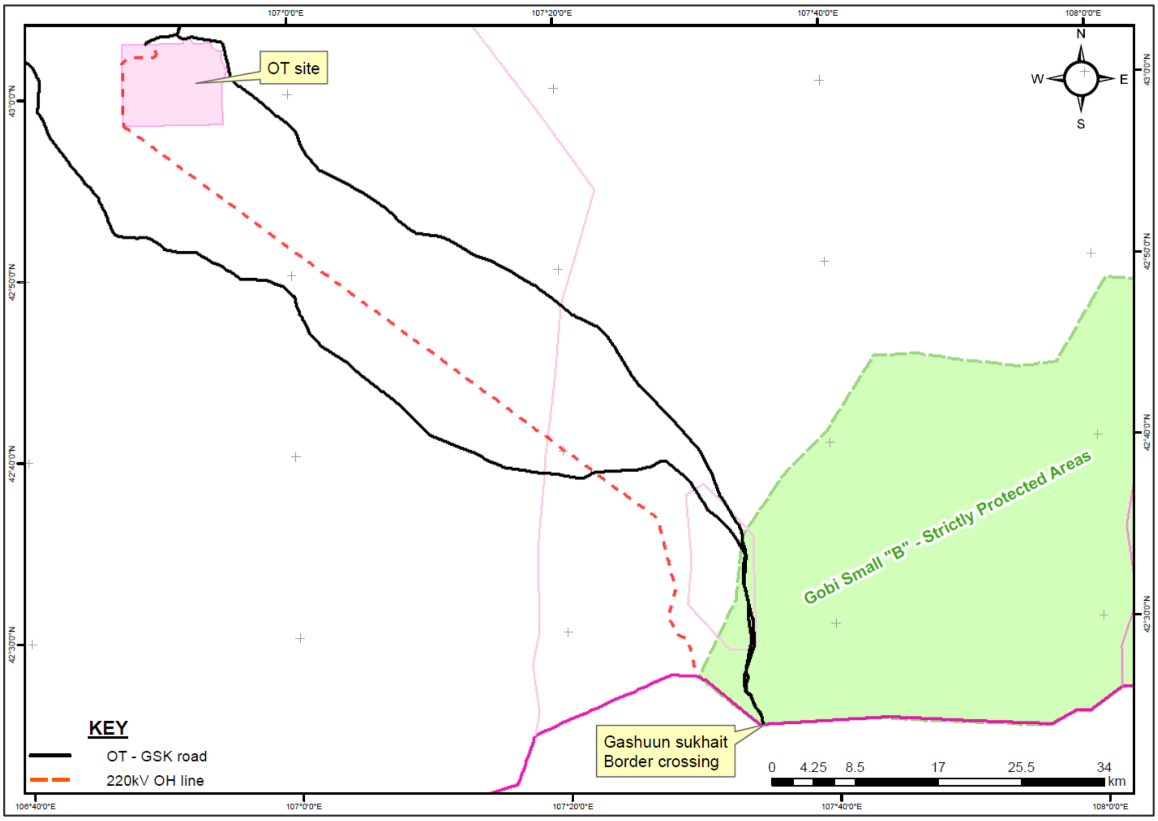


Figure 15-2: Road from Oyu Tolgoi site to Mongolia-China Border

15.3 Khanbumbat airport

A permanent domestic airport has been constructed at Oyu Tolgoi (Figure 15-1), 11 km north of the camp area, to support the transportation of people and goods to the site from Ulaanbaatar. It further serves as the regional airport for Khanbogd soum. The surface is concrete, with a concrete apron at the terminal building. The runway has been aligned to the prevailing northwest-southeast wind direction to minimize crosswind conditions and facilitate optimal landing and take-off conditions. The design criteria are set to service commercial aircraft up to the Boeing 737 800 series aircraft.

15.4 Potable water and wastewater

A major groundwater resource at Gunii Hooloi provides the raw water supply for the exploitation of the Oyo Tolgoi deposits.

A groundwater reserve estimation was undertaken by Tuvdendorj and Sosorbaram in 2015 (Report on the Exploration and Water Aquifer on Gunii Hooloi and adjacent areas - Water Reserve Estimate as at 1 January 2014). This report was discussed with the Water Resource Council of the Ministry of Environment and Tourism but the author's estimation of 1,113 L/s was not approved by the council. At a meeting of the Water Resource Council (6 July 2015) it was resolved that the Gunii Hooloi groundwater potential available water reserve is 185 L/s ("A" category), 613 L/s ("B" category), 117 L/s ("C" category) and with a total of 918 L/sec or 79,315 m^3/day This was approved by order number 2015/03 dated 2 November 2015.

The spatial distribution of the Gunii Hooloi aquifer, and borehole location plan is shown in Figure 15-3.

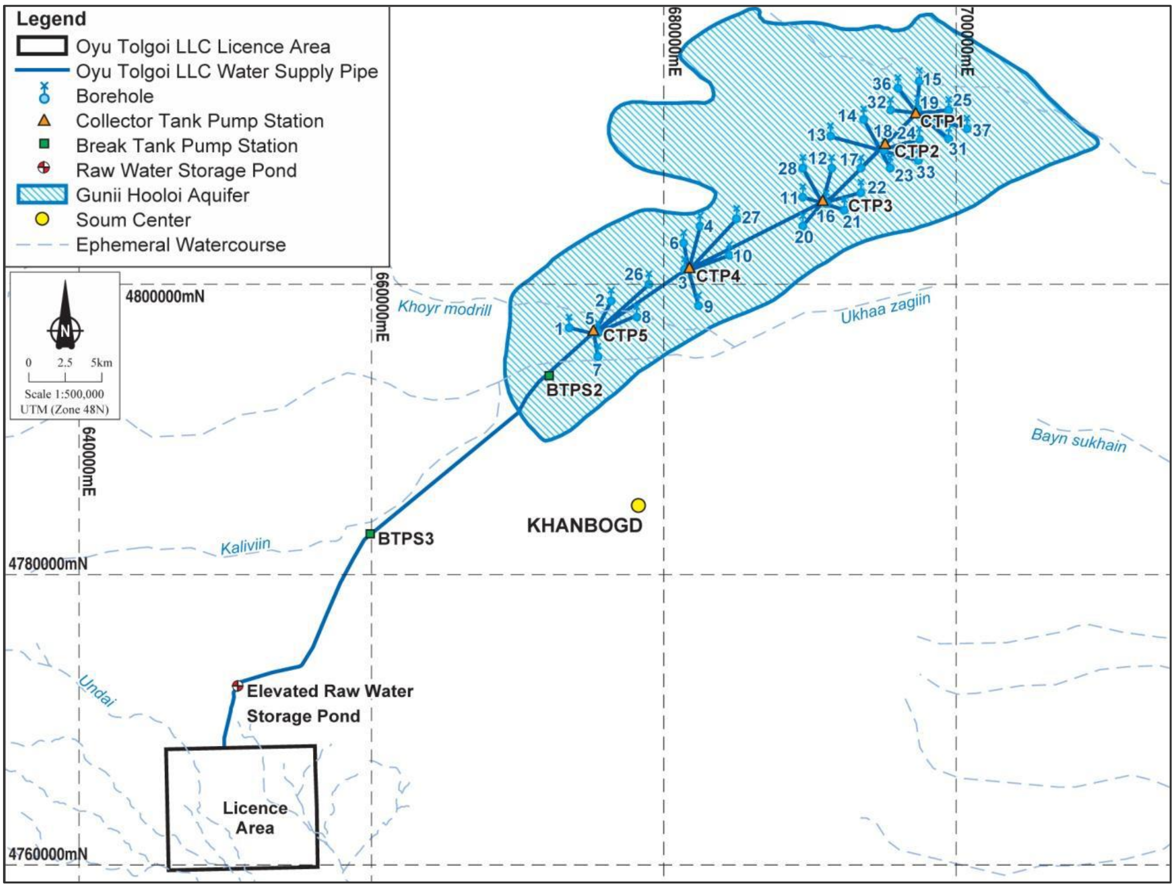


Figure 15-3: Production water bore locations in Gunii Hooloi groundwater aquifer

The Gunii Hooloi water pump station has a capacity of 77,760 m^3/ day. There are 28 wells, 5 pumping stations /collector tanks, 1 interrupted pump station, 2 water storage ponds each one 200,000 m^3, and a 85 km Ductile Iron Concrete Lined (DICL) main pipeline and a 65 km High Density Polyethylene (HDPE) water pipeline.

A total of four wastewater treatment plants are fully operation at the mine site, and one at the Khanbumbat airport with a total capacity of 2,780 m^3 (22,240 personnel/day) and are in operation for 24 hours per day. The Oyu Tolgoi drinking water supply is derived from the raw water supplied from Gunii Hooloi that is first filtered by reverse osmosis and then disinfected with ultraviolet light and ozone processes. It is then bottled in 18.9 L plastic containers to provide mine camps with drinking water.

15.5 Accommodation and offices

Oyu Tolgoi owns, operates and maintains accommodation facilities at site. There are ~9,500 beds along with supporting facilities such as a central dining hall, taverns, and recreational facilities.

Oyu Tolgoi has two on site camps, Oyut and Manlai, as listed in Table 15-1. Both camps were expanded during 2018 and 2019 with additional accommodation facilities to meet the ramp up of project personnel associated with the underground mine development.

Table 15-1: Accommodation Inventory

Name	Location	Beds	Expansion	Total
Oyut Camp	On-site	1,533	5,500	7,033
Manlai Camp	On-site	2,363	200	3,711
Total Beds		**3,896**	**5,700**	**9,596**

The Central Administration building was completed in 2012. It serves as the central, primary office space for operations staff on site, including executive and support personnel.

The Mine Dry Facility and Chandmani Office (completed in 2019) is a permanent two storey building adjacent to the Shaft Number 2 Headframe. The main function of the Mine Dry Facility is for provision of shower and change room facilities for the underground mine workers at Shaft Number 2.

15.6 Open pit truck shop complex

The open pit truck shop complex is approximately 1 km northwest of the primary crusher, within the maintenance complex, adjacent to the bonded customs storage area to the northeast and the main fuel storage facility to the southeast. It covers a land area of 500 m x 350 m, or 17.5 ha and incorporates outdoor facilities and four self-contained structural steel, pre-engineered buildings designed to accommodate the required facilities for repair, maintenance, and rebuild of the open pit mining equipment.

15.7 Information and communications technology (ICT) systems

Communications is a vital part of Oyu Tolgoi's infrastructure and operational capabilities. A state-of-the-art information, security, data, and voice communications system is installed to ensure that operational needs are met. A fibre optic communications backbone extends through the entire mine site and out to the borefield to support the following principal components:

- Distributed Control System (DCS).
- Supervisory Control and Data Acquisition Systems (SCADA).
- Mine Operating Systems (MOS).
- Programmable Logic Controller (PLC)-based control systems.
- Electrical monitoring system (EMS).
- Local Area Network (LAN) and Wireless (WLAN).
- Voice over Internet Protocol (VoIP) system.
- Security system, including closed-circuit television (CCTV) and access control system (ACS).
- Fire alarm system (FAS).
- Digital trunk radio system (DTR).
- Cable television (CATV) for operations personnel entertainment.

Each of the above components will be expanded to support modifications to the surface concentrator, underground development, power distribution system, and operations camp. Components and suppliers will be similar to those used for the existing facilities. This will provide continuity in support services and parts inventories of the systems and make use of the training and experience gained by site personnel. The network backbone infrastructure will continue to provide connectivity at the expanded and new facilities.

15.8 Other support facilities and utilities

There are numerous other infrastructure facilities servicing the site including a central heating plant, underground utility services, underground workshops, fuel storage, an operations warehouse, medical centre and a fire station.

16. Market studies

16.1 Nature and material terms of agency relationships

Rio Tinto has various intragroup arrangements relating to the sales and marketing of its products. There are no material third party agency relationships.

16.2 Results of relevant market studies

Key considerations in the development of the marketing strategy include:

- Location of customer compared to imported material landed at Chinese ports (Oyu Tolgoi to pay freight differential from mine to customer versus port to customer).
- Precious metals recovery and payment.
- Length of contract.
- Percentage of off-take to smelters versus traders.
- Percentage of tonnage on contract versus spot.
- Percentage of feed for any one smelter.
- Number of customers for a given scale of operation.
- Management of concentrate quality and volume during commissioning and ramp-up.
- Alternate off-shore logistics and costs.
- Delivery point and terms.

The commercial terms Oyu Tolgoi receives continue to be in line with conditions on the international concentrates market.

The copper concentrate sales and marketing division of Rio Tinto has identified and established long-term contracts with customers and also is in the process of negotiating agreements for concentrate off-take for 2023 and onwards.

With increased volume in outer years, further efforts will continue to refine the processes needed to ship copper concentrate from the mine to Oyu Tolgoi's customers in large volumes.

16.3 Commodity price projections

The Rio Tinto sales and marketing team monitors key trends and developments and adapt their commodity price views as conditions change.

Over 2023-2025, the refined copper market is expected to move to a surplus as projects, mostly producing copper concentrate, continue their ramp up (e.g., Quellaveco in Chile and Kamoa-Kakula in DR Congo) and others start up (e.g., Quebrada Blanca Phase 2 and Mantoverde in Chile, Udokan in Russia, and Tenke Fungurume in DR Congo).

Beyond 2025, a copper deficit opens in the absence of uncommitted projects being developed as demand continues to grow and base case production decreases with copper mines grades decreasing and mines reaching end of life and shutting down. In 2026, the deficit is estimated at 1.1 Mt of copper, and by 2032, it might exceed 7.0 Mt of copper (Figure 16-1). Copper plays a key role in the development of much needed infrastructure for de-carbonization of the world (such as wind and solar renewable energy, and electric vehicles). As the quality of copper deposits across the world is decreasing and the time and costs to develop new projects are increasing, the required primary supply to meet demand is challenged, providing supportive fundamentals for prices. Primary demand is expected to grow at a CAGR of 1.4 % in 2026-2032, requiring 2.6 Mt of additional copper.

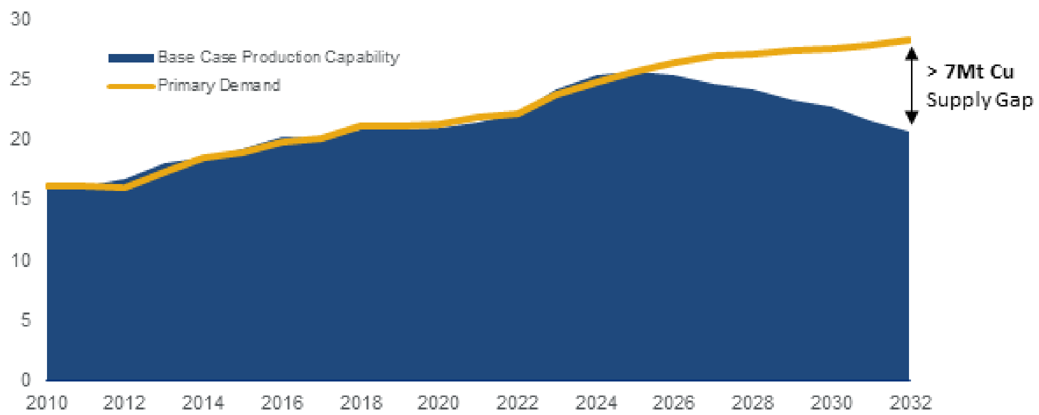


Figure 16-1: Supply-demand for mined copper in Mt/a (S*ource: Wood Mackenzie*)

The smelter terms used are based on the Rio Tinto copper concentrate sales and marketing group's assessment of the copper market and standard smelter terms in general use through the industry. Payable metals in the copper concentrate are copper, gold, and silver. Payment rates are variable depending on the grades of each element in the copper concentrate. The production profile for the reserves case is shown in Figure 16-2. Copper concentrate production in Figure 16-3 and the feed grade of payable metals in Figure 16-4.

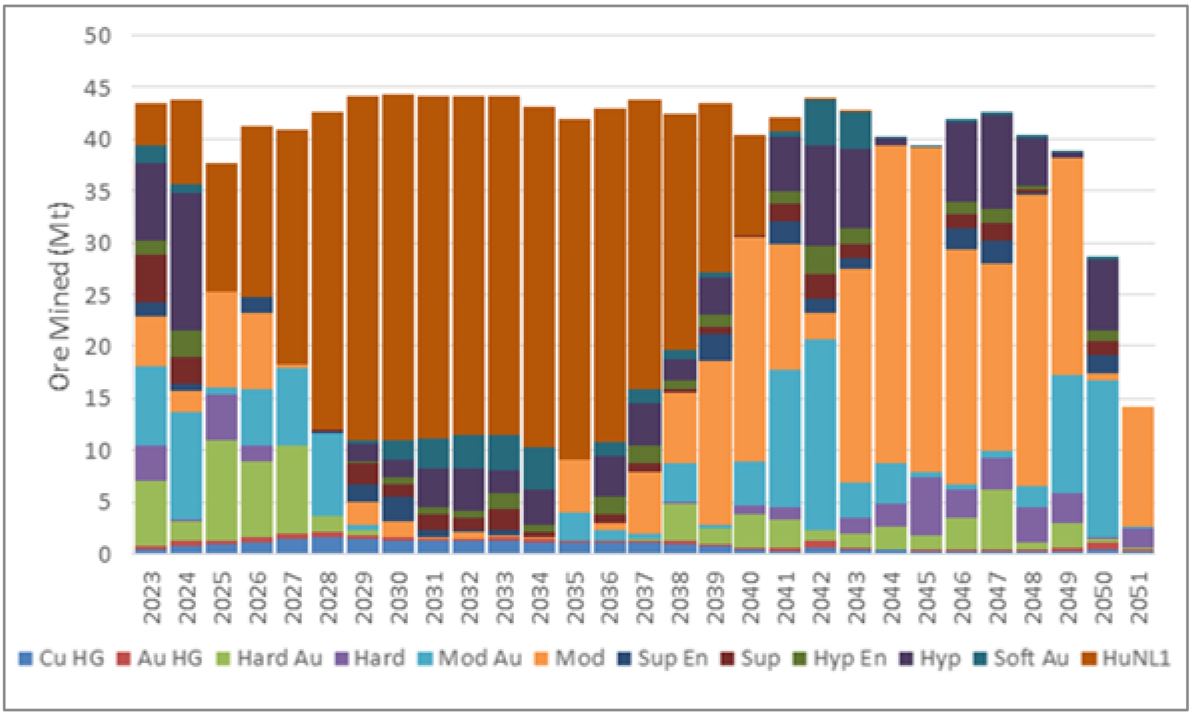


Figure 16-2: Long-term Oyu Tolgoi mine production profile

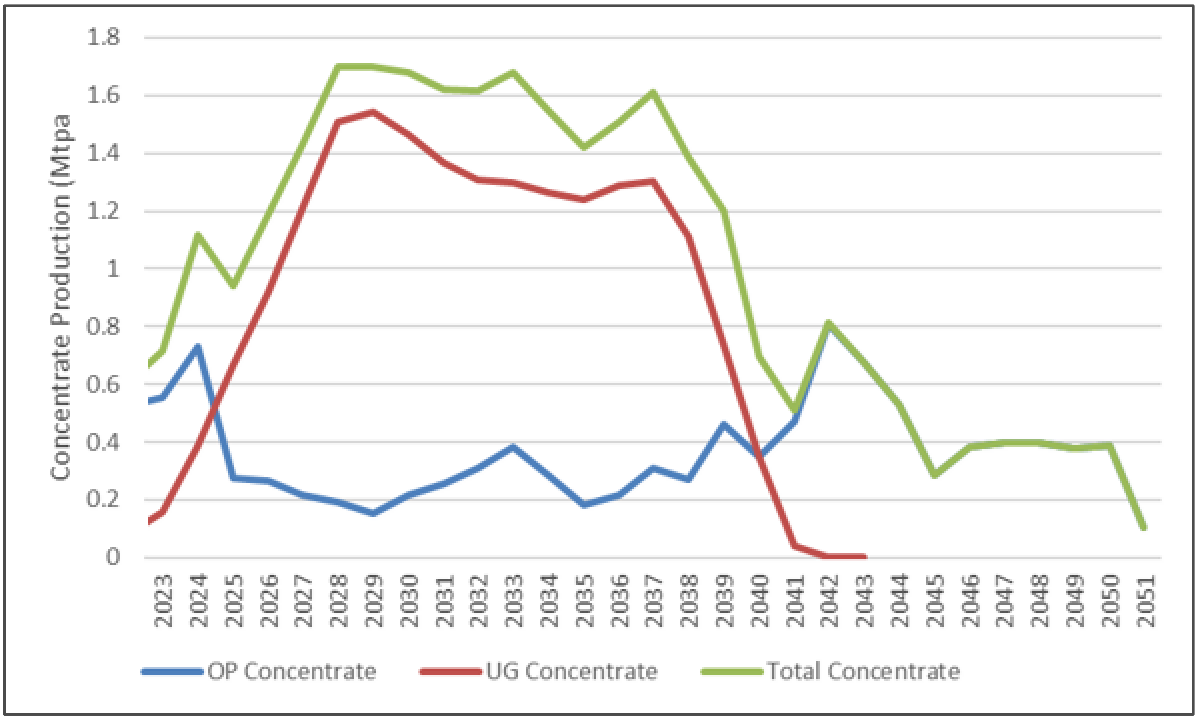


Figure 16-3: Concentrate production profile

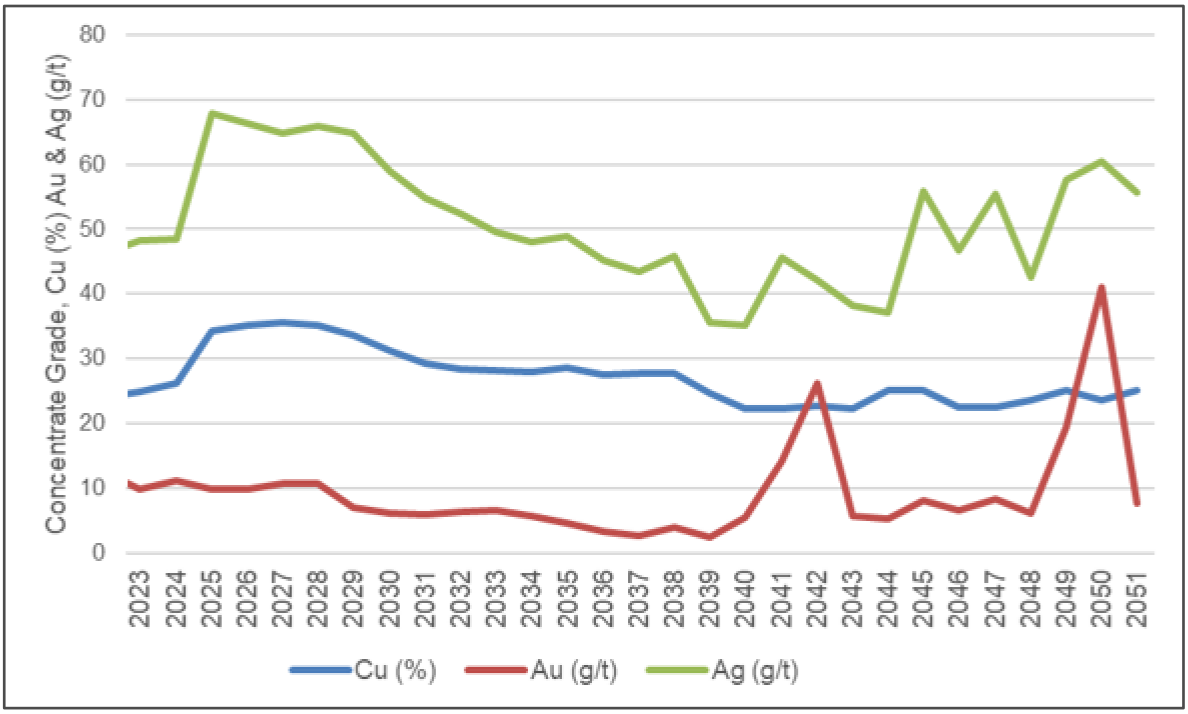


Figure 16-4: Assays of major payable metals in concentrate

16.4 Mining and processing

Rio Tinto utilises mining and processing contracts for some aspects of its operations. These contracts are considered not material to the Property due to the scale and duration.

16.5 Product transport and handling

The Oyu Tolgoi mine is located in southern Mongolia with no railway service. The mine operates continuously, year-round, to produce copper concentrate, which is transported by truck from the mine to the Chinese border at Ganqimaodao.

China is the only market that can be supplied via this border because the bi-lateral border at Gashuun Sukhait – Ganqimaodao has not obtained International Trade status.

Sales and Marketing are responsible for the logistics strategy in China. Transportation from the mine to the bonded warehouse, within China, is the responsibility of Oyu Tolgoi operations.

Sales to customers are currently completed on a Delivery at Place Huafang bonded warehouse basis. Customers are responsible for transportation within China, with compensation for transport costs provided through the freight differential price adjustment.

16.6 Forward sales contracts

Oyu Tolgoi currently has a mix of long-term contracts and spot agreements. The arrangements differ between entities with respect to commercial terms and length of contract.

Smelter customers are based in various provinces throughout China, as shown in Figure 16-5, while trader customers allow Oyu Tolgoi concentrate broad and far-reaching uptake across China's many smelters.

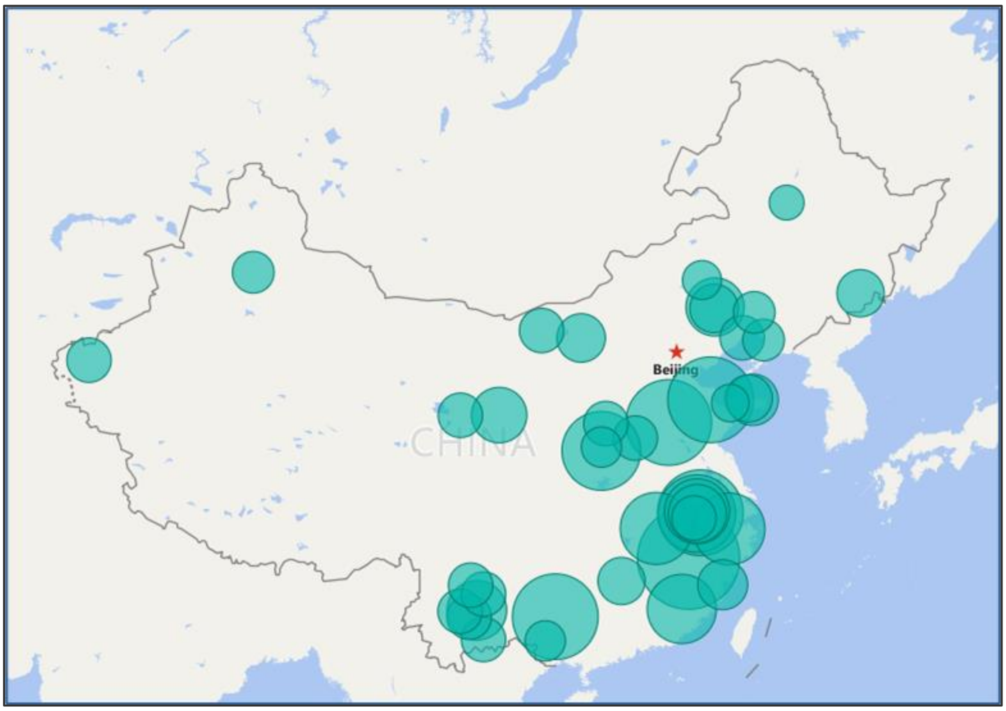


Figure 16-5: Locations of Chinese copper smelters

17. Environmental studies, permitting, and plans, negotiations, or agreements with local individuals or groups

17.1 Environmental and social impact assessment

Oyu Tolgoi LLC's environmental work for the Project is compliant with Mongolian regulatory requirements, internal policies and procedures, and external agreements. The environmental management plans for the Project are designed to ensure that key environmental factors are monitored and protected.

To meet its environmental and social obligations and commitments, Oyu Tolgoi LLC has completed a comprehensive Environmental and Social Impact Assessment (ESIA) for the Project (Oyu Tolgoi LLC, 2012). Oyu Tolgoi LLC has also implemented and audited health environmental management systems (EMS) that conform with the requirements of ISO 14001:2004.

The ESIA was publicly disclosed in August 2012 and identifies and assesses the potential environmental and social impacts of the Project, including cumulative impacts, focusing on key areas such as biodiversity, water resources, cultural heritage, and resettlement. The ESIA also sets out measures to avoid, minimize, mitigate, and manage potential adverse impacts to acceptable levels established by Mongolian regulatory requirements and good international industry practice, as defined by the requirements of the Equator Principles, and the standards and policies of the International Finance Corporation, European Bank for Reconstruction and Development, and other financing institutions.

The ESIA is built upon an extensive body of studies, reports, and detailed environmental impact assessments (DEIAs). The DEIAs provide baseline assessment for both social and environmental issues by drawing upon a range of internal and independent studies that have been prepared for the Project since 2003. The DEIAs are structured using a core categorization of Mining and Processing, Transport and Infrastructure Corridor, Gunii Hooloi Water Supply, Coal Fired Power Plant, and Airport. DEIAs were also required to address new or updated facilities and requirements not covered under the broader categories.

All DEIAs are prepared and approved in accordance with Mongolian standards. The ESIA and DEIAs prepared for Project design and development purposes and for Mongolian approvals have been prepared under the following laws:

- The Environmental Protection Law (1995).
- The Law on Environmental Impact Assessment (1998, amended 2001).
- The Minerals Law (2006).

The Project Area of Influence covered by the ESIA and related DEIAs is defined in Table 17-1. Summaries of the key baseline studies and core DEIAs prepared for the Project are presented in Table 17-2. Summaries of supplementary DEIAs and studies are presented in Table 17-3.

Table 17-1: Project Area of Influence and scope of the ESIA

Term	Scope
Project Area of Influence	Project elements defined as activities and facilities that are financed or over which the Project can exert control and influence through its design, impact management, and mitigation measures, including all Oyu Tolgoi facilities within the Oyu Tolgoi Property and surrounding 10 km buffer zone. Local roads used regularly by the Project. Communities that provide employees or services to Oyu Tolgoi. Local and regional transport network. Local services and utilities. Communities and community members that will be directly affected by the Project in ways that are foreseeable and within the reasonable control of the Project during construction, operations, and closure. Communities and community members that may be directly affected by population influx. Communities and herder households that may be affected by potential changes to local and regional groundwater supplies downstream of the Oyu Tolgoi site and along transportation corridors. Project elements that may be transferred to third-party ownership in the future, such as the airport and Gashuun Sukhait border crossing facility.
Potential future project elements	Although not directly addressed in the ESIA, certain potential future project elements were considered in the cumulative impact assessment, including potential expansion of the Project to support increased ore throughput, and potential long-term project power supply
Potential extensions to scope	The ESIA estimated a project with a 27 year design life. However, it is anticipated that operations at Oyu Tolgoi will continue for a longer period than the 27 year design life and that extensions to the ESIA will be required.

Table 17-2: Baseline and core DEIA studies for the Project

EIA study title	Description	Date	Status
Environmental Baseline Study for Oyu Tolgoi Project	Covers geography, geological, hydrology, hydrogeology, soil, climate, air quality, flora and fauna, the socioeconomic status, and infrastructure of the Project site and surrounding areas.	2002	No approval required
Environmental Baseline Study for Town Planning	Covers geography, geological, hydrology, hydrogeology, soil, climate, air quality, flora and fauna, the socioeconomic status and infrastructure of potential development and interconnecting infrastructure areas for Khanbogd town developments.	2012	No approval required
Oyu Tolgoi Project EIA Volume I: Transport and Infrastructure Corridor from Oyu Tolgoi to Gashuun Sukhait	DEIA of the road and power line proposal from Gashuun Sukhait to Oyu Tolgoi. Provides approval for access through the South Gobi Strictly Protected Area. Several amendments have been undertaken to address changing alignments.	2004 2006 2010 2012	Approved Approved Approved Approved
Oyu Tolgoi Project EIA Volume II: Water Supply from the Gunii Hooloi Aquifer	DEIAs for the proposed aquifer and water supply system for the provision of a sustainable water supply to the Project. Several amendments have been completed to capture developments in the groundwater resource assessment and water supply pipeline design.	2004 2009 2010 2012	Approved Approved Approved Approved

EIA study title	Description	Date	Status
Oyu Tolgoi Project Volume III: Oyu Tolgoi Mining and Processing Facilities	DEIA of the open pits, underground mine, concentrator, tailings and all facilities and support infrastructure located within the Oyu Tolgoi Property. The assessment was largely based on IDP05. It does however reflect the general permitting layout of May 2006. The maximum production rate was assumed as 85,000 t/d.	2006 2012	Approved Approved
Oyu Tolgoi Project Volume IV: Coal Fired Power Plant	EIA documentation drafted for a coal-fired power plant at the Oyu Tolgoi mine site. An amendment has been undertaken to reflect updates in design for three 150 MW generating units.	2006 2011	Not submitted Approved

Table 17-3: Updated list of DEIA reports for the Project

Project EIA component	Description	Date	Status
Fuel station facility	DEIA for the fuel facility built in 2004 within the Oyu Tolgoi Property. Amendment completed for extension of the fuel depot.	2005 2010	Approved Approved
Shaft 1	DEIA for Shaft #1, including headframe facilities, waste rock, and water disposal.	2005	Approved
Shaft 2	DEIA for Shaft #2, including headframe facilities, waste rock, and water disposal.	2006	Approved
Diesel power station	DEIA for the diesel power station located within the Mine Licence Area.	2007	Approved
Wastewater treatment plant	Supplementary DEIA for the construction camp wastewater treatment plant expansion to 4,000-person equivalent capacity.	2007	Approved
Quarry batch plant and Quarry	DEIA of hard rock quarry, concrete batching plant, and crusher located at the northern boundary of the Oyu Tolgoi Property.	2007	Approved
Airport	Construction projects for temporary and permanent airports have implemented.	2007 2011 2017 2018	Approved Approved Approved Approved
Chemicals	Covers the importation, storage, use, and disposal of chemicals. Amendments have been undertaken to update chemicals being used in construction, commissioning, and operation.	2008 2011 2012	Approved Approved Approved
Javkhlant Entrée Resources Ltd. lease area	DEIA for future project facilities, infrastructure, and Heruga underground mine located within the southern Javkhlant-Entrée lease area.	2009	Approved
Shivee Tolgoi Entrée Resources Ltd. lease area	DEIA for facilities, infrastructure, and portion of the Hugo Dummett underground mine located within the northern Shivee Tolgoi-Entrée lease area.	2009	Approved
Main fuel storage facility	DEIA for the main fuel storage facility within the Oyu Tolgoi Property.	2011	Approved
Undai River diversion DEIA	DEIA for diversion of the Undai River.	2011	Approved

Project EIA component	Description	Date	Status
Update of DEIA report of the construction and facilities in Shivee Tolgoi licence area.	Project facilities, infrastructure, and construction on the lease area at Shivee Tolgoi.	2012	Approved
DEIA of Oyu Tolgoi LLC's construction of main facilities and infrastructure	This report includes new infrastructure and facilities in mine site.	2012	Approved
Oyu Tolgoi to Khanbogd power line	DEIA report of a 35-kW power line connecting Oyu Tolgoi to Khanbogd.	2012	Approved
Waste management centre	Waste management centre was built with new technological solutions such as waste classified landfill, evaporation, and incineration.	2014	Approved
DEIA report of Oyu Tolgoi TSF project	The report includes environmental issues related to the Oyu Tolgoi concentrate thickener underflow.	2014	Approved
DEIA report of Tsagaan Khad to Oyu Tolgoi Road project	Environmental issues associated with an 18.6 km road construction activity connecting Tsagaan Khad to Gashuun Sukhait.	2015	Approved
DEIA of 93.8 km paved road construction project connecting Khanbogd – Oyu Tolgoi – Javkhlant bag	The 35.1 km paved road between Khanbogd to Oyu Tolgoi was built and commissioned in 2018.	2016	Approved
DEIA of the use of Undai River sand deposit project	The diverted part of Undai river diversion was planned to be covered by mining waste rock stockpile and the sand from this part is planned to be used for mining construction activity before the stockpile is completed.	2018	Approved
DEIA on OT Hazardous Landfill	The facility was established to dispose of hazardous waste from the mine in an environmentally safe manner in accordance with the Waste Law revised in 2017 and following regulations.	2020	Approved
DEIA on OT Chemical Warehouse	Oyu Tolgoi chemical warehouse was established to store chemicals used in the concentrator and mining operations environmentally friendly manner and in accordance with relevant Mongolian Chemical Warehouse Standard.	2020	Approved
ESIA of 18.6 km paved road construction project of the end of Oyu Tolgoi mine road "From Tsagaan Khad Intersection to Gashuunsukhait"	The 86-kilometer paved road from the mine site to Tsagaan Khad was previously completed and used, while the remaining 18.6-kilometer paved road from Tsagaan Khad to Gashuunsuhait port was completed and fully operated in 2022.	2021	Approved

Project EIA component	Description	Date	Status
Amendment report on the detailed environmental impact assessment of the copper-gold mining and processing project from the Oyu Tolgoi deposit	In 2020, the feasibility study of Oyu Tolgoi Mine was delayed without approval, but it was made on the basis of the legal requirement that additional amendments should be made in the DEIA. If the feasibility study of Oyu Tolgoi Mine is approved in 2023, further amendments on DEIA will be made.	2022	Approved
DEIA on the project using sand and red clay in the construction site of the tailings deposit, as well as the derived deposits from open pit mining	A detailed assessment report on the impact of this project on the environmental impact of the mining of copper ore from the open pit mine of the Oyu Tolgoi project and the widely distributed mineral derived deposits created during the preparation of the site for the tailings fund will be used as reserves for construction work	2022	Approved
DEIA on the environment of the "Khanbumbat" airport project to be implemented in the area of Khanbogd Sum, Umnugobi Province	According to the Aviation Safety Regulations, the Airport is an object that has a certain impact on the environment, especially on migratory birds, and a detailed Environmental Impact Assessment is required to be updated every 5 years.	2022	Approved

17.2 Management plans

Oyu Tolgoi LLC's various management plans set out how the Project will meet Oyu Tolgoi LLC standards and procedures to avoid, manage, mitigate, and offset operations-phase impacts and ensure Oyu Tolgoi LLC personnel and contractor compliance with the Project standards and Rio Tinto Occupational Health and Safety (OHS) standards.

Below is a list of the area covered by the operational health, safety, environment, and community (HSEC) related management plans implemented at the Project:

- Environmental and Social Action Plan.
- Environmental and Social Management Plan.
- Atmospheric Emissions Management Plan.
- Biodiversity Management Plan.
- Community Health, Safety and Security Management Plan.
- Cultural Heritage Management Plan.
- Emergency Preparedness and Response Plan.
- Hazardous Materials and Non-Mineral Waste Management Plan.
- Land Disturbance Controlling and Rehabilitation Management Plan.
- Mine Closure Plan.
- Mineral Waste Management Plan.
- Noise and Vibration Management Plan.

- Resettlement Action Plan.
- Stakeholder Engagement Plan.
- In-Migration Management Plan.
- Pastureland and Livelihood Improvement Management Plan.
- Water Resources Management Plan.

17.3 Environmental impacts and mitigation measures

17.3.1 Air quality

The Mongolian National Air Quality Standard (MNS 4585:2016) is intended for urban areas and is not considered applicable to a remote mining facility. As such, DEIAs prepared for the Project were not required to comply with this standard. In the absence of applicable national ambient air quality standards, ambient air quality standards have been adopted.

The Project Area of Influence is remote, and population density within 10 km of the Oyu Tolgoi Property is extremely low. There are currently no permanent residences within 10 km of the mine site. The following sites near the Project are considered sensitive receptors to emissions:

- Worker accommodation areas within the Property.
- Nomadic summer camps outside the Property.
- Winter herder shelters outside the Property.

Mitigation measures and residual impacts

The potential impacts for air quality have been identified and assessed. No significant residual adverse impacts are anticipated after the proposed design enhancements and mitigation measures are implemented and impacts are monitored under the Air Quality Management Plan.

Greenhouse gas emissions

Several types of greenhouse gases (GHG) will be emitted from project-related activities. A high proportion of these emissions will be CO_2, and there could be some minor emissions of methane (CH_4) and nitrous oxide (N_2O). GHG monitoring and reduction programs are currently in place.

17.3.2 Noise and vibration

Khanbogd, the nearest soum centre, is 45 km to the northeast of the Property and is not expected to be affected by noise during operations. Those receptors considered relevant to noise generated by the Project include:

- The worker accommodation facilities within the Property.
- Permanent winter herder camps outside the Property.
- Local population near activities related to the Project outside the Property.

Mitigation measures and residual impacts

The potential impacts for noise and vibration have been identified and assessed. No significant residual adverse impacts are anticipated after the proposed design enhancements and mitigation measures are implemented and impacts are monitored under the relevant management plan, including:

- Noise and Vibration Management Plan.
- Transport Management Plan.

17.3.3 Landform and geology

Actual and potential impacts

Actual and potential impacts on the topography, geology, and topsoil arising from the construction, operation, and closure of the Project include:

- Construction of mine infrastructure, including the TSF and waste rock dump areas.
- Impacts associated with open pit mining activities.
- Block caving mining activities and resulting surface subsidence zone.
- Creation of buildings and other structures, including camps and shaft headframes.
- Diversion of the Undai River and other ephemeral watercourses.
- Loss of topsoil from erosion by wind and water around earthworks, topsoil stockpiles, and restored areas.
- Potential subsidence impacts on the area overlying the Gunii Hooloi aquifer.

Mitigation measures and residual impacts

A “mitigation through design” approach has been adopted, which aims to prevent and mitigate, as far as practical, impacts on topography, landscape, geology, and topsoil. No significant residual adverse impacts are anticipated after the proposed design enhancements are implemented and impacts are monitored under the relevant management plan, including:

- Land Use Management Plan.
- Topsoil Management Plan.
- Transport Management Plan.
- Waste Rock Management Plan.
- Mine Closure and Reclamation Management Plan.
- Water Resources Management Plan.
- Hazardous Materials Management Plan.

The generation of revenues, employment opportunities, and community services from conversion of geological resource and sale of processed ore/concentrate was identified as a major positive impact on soum residents, residents of Omnogovi, and the Mongolian Government.

17.3.4 Water resources

Actual and potential impacts

Based on an appraisal of the baseline conditions and sensitivities discussed in the ESIA, actual and potential impacts on surface water and groundwater arising from the construction, operation, and closure of the Project include:

- Impacts on surface water systems, including the diversion of ephemeral watercourses and ephemeral and permanent springs in the Oyu Tolgoi Property. These impacts could affect water quantity or the length of time an ephemeral watercourse sustains surface or groundwater flows over the course of a year.
- Impacts on the ground surface associated with mining operations and dewatering of the aquifers in and immediately around the Property.
- Potential contamination from construction of mine infrastructure, including the TSF and waste rock dump areas.
- Impacts of dewatering the Gunii Hooloi aquifer, including potential for subsidence.

Mitigation measures and residual impacts

A “mitigation through design” approach has been adopted, which aims to prevent and mitigate, as far as practically possible, impacts on water resources. Groundwater abstraction will have an unavoidable residual impact on the Gunii Hooloi groundwater resource, which will be mitigated by ensuring that the plant operates efficiently to minimize water use and by maximizing the recycling and reuse of water. No other significant residual adverse impacts are anticipated after the proposed design enhancements are implemented and impacts are monitored under the relevant management plan, including:

- Water Resources Management Plan.
- Hazardous Materials Management & Waste Management Plan.
- Environmental Protection Plan.
- Tailings Management Plan.
- Mine Closure and Reclamation Management Plan.

Oyu Tolgoi will also take a proactive approach to any issues that arise with herder wells and take responsibility for assisting them to rectify any issue and restore their water supplies, if necessary. All such works will be intended to restore the same level of supply and not notably increase the herders’ supply, thus ensuring that the current balance between herd numbers and pasture stresses is not negatively affected.

17.3.5 Biodiversity

Summary of impacts

In 2011, Oyu Tolgoi implemented a Rapid Biodiversity Assessment as part of the risk assessment process for impacts on various identified biodiversity features. The risks were categorized as critical, high, medium, and low. Priority biodiversity features that require connectivity of the landscape to support their populations include:

- Species that might avoid Project infrastructure.

- Species of birds that could suffer mortality from collision or electrocution.
- Species that could be subjected to increased levels of hunting or collecting.
- Species that are susceptible to indirect loss of habitat around Project infrastructure.
- Species that could be affected by increased populations of natural predators.

Impacts rated by the Rapid Biodiversity Assessment process as moderate to low risk on specific biodiversity features, generally relate to non-priority status species. Mitigation options for low to moderate risks are also addressed by the mitigation options proposed for critical and high risk issues.

Biodiversity offset strategy

The Project has committed to a goal of net positive impact on biodiversity. As such, residual impacts on priority biodiversity features will be offset to achieve this goal. The Rapid Biodiversity Assessment program implemented in 2011 included the preparation of a biodiversity offset strategy for the Project that outlined what was considered at the time to be necessary to achieve net positive impact for priority biodiversity. This strategy is based on wide technical consultation and aims to demonstrate the technical feasibility of achieving a net positive impact on biodiversity.

Mitigation measures and residual impacts

Mitigation actions have been developed for all potential critical and high risk impacts to priority biodiversity features and priority ecosystem services, which are described in relevant management plans, including:

- Water Resources Management Plan.
- Atmospheric Emissions Management Plan.
- Land Disturbance Control and Rehabilitation Plan.
- Non-Mineral Waste Management Plan.
- Hazardous Materials Management Plan.

The Project will have unavoidable residual impacts on biodiversity. Residual impacts are predicted for 15 priority biodiversity features, two ecosystems, and three priority habitats known or likely to occur in the Project Area of Influence. Residual impacts include direct habitat loss, indirect habitat loss, and increased mortality from increased hunting, increased collecting, collisions with vehicles and power lines, and increased numbers of natural predators. Conservation of the Asiatic wild ass is recognized as the highest priority for the Project, given the international importance of the Southern Gobi region to this rapidly declining, globally endangered species and the residual impacts of the Project it is likely to impose.

17.3.6 Land use and displacement

Potential impacts

Oyu Tolgoi LLC will require approximately 11,347 ha of land to construct and operate the mine and ancillary facilities. This includes land for the Oyu Tolgoi Property that was granted in 2009 and additional land required for the TSF, concentrator, airport, Gunii Hooloi bore field and water pipeline, and transport-infrastructure corridor between Oyu Tolgoi and Gashuun Sukhait.

Land will also be temporarily disturbed during the construction phase for activities such as the installation of worker construction camps, excavation of borrow pits, and soil stripping along the water pipeline and transmission line corridors.

Mitigation measures and residual impacts

In 2003, when it became apparent that advanced evaluation of the Project would occur, it became necessary to resettle ten herder households from the Property and a surrounding residential exclusion zone. Accordingly, legally constituted resettlement agreements were concluded with each of the ten households in 2004. In 2011, when construction of processing facilities and ancillary infrastructure commenced, a further 89 herder households were recognised as being negatively impacted by the Project. Economic displacement compensation agreements were agreed with each of these households, and to meet lender compliance requirements and embed commitments into Oyu Tolgoi's management system, a Resettlement Action Plan was prepared in 2011, updated in each of 2013 and 2015.

Evaluation of the Resettlement Action Plan by an independent party, conducted in 2018, concluded that livelihoods of the affected herder families are fully restored except for five families with water dependencies. Oyu Tolgoi LLC is currently working with these families and implementing individual household livelihood improvement plans.

17.4 Social and cultural heritage management

Oyu Tolgoi LLC's Health, Safety, Environment and Community (HSEC) Policy affirms its commitment to protecting the environment and to safeguarding the health, safety and welfare of people affected by the Project including employees, contractors, and communities. The Oyu Tolgoi LLC is dedicated to performing its duties in a safe, sustainable, and environmentally responsible manner.

17.4.1 HSEC Management System

Oyu Tolgoi LLC has developed a comprehensive HSEC Management System. Accountability for compliance sits with line management, with support and technical expertise provided by HSEC resources.

The HSEC Management System is designed on the principle of continual improvement. It adopts the "Plan, Do, Check and Review" methodology and comprises 17 discrete elements for implementation. Monitoring of compliance is undertaken, wherever possible, through current processes that are established and aligned to the specific requirements of each element.

Evaluation of compliance with each HSEC Management System element is ongoing, with formal internal review undertaken annually, and as well as external review/audit processes that includes up to three reviews per year through project financing processes.

17.4.2 Cultural Heritage Management System

Oyu Tolgoi LLC seeks to "design out" impacts to archaeological heritage. Wherever possible, changes have been made to the location of fixed elements of the Project and the design of linear features, such as the roads and the water pipeline, in consideration of archaeological findings.

Many of the impacts on cultural heritage have already been realized in relation to land disturbance, topsoil stripping, and construction of new access roads and associated borrow pits. Existing and possible future impacts include:

- Physical loss of tangible heritage from physical land disturbance.
- Indirect disturbance of tangible heritage through the operation of construction vehicles and machinery, operations vehicles, dust deposition, and vibration effects.
- Damage or deliberate disturbance of heritage by Project workers or incomers to the region.
- Loss of intangible heritage over time as the patterns of work, kinship, worship, and sources of income change.

Potential for further impacts on archaeological and paleontological sites is expected to be low because the scale and intensity of additional earthworks and engineering activities will be low during the operations and decommissioning phases (compared with the construction phase). However, some levelling, landscaping, contouring, and other land-based activities do have the potential to result in further minor archaeological impacts. Should these activities remain within the existing disturbance footprint, no significant impacts are expected. Nevertheless, predicted changes to traditions and the traditional way of life are considered long-term effects.

The Cultural Heritage Management System describes methods to effectively identify, map, document, and protect any archaeological resources that may be encountered during the life of the Project. The objectives of the Cultural Heritage Management System are to:

- Outline the legal obligations/project standards regarding the protection of cultural heritage.
- Identify the actual and potential sources of impact on both tangible and intangible heritage.
- Establish effective plans, programs, and procedures for managing archaeological sites and cultural assets, including potential chance finds during construction and operations.
- Define roles and responsibilities.
- Define monitoring and reporting procedures.
- Define training requirements.

The Cultural Heritage Management System has several mitigation and management controls, including:

- Conducting surveys or an appropriate level of archaeological and/or paleontological investigation by the Institute of Academy and Institute of Palaeontology of Mongolian Academy of Science prior to land disturbance.
- Informing the relevant institutes in writing before undertaking any planned excavations, mining, or acquisition of land disturbance permits.
- Following established excavation, retrieval, and recording procedures in the event of chance finds.

17.4.3 Environmental and community programs

Biodiversity monitoring programs

Oyu Tolgoi LLC also works with international non-government agencies (NGOs), consultants and university researchers to achieve a net positive impact on biodiversity of the mine area. The annual biodiversity monitoring programs provide information to assess the effectiveness of the mitigation strategies that have been incorporated into the Oyu Tolgoi LLC operational management plans.

The Core Biodiversity Monitoring Program included a ground ungulate population survey covering around 79,000 km^2 area of the South Gobi region in 2019. The 2019 survey results indicated that the Oyu Tolgoi LLC's conservation efforts through the biodiversity offset program have contributed to excellent outcomes. Oyu Tolgoi LLC has implemented several biodiversity offsetting projects that contribute to moving towards a net positive impact on biodiversity and ecosystem services in the region, such as the anti-poaching project. Other offset projects include powerline insulation to reduce bird mortality, development of sustainable cashmere, and modification of railroad fencing to lower the impact on fauna.

Greenhouse gas emission monitoring and reduction programs

Oyu Tolgoi LLC has been measuring monthly GHG emissions since 2012 and completes an annual GHG workbook. Total GHG emissions from OT at 31 December 2022 were 1,876,781 tonnes CO_2 equivalent and 3.06 tonnes CO_2 equivalent per unit product (one tonne copper concentrate) against an annual GHG emission intensity forecast of 3.05 tonnes CO_2 equivalent per unit product. These emissions include both direct (from activities related to the Project) and indirect emissions (from generation of purchased energy).

Oyu Tolgoi LLC has implemented numerous programs and activities aimed at reducing its GHG emissions and to save energy, including:

- Discontinuing diesel generators at the training centre (2015), mine camp and site facilities (2017-18), and Khanbumbat airport (2018).
- Installation of walkway lighting powered by solar energy (34 sections installed in 2019).
- Installation of runtime management equipment on air conditioners (30% reduction in energy).
- The Natural Plants Propagation Center in Khanbogt was connected to the Khanbogt soum power grid. Diesel generators now only provide a standby option if needed. Annual abatement CO_2-e was 14.2 tonnes.
- 12kW solar panels were installed at the 'Ikh ger' complex's guard house. It reduced diesel consumption and results in an annual abatement of five tonnes of CO_2-e.

OT LLC is also studying a site renewable energy plan (up to 50MW) and exploring opportunities to produce green hydrogen to provide heating supply to camps.

Community programs

Oyu Tolgoi continues to have a positive impact on the communities surrounding the mine, especially Khanbogd, Manlai, Bayan-Ovoo and Dalanzadgad soums. In Khanbogd, the partnership with Oyu Tolgoi LLC led to the connection of the town to a permanent power supply; funding for new educational and healthcare facilities; sealing of local roads; social welfare programs; a new water supply system with capacity to support 13,000 residents; and construction of a 35.1 km sealed road between Oyu Tolgoi and Khanbogd, which opened in early 2019. In 2019, Oyu Tolgoi LLC also reached an agreement with local herders, made possible by the strong commitment of Oyu Tolgoi LLC's management and the extensive engagement by the company's Communities Team.

In addition to the above achievements, Oyu Tolgoi LLC makes an annual contribution of $5 million to the Gobi Oyu Development Support Fund, a separate fund that supports sustainable community development. Since its creation in September 2015, the Development Support Fund has invested $27 million in 197 sustainable development projects and programs, which have resulted in the creation of more than 391 permanent jobs, benefits to over 390,000 community members, including scholarships for 187 students, among many other achievements. To update the community knowledge base, Oyut Tolgoi LLC completed the 2018 Umnugobi socioeconomic and environmental baseline study update with the National Statistical Office and United Nation Population Fund. The study provides insights on key social trends and changes in the local community in the last 10 years.

17.5 Water and waste management

17.5.1 Water management

Oyu Tolgoi is one of the most water-efficient mines in the world with an average water use of 0.39 m^3 of water per tonne of ore processed in 2019. The water used by Oyu Tolgoi comes from a deep and saline aquifer and has no impact on drinkable water in the region. In 2019, water used by Oyu Tolgoi was continuously recycled at an average rate of 87.2%. An independent water audit is undertaken every five years, with the last audit completed in 2021. Compliance with water management and conservation policies, standards and legislation in 2019 was ensured through diverse processes including inspections from the Government of Mongolia as well as local community field verifications.

Achievements in water management include:

- 41 exploration water bores sealed and rehabilitated.
- 77 new herder wells created.
- Shoreline cleaning events for local water sources.
- Enhancement of three natural springs in Khanbogd soum.

Minimizing water use throughout all the operational aspects has been a key focus during mine planning and design. Examples of water conservation planning include:

- Reuse of cooling water.
- High efficiency tailings thickeners.
- High efficiency TSF reclaim.
- 100% mine water recovery.
- 100% treated wastewater reuse.
- 100% truck wash water reuse.
- Lagoon floating cover.

- Selection of low or zero water use equipment.

Ongoing attention to water conservation will be maintained through the continuous review of key performance indicators for water use and implementation of additional water conservation measures.

Ongoing work programs for developing water resources include:

- Updated hydrogeological model of Gunii Hooloi water resource based on monitoring response of operation.
- Clarification of aquifer reserve approval for the eastern part of the Khanbogd water resource.

17.5.2 Waste management

17.5.2.1 Mineral waste

Oyu Tolgoi LLC stores mineralised waste in TSFs, which are engineered structures designed to minimise impact on the local environment. TSF C1 has been in use since 2013 and is currently 49 m high. In 2019, 40 million dry cubic metres were pumped to the TSF, meeting the anticipated level rise of 6 m. The TSF uses the downstream method of wall construction. The last independent review of the facility was carried out in February 2019.

The Oyu Tolgoi tailings storage facility is being managed according to Rio Tinto and Australian National Committee on Large Dams (ANCOLD) Standards on tailings management and is conforming to the requirements of the Global Industry Standard on Tailings Management (GISTM). Three lines of defense are provided under the Rio Tinto group risk model, which provides three lines assurance under internal and product group level controls, independent design and operational reviews, an independent technical review panel and Group Internal Audit. Oyu Tolgoi LLC's tailings standard is consistent with the International Council on Mining and Metals (ICMM) position statement on TSF governance.

17.5.2.2 Non-mineral waste

As result of the development of the underground, the quantity of non-mineral waste generated at Oyu Tolgoi has significantly increased. For the past two years, Oyu Tolgoi LLC has focused on continuous improvement of non-mineral waste management through the development of the long term non-mineral waste management strategy and the reduction of the waste that goes to the waste management centre by improving the ability to reuse and recycle waste materials and segregating waste in the work areas. As a result of these activities:

- In 2019, 54% of total waste was diverted from the waste management centre by reuse and recycling.
- Since 2016, the quantity of landfill waste has decreased by 49%, to 3.4 kg per person per day in 2019.
- Over 2,250 m^3 of wood was reused in cooperation with the local Red Cross Primary Committee.

17.6 Progressive rehabilitation and closure planning

17.6.1 Progressive rehabilitation and planning

Oyu Tolgoi LLC's progressive rehabilitation planning adheres to all related Mongolian laws and regulations and industry best practices as stated in IFC and European Bank for Reconstruction and Development (EBRD) performance standards and the Rio Tinto closure standard.

Progressive reclamation will be performed on any areas of the mine site where it is deemed practical to do so and with consideration of the need to preserve future mine expansion options. Disturbed areas that are no longer used in the active operation will be physically and biologically rehabilitated concurrently with ongoing mining operations, as far as practicable.

Significant progressive rehabilitation works have been done for the rehabilitation of disturbed land following the completion of construction works, including:

- Historically used temporary airport.
- Historically used borrow pits and quarries used to support construction activities.
- Land disturbed by installation of underground pipelines.
- Land disturbed by drilling activities.
- Historically used tracks and access roads.
- Other areas disturbed during construction.

By the end of the 2019, 1,663 ha of land had been progressively rehabilitated out of a total of 6,036 ha of land affected by the mining operation. Physical and biological rehabilitation phases have been fully completed on 466 ha.

The company will also pursue opportunities for local communities and herder groups to participate in the implementation of progressive rehabilitation measures that could result in economic benefits and capacity development for those involved.

Technical rehabilitation

By the end of 2019, Oyu Tolgoi LLC had successfully completed the technical rehabilitation of a total area of 1,661.3 ha which were handed back to the local government.

Biological rehabilitation

To support biological rehabilitation, a 4 ha plant nursery was established on the outskirts of Khanbogd soum centre, where seed collection and preparation, shrub and tree propagation, and rare plant research activities are undertaken. By the end of 2019, Oyu Tolgoi LLC had completed the biological rehabilitation for total area of 466 ha of which 53 ha of land was associated with off-site construction works, such as road construction.

In 2019, 1.34 ha of landscaping was completed in the Oyut Camp, Mazaalai mess hall, north gate, and Khanbumbat airport. Oyu Tolgoi LLC also conducted a 1,500-tree planting campaign in Khanbogd. During the "open day" event, about 1000 saplings were given to local communities in Dalanzadgad.

17.6.2 Closure planning

The Mine Closure and Reclamation Management Plan, prepared by AMEC Americas Limited in 2012 and updated in 2014 (AMEC Environmental & Infrastructure, 2014), documents the outcomes of an order of magnitude closure study conducted with the following objectives:

- Compliance with relevant Mongolian national standards.
- Compliance with relevant international guidelines and directives.
- Documentation of closure vision, objectives, and targets.
- Early development of strategies to meet closure objectives and targets.
- Early identification of likely site-specific closure issues and assessment of risks.
- Identification of action items that should be conducted to manage and mitigate risks and enable efficient and effective closure methods and technologies in the future.
- Preparation of a preliminary closure schedule based on current information.
- Estimation of costs associated with the closure, developed to an intended accuracy of an order-of-magnitude study.
- Development of a multidisciplinary information resource.

The main supporting infrastructure and facilities at the site that are addressed in the closure plan include:

- The Oyut open pit mine and the Hugo North Level 1 underground mine and subsidence area.
- Underground and open pit infrastructure and equipment.
- Materials handling and processing facilities.
- Offices, truck shops, camps, and warehouses.
- Accommodation facilities.
- Waste management facilities.
- Standby diesel generators.
- Power distribution lines both on and off site.
- Access roads on and off site.
- Groundwater supply system from the off-site Gunii Hooloi bore field.
- Water treatment and distribution facilities.
- Water diversion structure (Undai River diversion dam and channel).
- Waste rock dumps and TSF.

Certain features of the mine will create permanent changes to the landscape that cannot be fully remedied through reclamation. The closure plan ensures that, where possible, these disturbed areas are physically and chemically stable to limit ecological impacts to the surrounding water, air, and land.

The proposed timeframe for implementing community and socioeconomic initiatives with regard to mine closure would span a period of about 15 years, beginning five years before closure, continuing through the estimated five years of mine closure and reclamation, and ending five years into the post-closure phase.

17.6.3 Post-closure monitoring

The site will be extensively monitored during the closure and post-closure phases of the mine, to characterize both physical and chemical stability of the Property and the environmental impact of the Project.

17.7 QP's opinion

It is the opinion of the QP that Oyu Tolgoi's current environmental assessment and management plans are appropriate to address issues related to environmental compliance with local and international agency standards and regulations, relationships with local individuals or groups, rehabilitation and waste management and the overall effect of the company's mining operations on the physical and social environment.

17.8 Commitment to local procurement and hiring

The Oyu Tolgoi Investment Agreement calls for best endeavours that not less than 60% of the construction workforce, 75% of mining and mine-related work, and 90% of the Oyu Tolgoi LLC operations staff will be Mongolian citizens, with preferential hiring of qualified people from the Project Area of Direct Influence. As at 31 October 2015, Oyu Tolgoi LLC reports on personnel ratios indicate full compliance with employment quotas stated in the Investment Agreement, and even exceedances of the requirement: 94.1% of Oyu Tolgoi LLC operations staff were citizens of Mongolia. Extensive training and skills development remain the priority; this requires joint effort by Oyu Tolgoi LLC in partnership with relevant government agencies, and the cooperation and support of the Internation Financial Institutions (IFIs) and NGOs.

18. Capital and operating costs

Capital and operating costs are reflective of the modelled Mineral Reserves only schedule, presented at a Property level on a 100 percent basis[4] and in real 2020 US$ dollars (with no allowance for inflation). Because asset values are presented in this TRS at a Property level on a 100 percent basis, capital and operating costs are modelled and presented on the same basis. External guidance in other Rio Tinto reporting is presented on an equity basis and in nominal terms. As such, the costs presented in this TRS are likely to deviate from costs published by Rio Tinto elsewhere.

At the time of reporting, the Property comprises total Rio Tinto share of Mineral Reserves of 0.7 Bt at 0.87% Cu and 0.30 g/t Au and Mineral Resources (excluding Mineral Reserves) of 2.7 Bt at a grade of 0.70% Cu, 0.30 g/t Au. The conversion of material from a Mineral Resource to a Mineral Reserve occurs on a progressive basis.

The capital and operating costs in this section are based on a Reserve Case mine plan that consists of both the Oyut open pit material and Hugo North Lift #1 underground ore. The Oyut open pit supplies the initial source of ore to the mill at a nominal capacity of 95 kt/d. Once production from underground commences, the open pit feed to the mill is continually displaced by the higher grade ore from Hugo North Lift #1.

The capital costs in this section include costs for Phase 1 of the Oyu Tolgoi mine development, which involved development of the Oyut open pit mine, the concentrator and associated infrastructure and Phase 2, which involves development of the Hugo North underground mine, conversion / modification of the concentrator and expansion of the site infrastructure. Phase 2 of the mine development is in progress.

Sustaining capital cost estimates include replacement of major equipment, replacement of major equipment components, planned growth of the mine, the construction of the TSF and other projects to maintain and improve efficiency and productivity of the operations. For the Hugo North mine, sustaining capital costs include all lateral development, undercut, and drawbell construction activities over and above capital expenditure, required to increase capacity to nameplate and sustain it. Additional Panel 1 and Panel 2 development completed prior to first drawbell is included in sustaining capital.

All operating and sustaining capital costs were prepared on the basis that all expenses have been quantified as much as possible and unit cost rates applied. Pricing is predominantly based on operating experience and market conditions as at the third quarter of 2019.

An amount of contingency has been provided in the operating cost estimates to cover the anticipated variances between the ground conditions and specific values that form the base estimate and the final Project costs. The total estimated Project value thus represents a cost having an equal estimated probability of overrun as underrun, or the P50 outcome.

Contingency for sustaining capital and operating costs has been calculated based on similar principles as those used for the initial capital costs.

This section excludes the schedule and costs impacts from the COVID-19 pandemic.

[4] For the purposes of this section, 100 percent basis means without regard for any apportionment of the expenses as between Rio Tinto and other equity holders, such as joint venture participants.

18.1 Capital costs

Capital costs are estimated based on internal studies undertaken by Rio Tinto, and historical performance. Capital is inclusive of all mine, power and other infrastructure capital required to maintain Oyu Tolgoi's physical assets.

Capital costs reflect development and sustaining capital, replacement and growth capital, including heavy mobile equipment (HME) required to replace aging fleet as well as replacement of major components and overhauls. All undercut drill and blast, associated swell mucking, and drawbell drill and blast are considered sustaining capital. Capital costs for development are summarised in Table 18-1 and sustaining capital costs are summarised in Table 18-2.

Table 18-1 summarizes the total capital costs for Phase 2 development and focuses on the capital costs that are required for the development of the mine and associated infrastructure. The Oyu Tolgoi mine is being developed in two Phases, with Phase 1 involving the now completed development of the open pit mine, construction of the concentrator and associated infrastructure and Phase 2 involving the on-going development of the Hugo North underground mine, modification of the concentrator and associated infrastructure. Phase 1 of the development was completed in 2013 with a total capital expenditure of $6.4 billion. Phase 2 development is ongoing with an estimated capital expenditure requirement of $7.4 billion[5].

Table 18-1: Summary of total Phase 2 capital costs by major area (US$M nominal, 100% basis)

WBS	Description	Total (US$M)
Direct Cost		
1000	Underground Mine	3,005
2000	Site Development	0
3000	Concentrator Conversion	167
5000	Utilities & Ancillaries	149
6000	Offsite Facilities	159
	Subtotal	3,480
Indirect Cost		
7000	Indirect Costs	1,563
8000	Owner's Costs	2,135
9000	Escalation, Growth & Contingency & Forex	179
	Subtotal	3,877
Total		7,358

[5] This amount includes $6,852 million of project costs and $505 million for pre-restart of the Phase 2 development for a total of $7.4 billion from the OTFS20. Subsequently, an updated cost and schedule reforecast was finalised in June 2022 incorporating further Covid-19 impacts to June 2022, cost price escalation and impacts of revised Mongolian labour laws ("2022 Reforecast" or "22RF"). The 2022 Reforecast remains the latest estimate, where the total capital cost for Phase 2 remains at $7.06 billion not including pre-restart costs (nominal – including escalation).

Table 18-2: Estimated sustaining capital for the Property (US$M real, 100% basis, from 2021 onwards)

Area	First 5 Years	First 10 Years	Life of Mine
Open Pit	99	233	820
Underground	1,365	2,231	2,739
Concentrator	33	61	149
Tailings	159	299	829
Infrastructure	93	110	255
General and Administration, Other	84	118	212
Total Sustaining Capital (before tax)	1,832	3,151	5,004
Value Added Tax, Custom Duties	193	340	539
Total Sustaining Capital (after tax)	**2,025**	**3,492**	**5,543**

18.2 Operating costs

Operating costs include costs associated with mining, processing, support, and other costs such as those associated with community relationships.

Across the supply chain, operating costs include both internal and external contract labour, diesel and energy, materials, corporate costs and other expenditure required in day-to-day operations.

The estimates were built up on the fundamental principle of centrality, giving them an equal probability of upside and downside. Life of mine total costs are shown in Table 18-3, Table 18-4, and Table 18-5.

Table 18-3: Open pit mining operating cost summary

Area	Operating Cost	Operating VAT & Duties	Sustaining Capital	Sustaining VAT & Duties	Total
Open Pit Mine ($M)	4,817	506	820	86	6,230
Open Pit Mine ($/t TMM)	1.61	0.16	0.29	0.03	2.17

Note: * Costs exclude incremental hauling costs to TSF, which are reflected under the Tailings Storage sustaining capital costs. Deferred stripping costs are included in operating costs. Costs excluding deferred stripping is $3,501.

Table 18-4: Underground mining operating cost summary

Area	Operating Cost	Operating VAT & Duties	Sustaining Capital	Sustaining VAT & Duties	Total
Underground Mine ($M)	3,457	380	2,739	301	6,877
Underground Mine ($/t underground ore mined)	7.9	0.9	6.2	0.7	16.0

Table 18-5: Processing and support operating cost summary

Area	Operating Cost	Operating VAT & Duties	Sustaining Capital	Sustaining VAT & Duties	Total
Concentrator ($M)	8,271	868	149	16	9,304
Tailings Storage Facility ($M)			829	87	916
Infrastructure ($M)	2,579	275	255	27	3,135
G&A ($M)	2,279	134	212	22	2,648
Total ($M)	**13,129**	**1,277**	**1,445**	**152**	**16,003**
Mine Closure ($M)			1,213	95	1,308
Total ($/t processed ore)	**10.69**	**1.04**	**1.18**	**0.12**	**13.03**
Mine Closure ($/t processed ore)			0.99	0.08	1.07

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19. Economic analysis

The accuracy of capital and operating cost estimates must comply with the following guidelines (Table 19-1):

Table 19-1: Capital and operating cost estimation accuracy guidelines

Factors[1]	Initial Assessment	Preliminary Feasibility Study	Feasibility Study
Capital Costs	Optional.[2] If included: Accuracy: ±50%. Contingency: ≤25%.	Accuracy: ±25% Contingency: ≤15%.	Accuracy: ±15%. Contingency: ≤10%.
Operating Costs	Optional.[2] If included: Accuracy: ±50%. Contingency: ≤25%.	Accuracy: ±25% Contingency: ≤15%.	Accuracy: ±15%. Contingency: ≤10%.

1. When applied in an initial assessment, these factors pertain to the relevant technical and economic factors likely to influence the prospect of economic extraction. When applied in a preliminary or final feasibility study, these factors pertain to the relevant technical and economic factors likely to influence the economic viability of the project.
2. Initial assessment, as defined in this subpart, does not require a cash flow analysis or operating and capital cost estimates. The QP may include a cash flow analysis at his or her discretion.

19.1 Summary

Rio Tinto has produced an economic evaluation of the Property's Mineral Reserves based on feasibility level study as at 1 January 2021. Analysis excludes Mineral Resources and other lower confidence inventory. All cashflows are presented at a Property level on a 100 percent basis, in real 2020 US$ dollars with no allowance for inflation.

Economic analysis confirmed the strong economic viability of the Property's Mineral Reserves, which deliver a post-tax NPV of $7.7 billion based on a real discount rate of 10%. This valuation differs from the IFRS recoverable amount used in our impairment reviews principally due to different commodity price assumptions, discount rate and the requirement to include Mineral Resources in that metric.

19.2 Methodology

19.2.1 Modelling approach

An economic evaluation of the Property's Mineral Reserves is completed. Valuations are conducted in a standalone valuation model that forecast cash flows relating to Rio Tinto's Oyu Tolgoi mine operations.

Mine economics have been evaluated using the discounted cash flow method, mid-year discounting and taking into account copper/gold concentrate production and sales. Sensitivities to price, operating costs, capital costs, foreign exchange and discount rate are evaluated.

19.2.2 Sources of assumptions

A combination of internal and external sources is used as the basis for the financial evaluation. Key assumptions used in this economic analysis are outlined in Table 19-2.

Table 19-2: Economic analysis assumptions used as the basis for financial evaluation

Category of Assumption	Source of Assumption
Pricing and Revenue	Consensus pricing provided by Rio Tinto Economics
Physicals	Oyu Tolgoi LLC Technical Services Department
Operating Costs	Oyu Tolgoi LLC actual costs flexed for physical drivers
Capital Costs	Oyu Tolgoi LLC Projects & Sustaining Capital estimates
Taxation	Mongolian Government Taxation Laws Rio Tinto Tax Department
Royalties	Mongolian Mineral Law

19.3 Inputs and assumptions

19.3.1 Financial

The financial model developed to evaluate the economics of the Reserve Case on a Project basis indicates that the estimated after-tax Project NPV using a 10% discount rate is $7,694 million. The internal rate of return (IRR) is 42% and the payback period is 5.5 years on an undiscounted basis starting from 2021.

The Project cash flows have been prepared on a January 2020 real-terms basis. Costs and revenue incurred prior to 1 January 2021 are treated as sunk costs in the financial analysis, and so are excluded from valuation and IRR as at 1 January 2021.

Table 19-3 outlines foreign exchange (FX) rates used in the economic analysis.

Table 19-3: FX rates used in economic analysis

FX Rates	2021+
FX Rate (MNT/USD Real)	2,618
FX Rate (RMB/USD Real)	6.90

19.3.2 Pricing and revenue

Oyu Tolgoi has used the price assumptions listed in Table 19-4 for the base financial evaluation of the end of 2020 mineral reserves estimate. All prices are assumed to be flat in real terms from 2025. The base discount rate is 10% with discounting starting 1 January 2021.

Note that cash flows previous to 2021 are considered sunk for the purpose of these evaluations. The study assumes a flat diesel cost of $0.8/L and constant real exchange rates of RMB 6.9 / USD and MNT 2,618 / USD over the life of mine.

Table 19-4: Price assumptions (US$ real)

Item	2021	2022	2023	2024	2025
Copper ($/t)	5,812	5,857	5,992	6,158	6,790
Copper ($/lb)	2.64	2.66	2.72	2.79	3.08
Gold ($/kg)	50,957	46,344	43,574	42,058	40,186
Gold ($/oz)	1,638	1,490	1,401	1,352	1,292
Silver ($/kg)	527	532	540	557	619
Silver ($/oz)	17	17	17	18	19
Diesel ($/L)	0.8	0.8	0.8	0.8	0.8

These forecast prices were used in the economic modelling and are lower than the latest consensus prices referred to in our latest Mineral Resources and Mineral Reserves tables. Actual prices in 2021 and 2022 were higher than those used in this modelling.

19.3.3 Taxes

Under the terms of the Investment Agreement, a range of key taxes has been identified for the term of the agreement at the rates and base currently applied. The taxes listed in Table 19-5 constitute the majority of taxes and fees payable to the Government of Mongolia under Mongolian Law.

Table 19-5: Taxes and fees paid to the Government of Mongolia

Item	Value
Government Royalty	
Basis	As per IA / Minerals Law
Revenue Basis	Gross Sales Value
Copper Rate	5%
Gold Rate	5%
Silver Rate	5%
Taxes	
Corporate Income Tax	
Basis	As per law
Rate	25%
Loss Carry Forward Limitation	8 years
Investment Tax Credit	
Basis	As per IA
Percent of Future Investment Eligible to March 2017	100%
Rate	10%
Years of ITC Carry-forward	3 taxable years

Withholding Tax Rates	
Basis	Tax Treaty
Dividends to Oyu Tolgoi LLC	10%
Dividends to BVI Shareholder	20%
Dividends to OTN BV	0%
Interest on Project Finance (depends on lender's tax residence)	0%–20%
Services Provided in Mongolia* (subject to any tax treaty reduction)	20%
Services Provided Offshore*	0%
Value Added Tax	
Basis	As per Law
Rate	10%
Refund for Production of Concentrate	No

Note: * 10% VAT to be added on and self-assessed by OT LLC.

19.4 Capital costs

Capital costs are summarised in Section 18.1.

19.5 Operating costs

Operating costs are summarised in Section 0. Unit operating costs reflect the 'all in' cost associated with producing each tonne of ore, on average, over time. Operating costs presented in Section 0 exclude closure and rehabilitation costs.

19.5.1 Closure costs

The total projected cost of closure of the Oyu Tolgoi mine site is $1.338 billion. The costs are summarized in Table 19-6. All costs are expressed in 2020 US$ with no allowances for escalation beyond this period. The estimate for closure costs has an expected accuracy of ±30% using Rio Tinto Closure Cost Estimating accuracy guidelines.

Table 19-6: Closure cost estimate

Cost Item	Cost (US$M)
Direct Costs	
Demolition and Removal of Permanent Facilities	365
Rehabilitation and Revegetation	336
Treatment and Disposal of Hazardous Wastes	4
Human Resources	33
Community	33
Post-Closure Monitoring and other Obligations	15
Subtotal Direct Costs	**787**
Indirect Costs	

Closure Support Facilities	72
Closure Management (EPCM) Services	57
Owner’s Costs incl. 10% VAT	130
Subtotal Indirect Costs	260
Contingency (25%)	262
Total Closure Cost	**1,308**

19.6 Cash flow

19.6.1 Cash flow analysis

Rio Tinto reviewed the Mineral Reserve production schedule, after-tax cash flows to confirm the economics of the mine plan contemplated by this Mineral Reserve schedule. The Property’s Mineral Reserves are value accretive, delivering $21.8 billion in post-tax free cashflow (Table 19-7).

Table 19-7: Non-discounted cash flow for the property

Item ($M)	Total	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Net Sales Revenue	56,692	1,718	985	1,120	1,917	2,114	2,730	3,390	3,961	3,558	3,217	2,896	2,841	2,930	2,627	2,394	2,384
Total Site Operating Costs	23,998	843	842	878	842	835	841	819	800	874	897	897	936	981	928	865	822
Taxes	513	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital Expenditure	10,330	1,483	1,035	873	625	417	358	321	478	330	240	260	234	183	142	196	273
Working Capital Funding	19	(10)	7	(1)	(3)	(0)	(4)	(4)	(7)	2	3	1	(0)	(2)	3	0	(2)
Net Cash Flow After Tax	21,832	(598)	(900)	(630)	452	862	1,535	2,254	2,690	2,351	2,077	1,737	1,671	1,767	1,554	1,332	1,291

Item ($M)	Total	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Net Sales Revenue	56,692	2,514	2,232	1,629	927	856	1,745	907	787	465	533	578	570	776	1,086	308
Total Site Operating Costs	23,998	860	785	932	888	831	828	711	692	434	614	570	631	557	408	356
Taxes	513	0	255	124	0	0	121	13	0	0	0	0	0	0	0	0
Capital Expenditure	10,330	291	328	106	95	78	60	108	62	268	127	156	98	83	97	924
Working Capital Funding	19	(4)	3	5	7	2	(6)	6	2	3	(2)	(0)	(0)	0	1	17
Net Cash Flow After Tax	21,832	1,367	861	463	(63)	(54)	742	69	31	(239)	(206)	(148)	(159)	135	580	(989)

2021 and 2022 numbers are forecast numbers based on the 2020 feasibility study, not actuals.

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19.6.2 Economic evaluation

Economic analysis and discounted cash flow modelling as at June 2020 confirmed the economic viability of the Property's Mineral Reserves which deliver a post-tax NPV of $7.7 billion as at 1 January 2021. The strong positive cash flows from 2025 come from the high grade underground ore mined and processed during this period. Negative cash flows at the end of the mine life are driven by closure costs, with the present value of all remaining closure costs recorded in the final year (Table 19-8).

Table 19-8: Cashflow and NPV ($real, US$m)

Parameter	Total	Present Value
Gross Revenues	68,775	25,716
Realization Costs	8,510	3,005
GoM Royalties	3,573	1,335
Net Revenues	56,692	21,376
Open Pit Mining Operating Costs	3,488	1,081
Underground Mining Operating Costs	3,356	1,190
Concentrator Operating Costs	7,730	2,600
Infrastructure Operating Costs	2,525	913
General &Administration Costs	2,279	844
Total Operating Costs	19,377	6,628
Net Earnings	37,315	14,747
Expansion Capital	2,076	1,815
Sustaining Capital	6,347	2,941
Total Capital	8,423	4,755
Working Capital Funding (Release)	19	-8
Closure	1064	61
Other Fees and Charges	282	90
Management Fee	1,927	761
Pre-Tax Cash Flow	25,600	9,088
Corporate Tax	513	87
Property Tax	460	156
VAT, Custom Duties	2795	1152
Total Tax	3,769	1,394
Pre-finance Project Net Cash Flow	21,832	7,694

19.7 Sensitivity analysis

Sensitivity analysis confirmed the Property's Mineral Reserves are robust against changes to major variables including price, capital expenditure, foreign exchange, operating expenditure and discount rate.

Sensitivity analysis is outlined in Figure 19-1 and Table 19-9 and demonstrate the sensitivities to changes in the valuation price, capital, and modelled discount rates.

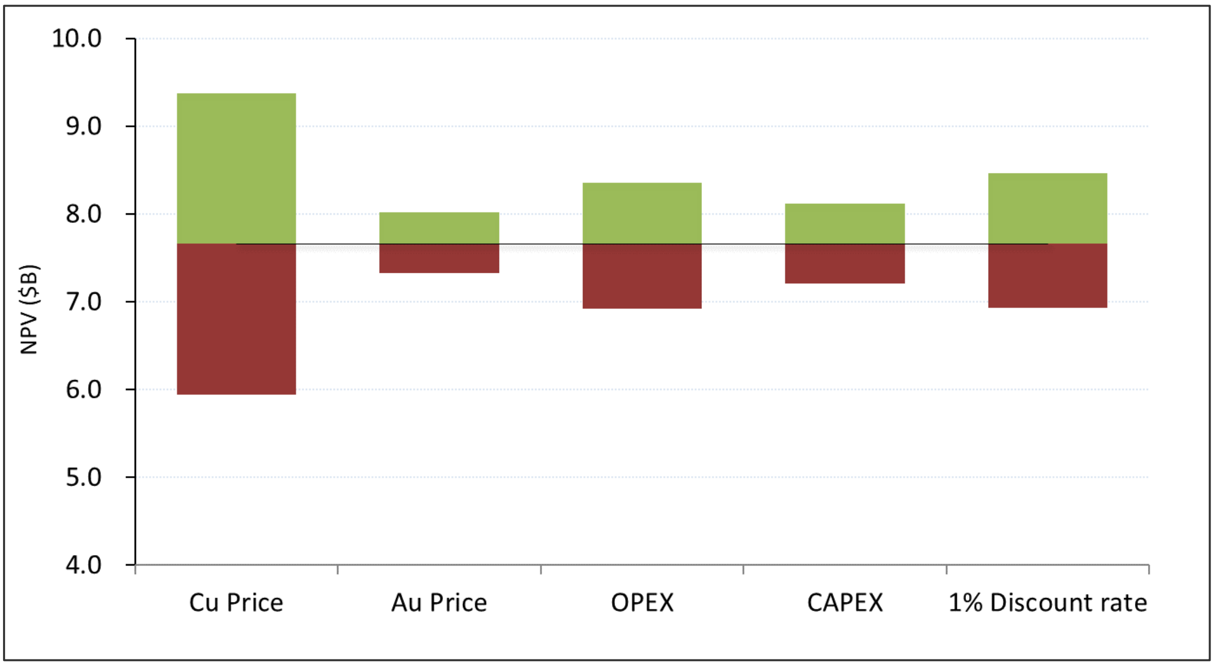

Figure 19-1: NPV Project sensitivity to 10% increase/decrease variations

Table 19-9: NPV Project price sensitivity to base case

Incremental NPV$_{10}$($M)		**Gold Price**				
		$15/g	**$30/g**	**$45/g**	**$60/g**	**$75/g**
Copper Price	$5,000/t	-7,403	-5,960	-4,520	-3,082	-1,641
	$6,000/t	-4,448	-3,008	-1,567	-154	1,147
	$7,000/t	-1,430	-64	1,208	2,490	3,727
	$8,000/t	1,208	2,487	3,718	4,946	6,147
	$9,000/t	3,707	4,929	6,122	7,308	8,443
	$10,000/t	6,149	7,332	8,509	9,640	10,762

20. Adjacent properties

The QPs have not included any relevant information concerning adjacent properties in this TRS as there are no adjacent properties that would materially change the estimates presented. In addition, Rio Tinto has a history of mining similar orebodies and has a well-defined process for defining orebody knowledge from its tenure.

21. Other relevant data and information

The QPs believe that all material information has been stated in the above sections of the TRS.

Oyu Tolgoi are in the process of updating the feasibility study for the Project in order to meet requirements of the Government of Mongolia.

22. Interpretations and conclusions

22.1 Mineral Resources

22.1.1 Interpretations and conclusions

Based on the information presented in this TRS, the QPs key conclusions are as follows:

- The data collected during exploration drilling and sampling programs is collected using appropriate industry standard practices relating to drilling, surveying, logging, sampling, analyses, and QA/QC.
- Base data is reviewed and validated by Subject Matter Experts (SMEs), working under supervision by the QPs, and has been deemed appropriate for use in developing geological models and estimating Mineral Resources for the Property.
- The geological models and resource estimates of deposits are created using established industry methods as set out in Section 11. Verification of each geological model and Mineral Resources estimate occurs as noted in Section 11.1.9. In addition, a peer review is completed at each step of the modelling process, inclusive of a sign-off by a QP at the completion of major steps. A QP also prepares separate documentation to aid and support the Mineral Resources classification.
- Mining, processing, and market modifying factors studies assumptions and parameters are used to establish the reasonable prospects of economic extraction necessary for reporting Mineral Resources. No significant risks exist that could impact the reliability and/or confidence of Mineral Resources estimates.

22.2 Mineral Reserves

22.2.1 Interpretations and conclusions

Based on the information presented in this TRS, the QPs conclude that the Mineral Reserves estimate is supported by appropriate technical data and assumptions, and no significant risks exist that could impact the reliability and/or confidence of the Mineral Reserve estimates.

- As shown in the economic sensitivity analysis in Section 19.6.2, the Mineral Reserves estimate for the Property is not highly sensitive to variation to capital and operating cost, or discount rate. Property valuation is most sensitive to product price, however as demonstrated the Property remains highly economic in these scenarios.
- The assumptions, methods and parameters used for generating the Mineral Reserves estimate are aligned with industry practices and suitable for the mineralisation of the Oyu Tolgoi and selected mining methods.
- All of the Mineral Reserves estimate is located within existing permitted operating mining areas, supported by established labour accommodation and transport facilities, processing, road infrastructure, HME maintenance workshops, ground water abstraction and discharge networks, and surface mine haul roads and waste dumps.
- Historical performance and reconciliation underpin the confidence in technical modifying factors such as ore loss and dilution, geotechnical parameters, and metallurgical and hydrogeological assumptions.

23. Recommendations

Based on the results presented in this TRS and consistent with Rio Tinto's long standing operating practices, ongoing technical work will be performed on the Property as part of studies to improve confidence, decrease risk and enable the conversion of Mineral Resources to Mineral Reserves. The following items are recommended to sustain Mineral Resources and Mineral Reserves:

- Complete in progress Hugo North Lift1 optimisation study (OTFS23) and obtain relevant Mineral Council and Government of Mongolia approvals.
- Update Mineral Resources estimates for Hugo South.

These recommendations reflect Rio Tinto's ongoing operating practices and as such costs are incorporated into the Property's operating and capital costs; therefore, the costs of these recommendations have not been separately disclosed in this TRS.

24. References

Corporate Policies. (2021). Retrieved 11 November 2021, from https://www.riotinto.com/-/media/Content/Documents/Sustainability/Corporate-policies/.

Corporate structure of Rio Tinto, from https://www.riotinto.com/invest/corporate-governance

Ayush, O 2006, “Stratigraphy, geochemical characteristics and tectonic interpretation of Middle to Late Paleozoic arc sequences from the Oyu Tolgoi porphyry Cu-Au deposit”, MSc thesis (in Mongolian), Mongolian Univ. Science and Technology, Ulan Bator, Mongolia, 80 p.

Burenkhuu, E., Gotovsuren, A., Badarch, G., & Dagvatseren, A., 1995. Report of geological complex study in the Galviin Gobi area (scale 1:200000). Ulaanbaatar: MRAM Geological Archive.

Hebert, Y. and Sharrock, G., 2018, October. Three-dimensional simulation of cave initiation, propagation and surface subsidence using a coupled finite difference–cellular automata solution. In Caving 2018: Proceedings of the Fourth International Symposium on Block and Sublevel Caving (pp. 151-166). Australian Centre for Geomechanics.

Itasca 2019, FLAC3D (Fast Lagrangian Analysis of Continua 3D) Version 7.0, Itasca Consulting Group, Inc, Minneapolis, USA.

Itasca Australia Pty Ltd, 2019. Numerical Assessment of Caveability Cave Initiation to Surface Breakthrough Panel 0 - Model D - Alternative Design - Oyu Tolgoi Mine. Internal Document prepared for Oyu Tolgoi LLC.

Jakubec, J. and Laubscher, D.H., 2000. The MRMR rock mass rating classification system in mining practice. In Proceedings of the 3rd international conference and exhibition on mass mining, Brisbane, Australia (pp. 413-421).

Jargaljav, G 2009, “Mineralisation and metasomatic alteration of Central Oyu copper-gold deposit”, PhD thesis (in Russian), Irkutsk Technical University, Irkutsk, 129 p.

Khashgerel, B 2010, “Geology, whole-rock geochemistry, mineralogy and stable isotopes (O, H and S) of sericitic and AA alteration zones, Oyu Tolgoi porphyry Cu-Au deposits, Mongolia”, PhD thesis, Univ. of Tsukuba, Japan, 114 p.

Myagmarsuren, S 2007. “Sulphide mineral paragenesis at the Hugo Dummett porphyry Cu-Au deposit, Oyu Tolgoi, Mongolia”, MSc thesis, Tohoku University, Japan, 93 p.

Munkbaatar, N., Chuluunbaatar, S., Sanjdorj, S., & Ulziibayar, G. (2005). Report on Hydrogeological Survey and Exploration for Gunii Hooloi and Galbyn Gobi in 2003-2004 for water supply at Oyu Tolgoi mine.

Odonchimeg.A. (2013). Laboratory analytical quality assurance-quality control quarterly report. OT LLC internal report.

Odonchimeg.A. (2014). Laboratory analytical quality assurance-quality control quarterly report. OT LLC, internal report.

Odonchimeg.A. (2015). Laboratory analytical quality assurance-quality control quarterly report. OT LLC, internal report.

Odonchimeg.A. (2016). Laboratory analytical quality assurance-quality control monthly and quarterly report. OT LLC, Internal report.

Otgonbayar, T., Odonchimeg, A., Munkhbat, T., & Crook, G., 2014. Resource report update on Heruga deposit (Javkhlant licence area). Ulaanbaatar, Geological Central Archive #7700: Oyutolgoi LLC.

OT LLC. (2012). Oyu Tolgoi Environmental and Social Impact Assessment (ESIA)

Oyunchimeg, R 2008, “Sulphide mineralogy and gold mineralisation at Hugo Dummett porphyry Cu-Au deposit, Oyu Tolgoi mineral district, Mongolia”, PhD thesis (in Mongolian), Mongolian Univ. Science and Technology, Ulan Bator, Mongolia, 116 p.

Savage, N 2010, “Origin of clasts, mineralisation and alteration within the DA2a conglomerate, Heruga porphyry Cu-Au-Mo deposit, Oyu Tolgoi, Mongolia: evidence for an older porphyry system or part of the early Oyu Tolgoi paragenesis?”, MSc mining geology dissertation, Cambourne School of Mines, UK, 119 p.

Sillitoe, RH., 2010: Porphyry Copper Systems. Society of Economic Geologists Economic Geology, v 105, pp. 3-41.

Sketchley, D., 2011. Oyu Tolgoi Project QA/QC Review, From Sampling to Assaying. Internal memorandum prepared for Oyu Tolgoi LLC.

Tuvdendorj, A., Sanjdorj, S., & Ulziibayer, G. (2008). Report on the Exploration and Underground Aquifer on the Ghunii Khooloi Deposit (Water Reserve Estimation as at 1st January 2008). Ulaaanbaatar: Ministry of Nature and Environment and Ivanhoe Mines.

Tuvdendorj, A., & Sosorburam, D. (2015). Report on the Exploration and Water Aquifer on Gunii Khooloi and adjacent areas - Water Reserve Estimate as at 1st January 2014.

Wainwright, A.J., 2008. Volcanostratigraphic framework and magmatic evolution of the Oyu Tolgoi porphyry Cu-Au district, South Mongolia, PhD, Univ. British Columbia, Vancouver, 263 p.

25. Reliance on information provided by the Registrant

The QPs have wholly relied upon the Registrant for the following:

- Macroeconomic trends, data, and assumptions, and interest rates (Sections 18 and 19).
- Marketing information and plans within the control of the registrant (Sections 16, 18 and 19).
- Legal matters outside the expertise of the qualified person, such as statutory and regulatory interpretations affecting the mine plan (Sections 3, 13, 15 and 17).
- Environmental matters outside the expertise of the qualified person (Section 17).
- Accommodations the registrant commits or plans to provide to local individuals or groups in connection with its mine plans (Section 17).
- Governmental factors outside the expertise of the qualified person (Section 17).
    - All necessary statutory approvals, licences and permits to operate the Property currently being in place and maintained, including the ongoing ability and commitment to comply with and satisfy all approvals, licence and permit conditions. This includes mining and processing, mineral waste disposal inclusive of tailings (Sections 3, 13, 14).
    - The Registrant's ability and willingness to adequately manage all stakeholder relationships so as to not adversely affect the prospect of ongoing operations at the Property (Section 17).

The QPs consider it reasonable to rely upon the Registrant for the above information based on the QPs' past and ongoing interactions with the subject-matter experts in these areas employed or engaged by the Registrant, as well as the Registrant's considerable experience in copper-gold mining. Further, the QPs have taken all appropriate steps, in their professional opinion, to ensure that the above information provided by the Registrant is accurate in all material respects and have no reason to believe that any material facts have been withheld or misstated.