IVANHOE MINES LTD
Form 6-K
October 14, 2005

SECURITIES AND EXCHANGE COMMISSION

Washington, DC 20549

FORM 6-K

REPORT OF FOREIGN PRIVATE ISSUER PURSUANT TO RULE 13a-16 OR 15d-16 OF THE SECURITIES EXCHANGE ACT OF 1934

From: October 12, 2005

IVANHOE MINES LTD.

(Translation of Registrant s Name into English)

Suite 654 999 CANADA PLACE, VANCOUVER, BRITISH COLUMBIA V6C 3E1

(Address of Principal Executive Offices)

(Indicate by check mark whether the registrant files or will file annual reports under cover of Form 20-F or Form 40-F.)

Form 20-F o Form 40-F þ

(Indicate by check mark whether the registrant by furnishing the information contained in this form is also thereby furnishing the information to the Commission pursuant to Rule 12g3-2(b) under the Securities Exchange Act of 1934.)

Yes: o No: þ

(If Yes is marked, indicate below the file number assigned to the registrant in connection with Rule 12g3-2(b): 82-__________.)

Enclosed:

Technical Report

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SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

IVANHOE MINES LTD.

Date: October 12, 2005

By: */s/ Beverly A. Bartlett*

BEVERLY A. BARTLETT
Corporate Secretary

IMPORTANT NOTICE

This report was prepared as a National Instrument 43-101 Technical Report, in accordance with Form 43-101F1, for Ivanhoe Mines by AMEC Americas Limited [AMEC] with input from certain other professional consultants and Qualified Persons retained by Ivanhoe Mines as more particularly described in the report. The quality of information, conclusions, and estimates contained herein is consistent with the level of effort involved in AMEC s and such other professional consultants and Qualified Persons services, based on :
i] information available at the time of preparation ii] data supplied by outside sources, and iii] assumptions , conditions , and qualifications set forth in this report.This report is intended to be used by Ivanhoe Mines , subject to the terms and conditions of its contract with AMEC. That contract permits Ivanhoe Mines to file this report as a Technical Report with Canadian Securities Regulatory Authorities pursuant to provincial securities legislation. Except for the purposes legislated under securities laws, any other use of this report by any third party is at that party s sole risk.

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SECTION 1 SUMMARY

This technical report summarizes the findings of the IDP study prepared for Ivanhoe Mines Mongolia XXK Inc. (IMMI) by AMEC Auscenco Joint Venture (AAJV), entitled Oyu Tolgoi Project, Mongolia Integrated Development Plan and issued August 2005. AMEC Americas Limited, a partner in the AAJV, was commissioned by Ivanhoe Mines Limited to complete an Independent Qualified Person s Report on the Oyu Tolgoi Project.

1.1 Overview of IDP

The Oyu Tolgoi property contains a large copper-gold resource recoverable by a combination of open pit methods and large-volume block-cave mining. The open pit mine designs were developed from a mineral resource model with 92% of the tonnage in the Measured or Indicated category (at 0.3% Cu equivalent cutoff grade). The primary underground mine resource, Hugo North, contains the majority of the economic value of the property. The underground block-cave mine designs were developed from a mineral resource model with 50% of the tonnage classified as Indicated and 50% as Inferred (at 0.6% Cu equivalent cutoff grade).

Ongoing drilling has encountered mineralized intersections that suggest the presence of an extension to the physical boundaries of the current resource.

Initial production from the open pit will be processed through a conventional 70,000 t/d crushing, grinding, and flotation circuit using proven technology and equipment sizing developed from extensive mineral processing testwork. Testwork has also confirmed that this circuit can process the higher-grade Hugo North ore at a rate of 85,000 t/d if additional capacity is added to the flotation and filtration circuits.

The open pit mine design is complete and optimized. It will provide the primary feed to the mill for the first few years until production from Hugo North ramps up. Stockpiled open pit material also tops up production from the underground for several years. Open pit mining will be done with a fleet of 220 to 240 tonne trucks and hydraulic shovels operated by IMMI. IMMI employees will be trained in block-cave mining methods for Hugo North, which, when combined with open pit ore, will provide feed to the mill for 40 years. This development and production scenario represents the ***base case*** for project assessment.

Construction of an exploration/early development shaft for Hugo North has begun. To maximize project value from the high-grade Hugo North deposit, this evaluation assumes that construction of a second production shaft will commence in 4Q 2005 and of a third 18 months later, both prior to obtaining results from the initial exploration shaft program.

A major ***expanded case*** was evaluated in which plant production increases to 140,000 t/d after Hugo North reaches its peak base case mining rate. The assessment of project economics for the expanded case is based on preliminary capital and operating cost estimates. To achieve this feed rate, production from Hugo North would be increased to over 90,000 t/d, the Hugo South deposit would be mined at a rate of 50,000 t/d, and open pit push-backs would be developed.

Planning associated with the initial phase of project development the Southwest open pit, concentrator, and infrastructure component is well advanced. However, commencement of development will need to be coordinated with the conclusion of current negotiations and discussions related to:

- the Special Stability Agreement with the Government of Mongolia
- a reliable electrical power supply
- VAT and import duty payments on materials and equipment
- a location on the Chinese mainline rail system for concentrate transfer from trucks loaded at Oyu Tolgoi
- completion of environmental assessment and the development of an environmental monitoring program.

Oyu Tolgoi is located in an isolated region of Mongolia with little developed infrastructure. The site is, however, only 80 km from the Chinese border, where resources exist to support the project in the energy, transportation, manufacturing, and construction areas. The development plan for the project is therefore based on the principle of maximizing Mongolian content while involving and realizing the benefits of the resources in China. Balancing the dual objectives is seen as achievable.

Western companies with recent experience on major industrial developments in China have confirmed the presence of an experienced construction industry capable of working to international standards of quality and completing projects on schedule. The implementation plan assumes that Chinese construction capacity and experience will fill the gaps where Mongolian resources need to be augmented.

It is also assumed that the Chinese road and rail transportation systems can accommodate the movement to site of imported materials required for construction and operations and the shipment off site of all concentrate produced at the process plant. This will need to be confirmed.

The rail system between the southern Gobi area and northern China is expected to be augmented by the construction of a new rail line connecting the anticipated coal field development at Tavan Tolgoi, 140 km northwest of Oyu Tolgoi, to an existing Chinese railhead. Construction of a rail link to this new line is an important requirement for the project in about Year 4 of operations, when concentrate production will exceed the reasonable capacity of the early trucking system. Under the expanded case, three or more trains would be loaded with concentrate every day. Completion of these related developments in time to support Oyu Tolgoi is one of the base assumptions for the IDP.

The Mongolian population generally has a strong basic education, although experienced mine labour is scarce. IMMI is committed to operating the project with a 90% Mongolian workforce within five years of start-up. To make this possible, IMMI has identified the need and allowed funding for a major training initiative that encompasses a dedicated facility, experienced trainers, and modern equipment. During the early production years, experienced expatriate personnel will provide commissioning and training support to help bring the capacity and productivity of Mongolian employees to equivalent Western standards.

The results of a significant program of environmental and socioeconomic assessment suggest that environmental concerns can be managed and that the socioeconomic benefits to Mongolia will be substantial. Two of three Environmental Impact Assessment reports for the project have been submitted. The first was approved by the Mongolian government in May 2004. The second was submitted at the end of June 2005, and the third will be ready later in the year. Approvals of these reports are expected to be a prerequisite to project approval. Regulatory review and approval is assumed to support the proposed project development schedule.

To date no environmental or socioeconomic baseline or assessment work has been conducted for China-related components of the project. The Chinese regulatory approval processes and subsequent construction period associated with rail facilities are also expected to support the project development schedule.

A project risk assessment concluded that although IMMI must address and resolve several critical issues before commencing project development, no risks have been identified that, if managed to a reasonable conclusion, would jeopardize the successful development and operation of the project. It is assumed that a risk mitigation and management system will be implemented.

Based on the AMEC s review, the character of the project is of sufficient merit to justify carrying out the recommended expenditures called for in the IDP.

1.2 Economic Benefit to Mongolia

Based on a report commissioned by IMMI and published in August 2005, the Oyu Tolgoi ***expanded case*** would have the following impacts on the economy of Mongolia between 2002 and 2043:

34.3% (average) increase in real GDP

10.3% (average) increase in employment

11.5% (average) increase in real per capita disposable income

US$7.9 billion (cumulative) increase in government operating balance, excluding debt payments

US$54 billion (cumulative) increase in exports.

1.3 Financial Summary

Table 1-1: Financial Model Discount Rates @ 8% and 10%*

Parameter	Unit	Base Case	Expanded Case
Key Input			
Copper (Cu) average per year	M lb	730	1,007
Gold (Au) average per year	000 oz	258	333
Mine Life	Years	40	35
Initial Capital (to achieve 70,000 t/a)[a]	$M	1,275	1,275
Future & Sustaining Capital	$M	2,673	4,156
Site Operating Costs (average)[b]	$ /t	5.94	5.62
Realization costs (transport to smelter, treatment & refining, royalties)	$ /t	6.32	6.03
Financial Projections			
After Tax Results:			
NPV 8%	$M	2,221	2,706
NPV 10%	$M	1,513	1,852
IRR	%	19.25	19.75
Payback	Years	5.80	6.53
Total Cash Costs /lb Cu (after Au credits)	$	0.39	0.40

* This assessment includes the use of Inferred resources that are considered too speculative geologically to have economic considerations applied to them that would enable them to be categorized as a Mineral Reserve. Inferred resources will require further exploration before they can

be upgraded to the higher Measured and Indicated categories.

Although the assumptions underlying the preliminary assessment are considered reasonable, there is no certainty that the predicted results will be realized.

[a] excludes realization costs

[b] excludes escalation and ramp-up capital

Figure 1-1: Phase 1 Base Case Cash Flow Schedule ($/lb Cu, $/oz Au)

* Value used in financial analysis

Figure 1-2: Phase 2 Expanded Case Cash Flow Schedule ($/lb Cu, $/oz Au)

* Value used in financial analysis

Table 1-2: Project Sensitivities Phase 1 Base Case*

Parameter	Base Value	Change	IRR Change (%)	NPV_8 Change ($M)	NPV_{10} Change ($M)
Gold Price	$400/oz	± $25/oz	0.4	68	57
Copper Price	$1.00/lb	± $0.05/lb	1.2	271	216
Initial Capital	1.274 M	± 10%	1.3	116	113
Site Operating & Transport	$6.78/t	± 10%	0.9	183	149
Smelter Charges $	75/wmt, $0.075/lb	± $10/wmt, $0.01/lb	0.4	93	74
Copper Recovery	90.8% (avg)	± 1% point	0.2	50	40
Power Cost	$0.0426/kWh	± 10%	0.2	46	36

* This assessment includes the use of Inferred resources that are considered too speculative geologically to have economic considerations applied to them that would enable them to be categorized as a Mineral Reserve. Inferred resources will require further exploration before they can be upgraded to the higher Measured and Indicated categories.

Although the assumptions underlying the

preliminary assessment are considered reasonable, there is no certainty that the predicted results will be realized.

Table 1-3: Project Sensitivities Phase 2 Expanded Case*

Parameter	Base Value	Change	IRR Change (%)	NPV_8 Change ($M)	NPV_{10} Change ($M)
Gold Price	$400/oz	± $25/oz	0.4	81	68
Copper Price	$1.00/lb	± $0.05/lb	1.2	346	274
Initial Capital	1.274 M	± 10%	2.1	116	113
Site Operating & Transport	$6.50/t	± 10%	1.0	241	195
Smelter Charges	$75 /wmt, $0.075/lb	± $%, $0.01/lb	0.4	120	94
Copper Recovery	89.7% (avg)	± 1% point	0.2	62	49
Power Cost	$0.0426/kWh	± 10%	0.2	58	46

* This assessment includes the use of Inferred resources that are considered too speculative geologically to have economic considerations applied to them that would enable them to be categorized as a Mineral Reserve. Inferred resources will require further exploration before they can be upgraded to the higher Measured and Indicated categories.

Although the assumptions underlying the preliminary assessment are considered reasonable, there is no certainty that the predicted results will be realized.

1.4 Ore Release Schedules

1.4.1 Phase 1 Base Case

Figure 1-3: Ore Sources and Feed Grades

Figure 1-4: Contained Metal Production, Life-of-Mine

1.4.2 Phase 2 Expanded case

Figure 1-5: Ore Sources and Feed Grades, Life-of-Mine

Figure 1-6: Contained Metal Production, Life-of-Mine

1.5 Development, Capital and Production Schedules

Figure 1-7: Base Case 85,000 t/d, 1st 20 years

Figure 1-8: Expanded Case 140,000 t/d, 1st 20 years

1.6 Mineral Resources

Table 1-4: Mineral Resource Estimate of 3 May 2005

	0.6% Cu Eq. Cutoff			0.3% Cu Eq. Cutoff		
		Grade			Grade	
Mineral Resource Category	Tonnes	Cu %	Au g/t	Tonnes	Cu %	Au g/t
Southern Oyu Deposits						
Measured	101,590,000	0.64	1.10	126,560,000	0.58	0.93
Indicated	465,640,000	0.62	0.43	790,590,000	0.49	0.27
Measured + Indicated	567,230,000	0.62	0.55	917,150,000	0.50	0.36
Inferred	88,500,000	0.47	0.41	78,240,000	0.37	0.18
Hugo Dummett Deposit						
Hugo North						
Indicated	581,930,000	1.89	0.41			
Inferred	581,290,000	1.08	0.32			
Hugo South*						
Indicated						
Inferred	490,330,000	1.05	0.09			
Total Project						
Measured+Indicated	1,149,160,000	1.30	0.47			
Inferred	1,160,120,000	1.02	0.23			

* Resource estimate of June 2004

Figure 1-9: Profile of Orebodies

SECTION 2 INTRODUCTION AND TERMS OF REFERENCE

This technical report summarizes the findings of the IDP study prepared for Ivanhoe Mines Mongolia XXK Inc. (IMMI) by AMEC Auscenco Joint Venture (AAJV), entitled Oyu Tolgoi Project, Mongolia Integrated Development Plan and issued August 2005. AMEC Americas Limited, a partner in the AAJV, was commissioned by Ivanhoe Mines Limited to complete an Independent Qualified Person s Report on the Oyu Tolgoi Project.

Duane Gingrich, P.Eng., an employee of AMEC and the AAJV Study Manager for the IDP, served as the Qualified Person responsible for preparing this technical report as defined in National Instrument 43-101 (N1 43-101) Standards of Disclosure for Mineral Projects, and in compliance with 43-101F1 (the Technical Report). Mr. Gingrich visited the project site on 17 March 2005.

Additional Qualified Person assistance was provided as follows:

Steven Blower, P. Geo., an employee of AMEC, was responsible for preparation of all sections on geology.

Mike Grundy, B. Eng. (Chemical Engineering), Aus.I.M.M., an employee of AMEC, was responsible for preparation of the sections on Metallurgy and Process Plant design.

Bernard Peters, B. Eng. (Mining), Aus.I.M.M. 201743, an employee of GRD Minproc Limited, was responsible for preparation of the section on Open Pit Mining.

Allan Haines, C. Eng, an employee of Steffen Robertson Kirsten (Australasia) Pty Ltd., was responsible for preparation of the subsection on Open Pit Mine Geotechnical.

Scott McIntosh, PE, an employee of McIntosh Engineering Incorporated, was responsible for preparation of Section 19.5 (except those portions attributed to SRK Consulting (Canada), plus the specific reference to the underground operating costs contained in Tables 19-10 and 19-11.

Jarek Jakubec, C. Eng., an employee of SRK Consulting Inc., was responsible for preparation of the subsection on Underground Mine Geotechnical.

Ivanhoe Mines Mongolia Inc. XXK (IMMI) holds mining licences associated with the Oyu Tolgoi project in Mongolia. Since 2000 the property has been the subject of an exploration program that has successfully delineated a large copper-gold resource contained in two deposits suitable for open pit development and two suitable for underground development. During the exploration period, several studies assessed various plant production rates and numerous mine plans. Exploration continues at the property, and mineralized drill intersections have been encountered that have not been categorized or included as part of this evaluation. This document is based on information available at the end of the first quarter 2005 and presents the current vision for developing the property.

The IDP report was prepared to describe the current status of the dynamic Oyu Tolgoi project and to clearly present the current vision for its development. The quality of geological and mineralogical knowledge of the deposits varies from high, for Southwest and Central, to moderate for the components of Hugo North and Hugo South considered in the report. Similarly, confidence levels for mine design and mineral processing and capital and operating cost estimates vary for the different deposits. As a result of these variations, the classification of work performed for the study varies from feasibility study level to scoping study level. The information associated with all levels of work was combined to prepare the economic evaluation for the project; therefore, the overall IDP report quality is classified as a preliminary assessment.

The preparation of the IDP study was coordinated by AMEC Ausenco Joint Venture (AAJV), a joint venture between AMEC E&C Services Limited (AMEC) and Ausenco International Pty. AAJV was also responsible for various other aspects of the study and reviewed the work by others for consistency and reasonableness. However, responsibility for the content of these sections remains with the original author. The main contributors to the report and their associated roles and responsibilities are outlined as follows:

IMMI ((Mongolia/Perth/Vancouver)

- Property ownership & tenure
- Exploration drilling
- Electrical power cost estimate
- Mineral resource model
- Government & public relations
- Financial modelling and analysis

AMEC (Vancouver)

- Mineral resource estimate

AAJV (AMEC/Ausenco Joint Venture) (Perth/Vancouver)

- Coordinate IDP preparation
- Metallurgy & plant design
- On-site, off-site infrastructure design
- Capital & operating costs for process plant, on-site & off-site infrastructure

GRD Minproc Limited (Perth)

- Open pit mine design
- Capital & operating costs for open pit mines

Steffen Robertson Kirsten (Australasia) Pty Ltd. (Perth)

- Geotechnical engineering for open pits

SRK Consulting Inc. (Vancouver)

- Geotechnical engineering associated with underground mines

McIntosh Engineering Inc. (Tempe, Arizona)
Design of block-cave underground mines

Capital & operating costs for underground mines
SGS Lakefield Research Limited (Lakefield, Ontario)
Flotation, gravity-recoverable gold, comminution & leaching testwork

SAG mill pilot plant
MinnovEX Technologies Inc. (Toronto)
Comminution & flotation testwork

Modelling / interpretation
AMMTEC Ltd. (Perth)
Flotation & comminution testwork
Knight Piésold Pty Limited (Perth)
Access road & tailings storage design

Site-wide water balance
Aquaterra Consulting Pty Ltd. (Perth)
Hydrogeology & raw water borefield design
Eco-Trade Co Ltd. (Perth)
2002 environmental baseline study

Environmental Impact Assessment
Sustainability Pty Ltd. (Perth)
Coordinate environmental, archaeological, & socioeconomic assessments

Training systems assessment
Teshmont L.P. Consultants (Winnipeg, Manitoba)
Power supply study
Fluor (Shanghai)
Coal-fired power plant evaluation

SECTION 3 DISCLAIMER

The preparation of the IDP study was coordinated by AMEC Ausenco Joint Venture (AAJV), a joint venture between AMEC E&C Services Limited (AMEC) and Ausenco International Pty. AAJV was also responsible for various other aspects of the study and reviewed the work by others for consistency and reasonableness. However, responsibility for the content of these sections remains with the original author. The main contributors to the report and their associated roles and responsibilities were presented earlier in Section 1. Similarily, for the preparation of this technical report, AMEC has used the information supplied by the additional consultants and Qualified Persons under the assumption that the concepts, design, estimates, and conclusions have been prepared by qualified persons.

This assessment includes the use of Inferred resources that are considered too speculative geologically to have economic considerations applied to them that would enable them to be categorized as a Mineral Reserve. Inferred resources will require further exploration before they can be upgraded to the higher Measured and Indicated categories.

Although the assumptions underlying the preliminary assessment are considered reasonable, there is no certainty that the predicted results will be realized.

The term ore is used for convenience throughout this report to denote material mined or processed. The use of the term is not meant to imply that this material falls within the classification of a Mineral Reserve as determined by the Canadian Institute of Mining and Metallurgy (CIM), the Australasian Joint Ore Reserves Committee (JORC), or other similar bodies.

SECTION 4 PROPERTY DESCRIPTION AND LOCATION

The Oyu Tolgoi property hosts a series of copper-gold mineralized deposits in a mid-Palaeozoic porphyry system. It is located in the Aimag (Province) of Omnogovi in the South Gobi region of Mongolia, about 550 km south of the capital city of Ulaanbaatar and 80 km north of the border with China (see Figure 4-1). The Oyu Tolgoi property is included in Mining Licence 6709A, which covers an area of 8,496 ha centred at latitude 43°00"45"N, longitude 106°51"15"E.

Figure 4-1: Oyu Tolgoi Project Location Map

4.1 Mineral Tenure

IMMI was granted mining licences for the Oyu Tolgoi property and three satellite properties on 23 December 2003 in accordance with the Minerals Law of Mongolia. Also in accordance with this law, IMMI submitted a Scoping Study in February 2004 to support these licences, which give IMMI the right to mine within the bounds of the licence area. The licences are valid for 60 years, with an option for IMMI to acquire a 40-year extension. The licences were converted from exploration licences originally issued on 17 February 1997.

The exploration licence fees were $1.50 /ha in 2002 and 2003 (years six and seven of tenure). Thus, IMMI has paid $12,744 to the Mongolian government each year since acquiring the property. The mining licence fees are as follows:

Years 1 3	$5.00 /ha
Years 4 5	$7.50 /ha
Year 6 on	$10.00 /ha

Surtech International Ltd legally surveyed the Oyu Tolgoi property in August 2002.

In November 2004 IMMI signed an Earn-In Agreement with Entrée Gold Ltd. (Entrée) to explore and potentially develop approximately 40,000 ha of Entrée s 100%-owned, Shivee Tolgoi (Lookout Hill) property, adjacent to Oyu Tolgoi. The agreement, which contains a number of conditions for IMMI to earn a participating interest in the project, will secure for IMMI a long-term option to utilize the optioned property to construct project facilities and give IMMI an interest in the property. The licence area in relation to the surrounding tenements and the property subject to the Entrée Earn-In Agreement are shown in Figure 4-2.

Figure 4-2: Oyu Tolgoi Tenements

4.2 Permits and Agreements

Upon transfer of the exploration licence, IMMI agreed to a 2% NSR royalty with BHP Minerals Exploration International Inc. (BHP). However, this 2% NSR royalty has now been acquired by IMMI.

Royalties payable to the Mongolian government are governed by Article 38 of the Minerals Law of Mongolia, which states: *Royalties shall be equal to 2.5 per cent of the sales value of all products extracted from the mining claim that are sold, shipped for sale, or used. Royalties shall be equal to 7.5 per cent of the sales value of gold extracted from the placer that are sold, shipped for sale, or used.*

When the areas were covered by exploration licences, an environmental plan accompanied the annual work plans submitted to the relevant soum, or district (Khanbogd Soum). The original environmental performance bond was posted in 1998 by BHP and is still retained by the soum for the ongoing work. Further requirements for environmental impact assessment are discussed below.

The soum must also be paid for water and road usage. Payments are computed at the end of each calendar year based on the extent of use.

Archaeological surveys and excavations have been completed in the project area by the Institute of Archaeology of the Mongolian Academy of Science. Archaeological approvals have been granted for disturbance at the site.

SECTION 5 ACCESSIBILITY, CLIMATE, AND PHYSIOGRAPHY

5.1 Location

The Oyu Tolgoi project is in the Aimag of Omnogovi, located in the South Gobi region of Mongolia. The property is approximately 550 km south of the capital city, Ulaanbaatar.

The elevation of the Oyu Tolgoi property ranges from 1,140 m to 1,215 m above sea level. The topography largely consists of gravel-covered plains, with low hills along the northern and western lease borders. Small, scattered rock outcrops and colluvial talus are widespread within the northern, western, and southern parts of the property.

5.1.1 Regional Centres and Infrastructure

There are a number of communities in the South Gobi region. The most prominent is Dalanzadgad, population 15,000, which is the centre of the Omnogovi Aimag and is 220 km northwest of the Oyu Tolgoi property. Facilities at Dalanzadgad include a regional hospital, tertiary technical colleges, a domestic airport, and a 6 MW capacity coal-fired power station. IMMI envisions that Dalanzadgad may be suitable as a regional centre for recruiting and training. The closest community to the property is Khanbogd, the centre of the Khanbogd soum. Khanbogd has a population of approximately 2,500 and is 35 km to the east. Other communities relatively near to the project include Mandalgovi (population 13,500), the capital of the Dundgovi aimag, 310 km north of the project on the road to Ulaanbaatar, Bayan Ovoo (population 1,600), 55 km to the west, and Manlai (population 2,400), 150 km to the north.

5.1.2 Transportation Infrastructure

Access to the property from the Mongolian capital, Ulaanbaatar, is possible either by an unpaved road, via Mandalgovi, a 12-hour drive under good conditions, or by air. IMMI has constructed a 2,000 m long gravel airstrip at the site and routinely receives flights from Ulaanbaatar. The Trans-Mongolian Railway crosses the Mongolia-China border approximately 420 km east of the property, traversing the country from southeast to northwest through Ulaanbaatar to the border with Russia. At the Mongolian-Chinese border the rail gauge changes from the Russian standard to the Chinese standard. A desert trail connects the rail line at Sajn Sand to the site.

The Chinese government has upgraded 226 km of road from Ganqimaodao to Wuyuan, providing a direct road link between the Mongolian border crossing at Gushaan Suhait, 80 km south of Oyu Tolgoi, and the Trans-China Railway system. A rough track/trail crosses the desert from the Mongolian border to the site.

Ulaanbaatar has an international airport, and Mandalgovi and Dalanzadgad have regional airports. There is currently charter air service between the site and Ulaanbaatar. The closest regional airport in China is at Hohhot. There are no airport facilities at Wuyuan or Bayan Obo.

5.2 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. Typical of desert climates, the site has low average humidity and significant variations in daily temperatures.

Knight Piésold conducted an extensive evaluation of the available climatic information for the project area using regional data from bibliographical sources and local data from nearby climate stations.

Data Sources

Data were derived primarily from climatic records for Byan Ovoo, approximately 75 km west of Oyu Tolgoi, and from two years of available Oyu Tolgoi site data. Although these data have some limitations they are considered adequate for use in design. Data were also obtained from Khanbogd, approximately 45 km northeast of the site, Dalanzadgad, 220 km northwest, and Hailutu, 200 km southwest, but the information from Byan Ovoo was deemed the most representative of conditions at Oyu Tolgoi.

Air Temperature

Temperatures range from an extreme maximum of about 50°C to an extreme minimum of about -34°C. The typical air temperature in wintertime fluctuates between 6°C and -21°C. In the coldest month, January, the average temperature is -21°C. Data from Byan Ovoo are shown in Table 5-1.

Table 5-1: Monthly Temperatures (°C) based on Byan Ovoo Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	-34.2	-33.3	-24.9	-21.7	-12.7	0.4	4.1	2.6	-4.6	-20.0	-26.5	-33.4
Average	-12.5	-8.0	-0.4	9.3	17.9	23.4	25.4	22.7	16.5	7.2	-2.9	-10.3
Maximum	9.0	16.2	24.0	31.0	38.4	49.9	40.2	39.0	39.0	29.8	25.3	14.0

Relative Humidity

The average relative humidity ranges from 18.7% in May to 53.3% in January. Daily relative humidity is dependent on current temperature and varies considerably. Table 5-2 shows monthly relative humidity statistics using the calculated hourly averages from the site weather station. The design relative humidity for summer is based on an analysis of the July 2002 and 2003 hourly temperatures and corresponding relative humidity values. The design relative humidity for a July 1 temperature of 34.5°C is 15.1%.

Table 5-2: Monthly Relative Humidity

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	19.0	12.5	3.0	2.0	1.0	1.5	4.5	8.0	1.0	2.0	5.5	10.5
Average	53.3	38.3	23.5	24.3	18.7	31.3	37.4	36.4	34.4	30.4	40.7	43.5
Maximum	81.5	67.0	88.0	89.5	100.0	96.5	100.0	100.0	100.0	81.0	85.0	80.5

Ground Temperature

From the data available to date, the minimum recorded ground temperature is -39°C and the maximum is 70°C. Table 5-3 shows the design freezing depths at the site based on the Mongolian Climate Data and Geophysical Parameters for Use in Construction Design Code Document No. CNR 2.01-01-93.

Table 5-3: Design Soil Freezing Depths

Soil Type	Freezing depth (m)
Clayey soil	1.5
Sandy soil	1.9
Gravely soil	2.2

Solar Radiation

Solar radiation data have been collected at the Oyu Tolgoi site station since 2002. Solar radiation is measured in W/m^2 and fluctuates during the day, ranging from 0 W/m^2 at night and peaking soon after mid-day. The average daily maximum for the two years of data available is 655 W/m^2, the highest daily maximum is 1,030 W/m^2, and the lowest daily maximum is 76 W/m^2.

Maximum levels of solar radiation are lower during the winter. The average daily maximum is 429 W/m^2 for January and 859 W/m^2 for July.

Precipitation

Average annual precipitation is 57 mm/a, 90% of which falls as rain and the rest as snow. Snowfall accumulations rarely exceed 50 mm. Maximum rainfall events of up to 43 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. The ground snow load is 0.1 kPa. Monthly rainfall data are shown in Table 5-4 and Table 5-5. Both tables are derived from Byan Ovoo data for 1975 to 2002.

Table 5-4: Rainfall Summary (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Maximum daily	2.1	3.8	4.4	10.4	19.0	16.2	29.5	102.0	19.2	4.0	4.3	1.5	
Average monthly	0.4	0.4	0.8	1.4	3.1	8.1	18.1	17.8	5.0	0.9	0.6	0.2	56.8
Average rain-days per month	0.6	0.6	1.0	0.8	1.5	3.0	4.5	3.9	1.4	0.6	0.7	0.4	19.0

Table 5-5: Rainfall Intensities (mm/h)

Return Interval Duration	1 in 2 Years	1 in 10 Years	1 in 20 Years	1 in 50 Years	1 in 100 Years	1 in 500 Years
10 minutes	15.4	44.2	63.5	99.8	138.3	284.2
30 minutes	10.0	28.7	41.3	64.8	89.9	187.7
60 minutes	6.8	19.5	28.0	44.0	60.9	125.2
2 hours	4.3	12.3	17.7	27.8	38.6	79.3
3 hours	3.2	9.2	13.3	20.9	28.9	59.4
6 hours	1.9	5.5	7.9	12.4	17.2	35.4
12 hours	1.1	3.2	4.6	7.3	10.1	20.7
24 hours	0.7	1.9	2.7	4.2	5.9	12.0
48 hours	0.4	1.1	1.5	2.3	3.2	6.3
72 hours	0.3	0.8	1.0	1.6	2.2	4.2

Thunderstorms and Lightning

Local records indicate that thunderstorms are likely to occur from 2 to 8 days each year at Oyu Tolgoi. Electrical activity generally totals about 29 hours each year. An average storm will have up to 83 lightning flashes a minute.

Evaporation

Given the importance of this variable for determining project water requirements, a number of different methods were used to generate and analyze evaporation data to determine design levels. The results are summarized in Table 5-6. It should be noted that site measurements are ongoing to confirm these results.

Table 5-6: Design Evaporation Data

		Evaporation	
Month	Sublimation (waterbodies frozen in winter) (mm)	Winter (open waterbodies) (mm)	Summer (open waterbodies) (mm)
January	22	82	
February	41	101	
March			142
April			256
May			439
June			378
July			382
August			285
September			192
October			132
November	53	11	
December	27	88	

Total Water Loss: Sublimation + Evaporation = 2,349 mm

Wind Loading and Dust Generation

Wind is usually present at the site, predominantly from the north. Very high winds are accompanied by sandstorms that often severely reduce visibility for several hours at a time. At present, site-specific wind monitoring data are available for only a short period of time, less than a year. Based on regional information, windstorms can have gusts up to 50 m/s. Snowstorms and blizzards with winds up to 40 m/s occur in the Gobi region for 5 to 8 days each winter. Spring dust storms are far more frequent and can continue through June and July. The average storm duration is 6 to 7 hours. An average of 120 hours of dust storm activity and 220 hours of drifting dust are recorded each year.

Based on the Mongolian Code, the Basic Wind Speed is 34 m/s. Maximum one-hour speeds recorded at Byan Ovoo are shown in Table 5-7. The number of dust days per year is shown in Table 5-8.

Table 5-7: Maximum One-Hour Wind Speeds (m/s) at Byan Ovoo

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum wind speed	13.4	14.0	15.4	18.1	16.6	16.2	16.3	14.8	16.0	18.6	19.3	14.5

Table 5-8: Frequency of Dust Storms in the Gobi Desert

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of days	0.7	1.0	2.4	4.7	4.1	1.5	1.0	0.4	0.6	0.7	1.9	0.7

5.3 Physiography

The region is covered by sparse semi-desert vegetation and is used by nomadic herders who tend camels, goats, and sheep. Several ephemeral streams cross the lease area and flow for short periods immediately after rainfall. Water is widely available from shallow wells.

The Oyu Tolgoi property is relatively flat, with occasional exposed bedrock. This topography will be amenable for the construction of the infrastructure, including the tailings storage facility, permanent and construction accommodations, and the processing plant.

5.4 Seismicity

5.4.1 General

Knight Piésold has completed a seismic hazard assessment of the Oyu Tolgoi site. The seismicity of the Oyu Tolgoi site was determined to be low, and the seismicity of eastern Mongolia is generally low. However, to the west of Oyu Tolgoi lies the Mongolian Altai a tectonically active mountain range stretching 1,700 km from southwest Siberia to the Gobi Desert. The easternmost extension of the Mongolian Altai is known as the Gobi Altai, which dies out approximately 50 to 100 km west of Oyu Tolgoi.

5.4.2 Mongolian Seismology Centre

The Research Centre for Astronomy and Geophysics of Academy of Science (Seismology Centre) is responsible for assessing seismology in Mongolia. IMMI appointed the Seismology Centre to perform a seismic assessment for the project. This work has been completed and the findings incorporated into the assessment by Knight Piésold.

5.4.3 Analysis and Conclusions

Based on the assessment, appropriate seismic design parameters were selected:

For plant site structures, the maximum acceleration associated with an earthquake with a return period of 475 years (10% chance of exceedance in 50 years) is 0.06g. This makes it a UBC Zone 1, which is recommended for design. For the Russian building code SNIP II-7-821, a seismic intensity rating of VI (6) would be used for the design of common facilities and of VII (7) for critical facilities at Oyu Tolgoi.

The foundation factor is defined by the soil profile. The site will mainly have foundation on rock or on dense or very stiff soil less than 15 m in depth. There are no areas of deeper loose or soft soils or soils that may liquefy.

For design of the tailings storage facility:

The operating basis earthquake (OBE) was selected as the earthquake with a 475-year return period. Assuming a design life of 30 years for the tailings facility, the probability of exceedance is 6%. The maximum acceleration for the 475-year-return-period earthquake is 0.06g. A conservative design magnitude of M7.5 has been selected for the OBE.

Considering the consequences of failure (safety of life, economics, social and environmental impacts), the hazard classification of the tailings facility is high.

The maximum design earthquake (MDE) with a maximum bedrock acceleration of 0.08g (1,000-year-return-period event) and design magnitude of M7.8 has been adopted.

SECTION 6 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 at the Central deposit and evidence of alteration and copper mineralization at the South deposit.

In 1996, geologists from Magma Copper Company identified a porphyry copper leached cap nearby and secured exploration tenements in late 1996. Magma was subsequently acquired by BHP.

Geophysical surveying at Oyu Tolgoi was first initiated by BHP in 1996. An airborne magnetometer survey was flown at a height of approximately 100 m on 300 m spaced, east-west oriented lines over approximately 1,120 km^2 of BHP s mineral concession. The survey provided good resolution of the magnetic features to facilitate geological and structural interpretation across the concession areas. BHP also undertook an induced polarization (IP) survey utilizing a single gradient array with a 2,000 m AB and a ground magnetometer survey. Both surveys were conducted on east-west-oriented lines surveyed by a local Mongolian surveying team at 250 m spacing. The surveys covered Southern, Southwest, Central, and North Oyu exploration targets but did not extend into the Far North region that ultimately became the Hugo Dummett deposit.

BHP carried out geological, geochemical, and geophysical surveys and diamond drilling programs (23 holes total) in the Central and South deposits in 1997 and 1998. Copper and gold were encountered at depths from 20 m to 70 m below surface. Based on the results of this drilling, BHP estimated a preliminary resource of 438 Mt, averaging 0.48% copper and 0.25 g/t gold, early in 1999. The historical resource estimate pre-dates National Instrument 43-101 and is not necessarily in accordance with the resource classification categories prescribed therein.

BHP then halted its exploration in Mongolia and offered its properties for joint venture. IMMI visited Oyu Tolgoi in May 1999 and made an agreement to acquire 100% interest in the property, subject to a 2% Net Smelter Royalty (NSR).

In 2000, IMMI completed 8,000 m of reverse circulation (RC) drilling, mainly at the Central deposit, to explore the chalcocite blanket discovered earlier by BHP. Based on this drilling, IMMI estimated an Indicated resource of 31.7 Mt at 0.80% copper and an additional Inferred resource of 11.2 Mt grading 0.78% copper for the chalcocite blanket. The historical resource estimate pre-dates National Instrument 43-101 and is not necessarily in accordance with the resource classification categories prescribed therein.

In 2001, IMMI continued RC drilling, mostly in the South deposit area, to test possible oxide resources, and then drilled three diamond core holes to test the deep hypogene copper-gold potential. Hole 150 intersected 508 m of chalcopyrite-rich mineralization grading 0.81% copper and 1.17 g/t gold; hole 159 intersected a 49 m thick chalcocite blanket grading 1.17% copper and 0.21 g/t gold, followed by 252 m of hypogene covellite mineralization grading 0.61% copper and 0.11 g/t gold.

These results encouraged IMMI to mount a major follow-up drill program. In late 2002, drilling in the far northern section of the property intersected 638 m of bornite-chalcopyrite-rich mineralization in hole 270, starting at a depth of 222 m. This hole marked the discovery of the Hugo Dummett deposit.

IMMI completed all of its earn-in requirements by June 2002 and acquired the 2% NSR royalty retained by BHP in November 2003. As a result, IMMI became the sole owner of the property.

SECTION 7 GEOLOGICAL SETTING

This section has been copied verbatim from the May 2005 Technical Report on the Oyu Tolgoi Mineral Resource estimate (Juras, 2005).

7.1 Regional Geology

The Oyu Tolgoi camp in southern Mongolia lies within the Paleozoic Gurvansayhan Terrane, which consists of highly-deformed accretionary complexes and oceanic island arc assemblages (Badarch et al., 2002). The Gurvansayhan Terrane is itself a component of the Altaid orogenic collage a continental-scale belt dominated by collisional tectonics related to Late Paleozoic convergence and rotation of Neoproterozoic and pre-0.6 Ga cratonic blocks. In the region surrounding Oyu Tolgoi, the Altaid orogenic collage forms a broad corridor of major strike-slip faults, contractional fault and fold belts, and fault-controlled Mesozoic sedimentary basins. Major structures in this area include the Gobi-Tien Shan sinistral strike-slip fault system, which 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 overthrust by basement blocks to the north and northwest of Oyu Tolgoi (Figure 7-1). To the east of Oyu Tolgoi, regional structures are dominated by the northeast-striking East Mongolian Fault Zone, which forms the southeastern boundary of the Gurvansayhan Terrane. This regional fault may have formed as a major suture during Late Paleozoic terrane assembly, with Mesozoic reactivation leading to the formation of northeasterly-elongate sedimentary basins along the fault trace.

Figure 7-1: Location of Oyu Tolgoi, Gurvansayhan Terrane, and Major Cenozoic Faults in Southern Mongolia

The present morphology and structure of southern Mongolia largely reflect the influences of Mesozoic to Cenozoic intra-plate deformation events. The principal recognized deformation episodes include: 1) Late Jurassic to Cretaceous north-south extension, accompanied by the intrusion of granitoid bodies, unroofing of metamorphic core complexes, and formation of extensional and transpressional sedimentary basins; and 2) superimposed northeast-southwest shortening associated with major strike-slip faulting and folding within the Mesozoic basins.

7.2 Property Geological Units

7.2.1 Stratified Rocks

The Oyu Tolgoi area lies within an east-west-trending belt of Devonian-Carboniferous volcanic and sedimentary rocks of continental margin and island arc affinities, constituting the South Mongolia Volcanic Belt. Two major stratigraphic sequences are recognized in the project area (Figure 7-2): 1) tuffs, basaltic rocks, and sedimentary strata of probable island arc affinity, assigned to the Upper Devonian Alagbayan Formation; and 2) an overlying succession containing conglomerates, fossiliferous marine siltstones, sandstones, waterlain tuffs, and basaltic to andesitic flows and volcaniclastic rocks, assigned to the carboniferous Sainshandhudag Formation. The two sequences are separated by a regional unconformity that, in the Oyu Tolgoi area, is associated with a time gap of 10 Ma to 15 Ma.

A thin covering of gently-dipping to horizontal Cretaceous stratified clays and clay-rich gravels overlies the Paleozoic sequence, infilling paleochannels, and small fault-controlled basins.

Devonian Alagbayan Formation

The oldest rocks identified at Oyu Tolgoi are correlated with the Upper Devonian Alagbayan Formation. They subcrop in the area around and to the west of the South and Southwest Oyu deposits, and are intersected in drill holes in all of the deposit areas. Four major lithologic divisions are present within the Alagbayan Formation, and each of these divisions comprises two or more mappable subunits. The two lower units are commonly strongly altered and form important ore hosts, while the upper two units, although pre- to syn-mineral in age, lack significant alteration and mineralization.

Unit DA1: Basaltic Flows and Volcaniclastic Rocks

The stratigraphically lowest rocks identified to date at Oyu Tolgoi consist of mafic volcanic flows and volcanogenic sedimentary rocks, forming a sequence at least several hundred metres in thickness. These rocks are commonly strongly altered and host much of the contained copper in the Southern Oyu and Hugo Dummett deposits.

Figure 7-2: Stratigraphic Column of Paleozoic Bedrock Units in the Oyu Tolgoi Project Area

Three main lithotypes are present in the lower sequence. Lowest is a subunit consisting of grey to green finely-laminated volcanogenic siltstone and interbedded fine sandstone. These rocks are overlain by and partially interbedded with dark green, massive porphyritic (augite) basalt, characterized by up to 35% phenocrysts in a fine-grained pilotaxitic matrix of plagioclase and augite. The third principal rock type is monolithologic to slightly polylithic basaltic lapilli tuff to volcaniclastic conglomerate/breccia, occurring above or partially interbedded with the massive augite basalt.

Unit DA2: Dacite Tuff / Volcaniclastic Rocks

Volcanic fragmental rocks of dacitic composition overlie the basaltic rocks of unit DA1 and form an important ore host in parts of the Hugo South deposit. The dacite sequence can be up to 200 m thick and consists of two major divisions. Volumetrically dominant is buff to dark green, dacite lapilli tuff with common eutaxitic texture and ovoid to globular fragments. This subunit occurs in the lower part of the sequence and is usually overprinted by intense sericite and advanced argillic alteration. It is overlain by or partially interstratified with a thinner unit of typically unsorted, polymictic block tuff to breccia. This coarser subunit is usually less altered than the lapilli tuff and does not contain significant copper mineralization.

A zircon U/Pb date of 365+/-4 Ma from the Hugo Dummett deposit constrains the age of the dacite sequence to Upper Devonian (Wainwright et al., 2005).

Unit DA3: Clastic Sedimentary Sequence

A clastic sedimentary sequence that overlies the dacite marks an important change in stratigraphic style that is recognizable throughout the Oyu Tolgoi project area. This clastic sequence is only weakly altered and measures up to approximately 100 m in thickness. Two main rock types are present. A finer subunit consisting of rhythmically interbedded carbonaceous siltstone and fine brown sandstone forms a lithologically distinctive unit overlying the top of the dacite. This unit is ubiquitous in drill holes in Hugo North and is also discontinuously distributed in the more southerly deposits. A second subunit characterized by polylithic conglomerate, sandstone, and siltstone is abundant in the South Oyu deposits and parts of the Hugo South deposit. The conglomerate typically has a muddy matrix, and is transitional downward to boulder conglomerate and volcanic breccia at the top of the underlying dacite sequence. Cross-cutting relationships with radiometrically-dated units constrain the age of these clastic strata to Upper Devonian.

Unit DA4 Basaltic Flows / Fragmental Rocks, Siltstone

The uppermost strata of the Alagbayan Formation at Oyu Tolgoi comprise a sequence of basaltic flows and volcaniclastic rocks, overlain by and partly interstratified with thinly-bedded siltstone and massive sandstone. Together with unit DA3, these strata form a weakly-altered to unaltered, pre- to syn-mineralization cover sequence to the Oyu Tolgoi deposits averaging around 600 m thick.

Basaltic composition, dark green volcanic breccia with vesicular, fine-grained to coarsely porphyritic basaltic clasts is the dominant lithotype in the upper Alagbayan Formation. These breccias are commonly interstratified with volcanogenic sandstones and conglomerates that appear to be directly derived from the basalts. Middle parts of unit DA4 are dominated by thinly-interbedded red and green siltstone, which contain subordinate basalt layers in their lower levels. Uppermost strata of the unit are massive green to grey sandstone with rare siltstone interbeds.

Lower Carboniferous Sainshandhudag Formation

The Lower Carboniferous Sainshandhudag Formation forms the upper of the two major stratigraphic packages at Oyu Tolgoi. The unit post-dates porphyry mineralization and is separated from the underlying Devonian rocks by a regional unconformity. Radiometric dates and biostratigraphic correlations suggest the unconformity spans a time gap of 10 Ma to 15 Ma, omitting most of the Famennian (Upper Devonian) and Tournaisian (Lower Carboniferous) stages.

The Sainshandhudag Formation is divided into three major units at Oyu Tolgoi: a lowermost tuffaceous sequence, an intermediate clastic package, and an uppermost volcanic/volcaniclastic sequence.

Unit CS1: Andesitic Lapilli Tuff and Volcaniclastic Rocks

Lowest strata within the Sainshandhudag Formation in the Oyu Tolgoi area consist of andesitic lapilli tuff with abundant fiamme, and subordinate block tuff to breccia. These rocks are characterized by a crowded feldspar phenocryst-rich matrix and angular lithic clasts, which are invariably fine-grained and non-porphyritic.

The andesitic tuff is widely distributed in the Oyu Tolgoi area and measures up to 200 m in thickness. It is absent from the base of the Sainshandhudag Formation in several drill holes along the east side of the Hugo Dummett deposit, where higher units in the Sainshandhudag Formation disconformably overlie Devonian strata.

A U/Pb zircon date obtained from the Hugo Dummett deposit area suggests an age of 351 ± 2 Ma for the andesitic tuff/volcaniclastic unit (Wainwright et al., 2005).

Unit CS2: Conglomerate, Sandstone, Tuff, and Coal

A clastic sedimentary sequence overlies the lower andesitic package and measures up to 200 m in thickness. The sequence typically shows a progression from a lower conglomerate-sandstone-siltstone dominant unit to an overlying siltstone-waterlain tuff unit. Carbonaceous siltstone and coal beds occur in the lower part of the sequence.

Abundant marine and plant fossils constrain an Upper Tournaisian-Lower Visean (Lower Carboniferous) age for the unit.

Unit CS3: Basaltic and Andesite Lava and Volcaniclastic Rocks

The uppermost division of the Sainshandhudag Formation consists of a thick sequence of andesitic to basaltic flows and volcaniclastic rocks comprising several subunits. These subunits include, in order of superposition, a basal thin volcanic sandstone, a discontinuous porphyritic basaltic andesitic lava sequence, a thick basaltic breccia-to-block tuff unit, and an interstratified- to overlying-porphyritic basalt flow sequence. Together, these units can measure over 800 m in thickness.

7.2.2 Intrusive Rocks

Intrusive rocks are widely distributed through the Oyu Tolgoi area and range from large batholithic intrusions to narrow discontinuous dykes and sills. At least seven classes of intrusive rocks can be defined on the basis of compositional and textural characteristics. Copper-gold porphyry mineralization is related to the oldest recognized intrusive suite, comprising large Devonian quartz monzodiorite intrusions that occur in all of the deposit areas. Many of the older intrusive units found on the property are strongly to intensely altered (e.g., quartz monzodiorite suite), and the compositional classifications used for these units should therefore be considered only as field terms.

Basalt / Dolerite

Mafic dykes are the youngest intrusive rocks recognized on the Oyu Tolgoi property and intrude all stratified units. They are typically aphanitic to fine-grained, locally vesicular, and contain variable amounts of plagioclase phenocrysts. In the deposit area, they are limited to dykes from metres to at most a few tens of metres wide, but in the southwest part of the property they may also occur as large, sill-like intrusive masses. This class of intrusions includes a strongly magnetic, north-striking subvertical dolerite dyke that cuts across the Hugo Dummett deposit.

Rhyolite

Rhyolite dykes and sills are abundant throughout the property and measure up to a few metres to tens of metres wide, with strike extents of hundreds of metres. Except where emplaced as sills, they typically have steep dips, and strike orientations are variable. Texturally they are aphanitic and aphyric. Intrusive breccias are common along dyke contacts, commonly incorporating both rhyolitic and wall rock fragments within a flow-banded groundmass. U/Pb zircon dates obtained from the rhyolite dykes are 335 ± 3.1 Ma (Wainwright et al., 2005).

Hornblende Biotite Andesite, Dacite

Hornblende biotite andesite and dacite dykes occur in all of the deposit areas, but usually are less volumetrically significant than other intrusive units. Both units are part of a trachyte suite, which may be genetically related to flows and pyroclastic units of the Sainshandhudag Formation. They are typically strongly porphyritic with feldspar, hornblende, and biotite. Quartz phenocrysts are common within the dacite dykes.

Biotite Granodiorite

Late- to post-mineral biotite granodiorite intrusions form a voluminous dyke system along the western side of the Hugo Dummett deposit and the more-restricted dykes and sills elsewhere. The intrusions are compositionally and texturally varied and likely include several intrusive phases. Typically, they contain large plagioclase phenocrysts with lesser small biotite phenocrysts, within a fine-grained to aphanitic brown groundmass. In the Hugo Dummett deposit, the age of the biotite granodiorite is constrained by U/Pb dating of zircon to 362 ± 4 Ma (Wainwright et al., 2005).

Quartz Monzodiorite

Porphyry-style mineralization at Oyu Tolgoi is genetically linked to Late Devonian quartz monzodiorite to monzodiorite intrusions, which form the most voluminous intrusions in the deposit area. These intrusions are texturally and compositionally varied, and several distinct phases can be distinguished within the deposits. They are typically phenocryst-crowded, with >40% plagioclase phenocrysts up to 5 mm long, and 10% to 15% biotite and hornblende. Preliminary U/Pb zircon ages of 370.6 Ma and 378 Ma have been obtained from unaltered and altered phases of the quartz monzodiorite in the Southwest Oyu deposit. These dates are at odds with the younger ages obtained from the dacite tuff country rocks and require further analysis. The form and characteristics of the quartz monzodiorite subunits are described in more detail in the following individual deposit descriptions.

Northwest Granitic Complex

The Oyu Tolgoi deposit area is bounded on the northwest by a large, polyphase granitic complex. Intrusive phases recognized in this complex include syenite, granite, quartz monzonite, quartz diorite, and quartz syenite. The temporal relationships between these different compositional phases have not been documented, and the only radiometric date obtained to date is a U/Pb zircon age of 348 Ma (Wainwright et al., 2005), implying that the complex post-dates mineralization at Oyu Tolgoi. The Northwest Granitic Complex is separated from older rocks of the deposit area by the northeast-striking, steeply northwest-dipping North Boundary Fault. The movement history of this fault is uncertain, and it may largely be the result of movement focused along the intrusive contact during post-intrusion deformation.

Hanbogd Complex

The Early Permian Hanbogd alkaline granite complex is a large, circular intrusion exposed just east of the Oyu Tolgoi property. The complex has a concentric structure defined by abundant pegmatite (dykes enriched in rare earth elements and Zr. The Hanbogd Complex has a flat roof, as indicated by numerous basaltic wall rock roof pendants, and may therefore have a pancake or lopolithic intrusive form.

7.3 Property Structural Geology

The Oyu Tolgoi project area is underlain by complex networks of faults, folds, and shear zones (Figure 7-3). Most of these structures are poorly exposed on surface and can only be defined through integration of detailed exploration data (primarily drill hole data), property-scale geological mapping, and geophysical data. Ivanhoe has made extensive use of oriented core drilling at Oyu Tolgoi, and the structural data collected has been invaluable in helping determine the subsurface morphology and structural history of the project area. Major structures in the project area strongly influence the distribution of mineralization by both controlling the original position and form of mineralized bodies, and modifying them during post-mineral deformation events.

7.3.1 Solongo Fault

The Solongo Fault is an east- to east-northeast-striking, subvertical structure that cuts across the Oyu Tolgoi property just south of the Southwest Oyu and South Oyu deposits. All of the significant mineralization discovered to date on the Oyu Tolgoi property is on the northern block of this fault.

The Solongo Fault typically occurs as a strongly tectonized, foliated zone up to several tens of metres wide. Rhyolite dykes commonly intrude the fault zone, and themselves have tectonically brecciated margins. On ground magnetic data, the fault forms a major linear anomaly that can be traced across the entire width of the Oyu Tolgoi property.

Figure 7-3: Simplified Geological Map of Oyu Tolgoi Concession

Note: Shows distribution of stratigraphic and intrusive units and major structural features of the western two-thirds of the concession

The Solongo Fault forms a major structural break, and there is a minimum of approximately 1,600 m of south-side-down stratigraphic offset where it juxtaposes mineralized basalt (unit DA1b) in the South Oyu deposit against sediments correlated with the upper Alagbayan Formation (unit DA4) to the south. Depending on movement direction, net slip may be considerably greater. The displacement history of the Solongo Fault is poorly constrained. The fault clearly existed prior to emplacement of rhyolite dykes, which are part of a suite dated at 335 ± 3 Ma. Rhyolite dykes locally cross the fault with little or no apparent displacement, implying that movement since their emplacement was negligible.

7.3.2 Northwest Shear Zone

The Northwest Shear Zone is a wide, ductile shear zone that cuts across the far northwest corner of the Oyu Tolgoi project area (Figure 7-3). This shear zone consists of mylonitic to ultramylonitic rocks in the centre, grading outward over about 200 m to rocks lacking visible ductile strain. Together with the Boundary Fault, the shear zone marks the break between the volcanic and sedimentary strata hosting and surrounding the Oyu Tolgoi deposits (Alagbayan and Sainshandhudag formations), and the carboniferous granitic complex exposed on the northwestern corner of the property. Ubiquitous subhorizontal stretching lineation, asymmetric mesoscopic fabrics (shear bands, asymmetric porphyroclasts), and map-scale deflections of dykes indicate that the Northwest Shear Zone accommodated dominantly dextral strike-slip movement. The magnitude of displacement is not closely constrained, but the geometry of deformed dykes in the shear zone indicates that at least several kilometres of displacement have occurred. Deformed quartz-feldspar porphyry dykes in the shear zone are geochemically identical to the rhyolite intrusions in the deposit area, and have produced an identical U/Pb age of 335 ± 3 Ma, placing a maximum age on shear zone deformation; no minimum age is constrained.

7.3.3 Central Fault

The Central Fault is a west-northwest-striking, moderately north-dipping structure that lies between the Hugo South and Central Oyu deposits. It occurs in numerous drill hole intersections in Hugo South, and its surface trace coincides with a strong linear magnetic anomaly.

Stratigraphic distribution across the Central Fault shows conflicting stratigraphic relationships at different levels. The fault consists of several splays and may have experienced multiple periods of displacement. The simplest interpretation of geological relationships is that early fault displacement resulted in north-side-down apparent offset, followed by a later apparent reverse displacement of lesser magnitude. Stratigraphic evidence suggests the Central Fault may have been active as a Late Devonian growth fault. However, the fault is clearly visible as a linear magnetic feature cutting the overlying Sainshandhudag Formation, implying that movement continued into the carboniferous or later.

7.3.4 Axial Fault, West Bat, East Bat Faults

The alignment of the Southwest Oyu, Central Oyu, and Hugo Dummett deposits, along with the elongate form of the Hugo Dummett deposit itself, strongly implies that an underlying north-northeast-striking fault or fault zone (referred to as the Axial Fault) controlled emplacement of porphyry intrusions and related hydrothermal activity. For example, the tabular, north-northeast-elongate form of the biotite granodiorite dyke complex that follows the west side of the deposit may reflect fault-controlled intrusion.

The Hugo Dummett deposit lies within a north-northeast-trending structural high bounded by the West Bat and East Bat faults. Although the latest movement on these bounding faults displaces post-mineral strata, they may represent the shallow expression of a longer-lived, deposit-controlling fault zone. Offsets of post-mineral stratigraphic contacts measure at least a kilometre (east-side up) for the West Bat Fault, and 200 m to 300 m (west-side-up) for the East Bat Fault. For both of these structures, the true slip direction is uncertain, and if there is a large strike-slip component of movement, total displacement may be significantly greater than stratigraphic offset.

7.3.5 Boundary Fault System

Roughly coincident with the northern boundary of the Oyu Tolgoi concession, an east-northeast-striking fault zone juxtaposes the Devonian sequence hosting and overlying the Oyu Tolgoi deposits against the carboniferous granitic complex to the north. Faults within this system include the North Boundary Fault, a splay of the North Boundary Fault, and the Boundary Fault. These faults dip steeply to the north or northwest, and occur as strongly-developed, foliated gouge and breccia zones ranging from decimetres to several tens of metres wide. They juxtapose younger rocks (north block) over older (south block), but true displacement direction and magnitude are poorly constrained.

7.3.6 Northeast-Striking Secondary Faults

Magnetic and satellite images show a strong northeast to east-northeast linear structural fabric cutting across parts of the Oyu Tolgoi property. Many of these lineaments can be correlated with faults identified in drill holes (e.g., East Bounding and West Bounding faults at the Southwest Oyu deposit), but others occur in areas where few or no drill holes have been completed, and may mark the positions of undocumented faults. Northeast-striking faults in the Southwest Oyu deposit form a primary control on the distribution of copper and gold mineralization, and the presence of mineralized clasts within the fault zones implies that they were also active following mineralization. Other northeast-striking faults displace stratigraphic contacts in the Lower carboniferous Sainshandhudag Formation near the South Oyu deposit.

7.3.7 Folds

Variations in bedding attitude recorded in both oriented drill core and surface outcrops define two orientations of folds on the Oyu Tolgoi property: 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 and Alagbayan formations. They are likely present in stratified rocks throughout the property, but outcrop and drill hole data are insufficient to define them in many areas.

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

Sedimentary facing direction indicators in drill holes along the east flank of the Hugo Dummett deposit indicate that parts of the upper Alagbayan Formation are overturned. The overturning is interpreted to be associated with tight to isoclinal folds. These folds are cut by biotite granodiorite dykes, and therefore most were formed within the Late Devonian.

7.4 Southern Oyu Deposits

The Southern Oyu deposits include the Southwest Oyu or Southwest, South Oyu or South, Wedge Zone of Wedge, and Central Oyu or Central deposits. These deposits form contiguous zones of mineralization representing multiple mineralizing centres, each with distinct styles of mineralization, alteration, and host rock lithology. The boundaries between the individual deposits coincide with major fault zones (Figure 7-3). Strong, high-sulphidation mineralization and associated advanced argillic alteration, hosted by dacite tuff and quartz monzodiorite, are characteristic of the Central and Wedge deposits. The mineralization grades downward into chalcopyrite-gold mineralization with associated biotite-chlorite alteration hosted within basalt. At Southwest the dacite tuff and overlying strata have been removed by erosion, exposing deeper-level chalcopyrite-gold mineralization with associated biotite-chlorite alteration, hosted within basalt. Mineralization at the South deposit is chalcopyrite-bornite dominant with associated biotite-chlorite alteration, and is hosted within quartz monzodiorite, basalt, and dacite tuff.

7.4.1 Southwest Oyu Deposit

Host Rocks

The Southwest Oyu or Southwest deposit is a Au-rich porphyry system characterized by a southwest-plunging, pipe-like geometry with over a 700 m vertical extent. Over 80% of the deposit is hosted by massive to fragmental porphyritic basalt of the Upper Devonian Alagbayan Formation, 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. These include 1) early-strongly-altered quartz-veined dykes mainly limited to the high-grade central deposit core (informally referred to as OT-Qmd); 2) superimposed younger fragmental dykes entraining early quartz vein clasts but lacking strong sulphide mineralization (informally referred to as xQmd); and 3) voluminous massive quartz monzodiorite containing weaker mineralization, flanking and underlying the high-grade deposit core.

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

Structural Geology

Most of the Southwest deposit, and the entire high-grade, gold-rich core of the deposit, lies between two northeast-striking faults, the West Bounding Fault and the East Bounding Fault. Both faults are clearly defined on ground magnetic 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 in zones ranging from a few metres to a few tens of metres wide. Both faults have subparallel splays locally. Correlation of drill hole intersections constrains an average fault dip of 80° to 310° for both faults. The East Bounding Fault juxtaposes younger rocks to the southeast against the Alagbayan Formation rocks (augite basalt) hosting the deposit, while the West Bounding Fault is mainly intraformational 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.

The cataclasite within the fault zones contains abundant quartz, quartz sulphide, and sulphide (py, cpy, sph, gal) 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 mineralization. Kinematic indicators within the fault zones imply dominantly sub-horizontal, sinistral movement on the bounding faults.

Quartz-dominant veins with variable amounts of sulphide (py, cpy, bn), K-feldspar, chlorite, and carbonate are ubiquitous in the Southwest deposit, and there is a general correlation between vein density and copper and gold grade. Most veins have widths of several millimetres to several centimetres, although within the core of the deposit veins up to a metre or more thick occur. Vein contacts can be either planar or variably deformed, and folded and/or faulted veins are common. Veins within the high-grade deposit core display subparallel to sheeted forms with a preferred southwest-dipping orientation. These pass into more irregularly oriented stockwork veins in peripheral mineralized zones, where subvertical north- to northwest-striking orientations are most common.

Fault geometry and kinematics, vein orientations, and deposit geometry at Southwest support a structural model invoking deposit formation in a dilational fault transfer zone. This zone is delineated by the West Bounding Fault on the northwest and the East Bounding Fault on the southeast. The preferred vein orientation within the core of the deposit reflects the local stress geometry within this zone of dilation. The Southwest deposit probably formed as a subvertical cylindrical body and attained its present west-southwest plunge during post-mineral regional deformation. This post-mineral rotation is consistent with the easterly stratigraphic dips of both pre- and post-mineral rocks in the deposit area.

7.4.2 South Oyu Deposit

Host Rocks

The South Oyu or South deposit occurs within an east- to northeast-dipping sequence of Alagbayan Formation strata (basalt and dacite tuff units), intruded on the southwest by an irregular quartz monzodiorite body. Much of the basalt sequence contains fragmental textures with juvenile pyroclasts and is texturally similar to the overlying dacite tuff sequence. To the northeast, the altered and mineralized rocks are overlain by mudstones and conglomerates of the upper Alagbayan Formation, which pass up-section into the overlying basalt and sediment sequence and ultimately into rocks of the Sainshandhudag Formation.

The deposit area is cut by numerous barren dykes, most of which belong to the post-mineral rhyolite and basalt intrusive suites. These dykes typically have widths of only a few metres, with the exception of a major, east-west rhyolite dyke that cuts through the middle of the South deposit and attains widths of up to a few tens of metres. This wide dyke commonly balloons into larger intrusive masses where it intersects the South and Solongo faults. Although irregular in form, the rhyolite dykes have roughly west to west-northwest strikes and steep dips. In contrast, the basalt dykes have moderate north-easterly dips, subparallel to contacts within the stratified host rocks.

Structural Geology

The South deposit lies on a fault block bounded on the northwest by the northeast-striking South Fault, and on the south by the east-northeast-striking Solongo Fault (Figure 7-3). The South Fault forms a zone with several strands over a width of up to 90 m, which juxtapose progressively younger strata on the northwest against older strata to the southeast. Drill hole intersections of these faults typically consist of gouge and breccia zones up to several metres wide. To the west, the faults strike into a large quartz monzodiorite intrusion. The faults are difficult to trace through the intrusion and offset of the intrusive contact is minimal, implying that most movement pre-dated emplacement of the quartz monzodiorite.

The Solongo Fault truncates the southern edge of the South deposit. It forms a wide, strongly tectonized zone. Stratigraphic offset on the Solongo Fault is at least 1,600 m. No significant mineralization has been identified on the south side of the fault.

Copper mineralization in the South deposit is associated with stockworks of thin (usually < 10 cm) quartz+sulphide veins. In surface exploration pits and trenches, veins occur as steep, northwest-striking, strongly sheeted sets. However, veins intersected in drill holes have a stockwork style and lack the strong preferred orientation visible in surface exposures.

7.4.3 Wedge Deposit

Host Rocks

The Wedge deposit occurs within a northeast-dipping sequence of Upper Devonian Alagbayan Formation strata similar to that hosting the adjacent South deposit. However, in the Wedge deposit, the dacite tuff unit is significantly thicker (up to 180 m) than at South and forms the dominant host to copper mineralization. On the northeast, conformably overlying non-mineralized rocks of the upper Alagbayan Formation and lower Sainshandhudag Formation form the upper limit of mineralization.

Mineralized rocks in the Wedge deposit are cut by numerous barren dykes, including biotite granodiorite, hornblende biotite andesite, and rhyolite compositions. Biotite granodiorite and hornblende biotite andesite are more common along the northwest margin of the deposit and typically have northeast strikes, parallel to the East Bounding Fault. These intrusions are also common as sills, typically intruding along the stratigraphic contact between the dacite tuff and the overlying sedimentary strata. Rhyolite dykes are common throughout the deposit. They typically have steeply-dipping contacts but varied strike orientations.

Structural Geology

The Wedge deposit occupies a rectangular fault block bounded on the west by the northeast-striking East Bounding Fault and on the south by the east-northeast-striking South Fault (Figure 7-3). Within this block, stratigraphic contacts are continuous and relatively planar, showing little evidence of structural disruption.

Movement on the East Bounding and South faults has juxtaposed younger strata within the fault block hosting the Wedge deposit against older strata on the adjacent blocks containing the Southwest and South deposits. Stratigraphic contacts are relatively continuous between the Wedge deposit and the Central deposit, implying that displacement on the East Bounding Fault is largely transferred to the Rhyolite Fault (between Southwest and Central), leaving the Wedge and Central as a structurally intact block that has been displaced downward relative to the Southwest and South deposits.

Fault disruption is common along the contact between the Alagbayan Formation dacite tuff and the overlying sedimentary strata. However, there is no evidence of significant stratigraphic omission or repetition associated with this faulting, and the movement may be relatively minor.

7.4.4 Central Oyu Deposit

Host Rocks

The Central Oyu or Central deposit is hosted within a swarm of feldspar-phyric quartz monzodiorite intrusions, emplaced into porphyritic augite basalt and overlying dacite tuff of the Alagbayan Formation. The dacite tuff is in turn overlain by unmineralized sedimentary and mafic volcanic rocks of the upper Alagbayan Formation, which currently dip moderately to the east.

Several phases of intra-mineral and late-mineral quartz monzodiorite intrusions have been distinguished in the Central deposit based on textural variations and intensity of mineralization 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 Formation.

Basalt flows and dacite tuffs of the Alagbayan Formation are preserved as a series of isolated, irregular, moderately north- to northeast-dipping bodies within the quartz monzodiorite dyke swarm. These volcanic windows are up to 200 m thick and extend several hundred metres down dip to the limit of drilling. The contact between the dacite and the overlying sedimentary sequence is commonly faulted and forms the upper limit to mineralization, as elsewhere in the Oyu Tolgoi district.

Post-mineral dykes are common in the Central deposit and comprise rhyolite, biotite granodiorite, hornblende biotite andesite, and dacite dykes. The rhyolite dykes are most abundant, with the majority occurring as west- and west-northwest-striking bodies in the southern half and on the periphery of the deposit. Biotite-granodiorite dykes occur along the deposit s eastern margin and tend to strike north to north-northeast. East-northeast striking hornblende biotite andesite dykes occur mainly along the north-eastern margin of the deposit.

Structural Geology

Drill holes through the Central deposit show little evidence of significant post-mineral faulting, and the mineralogical zoning, grade distribution, and continuity of contacts are consistent with the deposit being contained in a structurally intact block. Most contacts in the deposit are intrusive or stratigraphic, although minor faulting occurs locally.

Post-mineral faults form minor zones of breccia and cataclasite in some drill holes, but it is not possible to correlate these intersections between drill holes to define continuous fault surfaces. Pre- or syn-mineral faults, if present, are largely obscured by intrusive and hydrothermal overprinting.

The Central deposit area is overlain to the east by non-mineralized conglomerate, mudstone, and siltstone of the upper Alagbayan Formation. Wide zones of breccia and foliated breccia occur either along the basal contact of or within the lower portion of these sedimentary strata. The displacement history of these zones is uncertain, and they may be related to minor post-mineralization movement between the two rheologically contrasting rock packages.

Along its southern margin, 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 ignimbrite and overlying sedimentary units have been uplifted and eroded from the block south of this fault.

Mineralized veins within the Central deposit show a range in orientations, the most common including southwest-, west-, and northwest-dipping attitudes. Vein orientations are similar to those documented in the Southwest deposit, although the degree of preferred orientation in the deposit core is weaker at Central. Similar preferred vein orientations at Central and Southwest suggest that the two deposits were formed in a similar structural regime. However, the Central deposit lacks the strong bounding fault control that is fundamental to the form and geometry of the Southwest deposit. This lack of bounding fault control may account for the more-irregular form of the mineralized body at Central.

Post-mineral tilting of the Central deposit is implied by bedding dips in the enclosing and overlying stratigraphic sequence. Rotating the structural data for the Central deposit sufficiently to restore bedding to horizontal indicates a strong preference for subvertical veins within the deposit at the time of formation.

7.5 Hugo Dummett Deposit

The Hugo Dummett deposit consisting of Hugo North and Hugo South, contains porphyry-style mineralization associated with quartz monzodiorite intrusions, concealed beneath a deformed sequence of Upper Devonian and Lower carboniferous sedimentary and volcanic rocks. The deposit is highly elongated to the north-northeast and extends over 3 km (Figure 7-3). Although mineralization is continuous over this entire length, it thins markedly and decreases in grade where the host strata are displaced by an east-west striking, north-dipping fault, termed the 110 Fault. This fault defines the boundary between Hugo South and Hugo North. The depth to the top of the high-grade (>2.5% Cu) zone varies from 300 m at Hugo South to about 900 m at Hugo North.

7.5.1 Hugo South Deposit

Host Rocks

The Hugo South deposit is hosted by an easterly-dipping sequence of volcanic strata correlated with the lower part of the Devonian Alagbayan Formation and quartz monzodiorite intrusive rocks. Stratigraphically lowest rocks in the sequence consist of porphyritic basalt flows and minor volcaniclastic strata. These rocks are overlain by dacite tuffs and breccias forming a sequence approximately 100 m to 200 m thick. Weakly-altered to unaltered sedimentary and volcanic rocks of the upper Alagbayan Formation and Sainshandhudag Formation overlie the mineralized sequence along the eastern flank of the Hugo South deposit. The thickness of the non-mineralized Alagbayan Formation sequence commonly exceeds 600 m, although structural thickening may occur within the sequence. The Sainshandhudag Formation strata unconformably overlie, and are locally faulted against, the Alagbayan Formation.

Several phases of intrusive rocks occur in the Hugo South deposit. The oldest recognized intrusions are quartz monzodiorite bodies, which underlie the entire deposit area and contain low copper grades. Quartz monzodiorite contacts are irregular, but overall show a preferred easterly dip, subparallel to contacts in the enclosing stratified rocks. The quartz monzodiorite is broadly contemporaneous with alteration and mineralization, and two varieties are distinguished on the basis of alteration characteristics and position within the deposit: 1) an intensely quartz veined phase that occurs along the upper margin of the main intrusive body or as a separate east-dipping tabular body in the overlying strata; and 2) a lower-grade, more weakly veined variety, which makes up the large intrusive body forming the lower part of and underlying the entire deposit.

Late- to post-mineral biotite granodiorite intrusions form a north-northeast-striking dyke complex cutting across the western edge of the deposit. Based on correlations between drill hole intersections and measurements of individual contacts using oriented drill core, dyke contacts appear to have a moderate to steeply west-dipping preferred orientation.

Younger intrusions include rhyolitic, hornblende biotite andesite, dacite, and basalt/dolerite compositional varieties. These intrusions usually occur as dykes with subvertical orientations, or less commonly as easterly-dipping sills emplaced along stratigraphic contacts. They are non-mineralized and not volumetrically significant except locally in the deposit.

Structural Geology

The Hugo South deposit occurs within a north-northeasterly elongate block bounded on the north and south by moderately north-dipping faults, and on the east and west by steep, north-northeast-striking faults. Strata within the block form a homoclinal sequence dipping moderately to the east-southeast.

Deformation of the Hugo South deposit is dominated by brittle faulting (Figure 7-4). Major faults cutting the deposit can be grouped on the basis of orientation into four sets: 1) east-west striking, moderately north-dipping faults (110, Central faults); 2) steep north-northeast-striking faults (East and West Bat, East Hugo, and Axial faults); 3) north-northeast-striking faults that dip moderately east, subparallel to lithologic contacts (Contact, Lower faults); and 4) east-west-striking, subvertical faults (East-West Fault).

110 Fault

The 110 Fault defines the division between the Hugo North and Hugo South deposits, although mineralization is continuous across the fault. The fault strikes east-west and dips northerly at approximately 45° to 55°. In drill hole intersections, the 110 Fault consists of zones of non-cohesive gouge and breccia up to several metres thick. Tectonic fragments within the fault zone are derived from adjacent wall rocks and include mineralized quartz veins within strongly foliated clay gouge.

Figure 7-4: Simplified Interpretation of Section 6200 N, Hugo South Deposit

Note: Shows distribution of major lithologic units, principal faults, and Cu mineralization

The 110 Fault juxtaposes younger strata on the hangingwall block (north) against older strata on the footwall block (south). The stratigraphic offset of the base of the upper member of the Alagbayan Formation varies between approximately 100 m and 200 m. Depending on the net slip direction, the true offset may be greater. The fault is truncated up-dip by the East-West Fault, and the intersection between the two fault surfaces is subhorizontal. Because it is truncated by the East-West Fault, the 110 Fault does not have a surface trace in the Hugo Dummett deposit area. Stratigraphic evidence suggests that earliest movement on the 110 Fault had a large north-side-down component and may have been syn-depositional with respect to the strata immediately overlying the ignimbrite unit. In particular, in several areas coarse volcanic breccias (block and ash tuff unit) are thicker in drill holes immediately north of the fault than on the southern fault block. In addition, the upper basalt + sediment portion of the Alagbayan Formation is up to 200 m thicker on the northern fault block than to the south. However, the variation in thickness could be associated with varying depths of erosion at the disconformity marking the top of the unit. Additional evidence for early movement on the 110 Fault is the lack of offset of the biotite granodiorite dyke contact where the two intersect, implying that most of the stratigraphic displacement pre-dates dyke emplacement.

Kinematic indicators in the foliated gouge indicate oblique sinistral + reverse movement on the 110 Fault, contrary to the apparent stratigraphic displacement. These fabrics likely record a late period of movement that is of lesser apparent magnitude than earlier displacements. Cataclasite developed during this stage of movement contains tectonic fragments of veins with copper sulphides, indicating post-mineral timing. However, the late fault movement does not significantly displace mineralization.

Central Fault

The Central Fault is a shallowly to moderately north-dipping structure that lies beneath the southern portion of the Hugo Dummett deposit. It projects to surface between the Hugo South and Central deposits. Drill hole intersections indicate a strike of approximately 90° to 100°, and its surface trace coincides with a strong linear magnetic anomaly. At shallow levels, stratigraphic contacts are offset across the Central Fault with apparent normal displacement. At deeper levels (OTD401 series drill holes), the opposite stratigraphic relationships occur: dacite tuff of the Alagbayan Formation is faulted over sedimentary strata correlated with the upper Alagbayan Formation. In drill core, the Central Fault consists of a zone of fault breccia and gouge that can be up to several metres thick.

Contradictory stratigraphic relationships (stratigraphic repetition at deeper levels, stratigraphic omission at shallow levels) imply that the Central Fault may have experienced multiple periods of displacement, similar to the history proposed for the 110 Fault. The simplest interpretation is that early displacement resulted in north-side-down apparent offset, followed by a later period of reverse displacement during a period of roughly north-south contractional deformation. The magnitude of reverse displacement was insufficient to restore the entire apparent normal offset. At depth, the reverse sense reactivation may have been localized along a splay in the hangingwall of the principal fault surface, resulting in local stratigraphic repetition.

East-West Fault

The East-West Fault cuts across and displaces the northern end of the Hugo South deposit. Drill hole intersections constrain the fault orientation to subvertical with a strike of approximately 080° to 090°. It forms an abrupt boundary to alteration and mineralization in several sections. Biotite granodiorite dyke contacts the Contact Fault, East Hugo Fault, 110 Fault, and East Bat Fault are all cut by the East-West. In drill hole intersections, the East-West Fault occurs as a zone of clay-rich breccia and locally foliated gouge up to several metres in width, similar in character to the Central and 110 faults. Narrow basaltic dykes commonly occur within the fault zone.

Offsets of a late basaltic dyke, stratigraphic contacts, and the axis of the Hugo South deposit constrain an oblique dextral + north-side-down net slip of roughly 150 m to 200 m on the fault, along a gently eastward-plunging slip vector.

Deposit-Parallel Faults

Moderately east-dipping (deposit-parallel) faults that occur within and immediately adjacent to the Hugo Dummett deposit include the Contact Fault and the Lower Fault. The Contact Fault is a bedding-parallel detachment zone that normally occurs at the transition between the dacite tuff unit (middle Alagbayan Formation) and the overlying sediment/basalt sequence. The intensity of fabric development along this fault is highly variable: in some drill holes it occurs as a wide zone of anastamosing foliation and brecciation in carbonaceous mudstones within the base of the upper sequence; elsewhere there is little tectonic disruption along the contact. The Contact Fault is often intruded by dykes or sills of basaltic, andesitic, or rhyolitic composition. The Contact Fault marks the upper limit of strong alteration in most of the Hugo Dummett deposit. Bedding above and below the faulted contact is concordant. Other than the variable thickness of lithologic marker unit near the contact (e.g., uppermost block and ash tuff in the middle Alagbayan Formation), there is no indication that significant structural omission or repetition has occurred at the Contact Fault.

In the western part of the Hugo Dummett deposit, the biotite granodiorite dyke crosses the Contact Fault at a high angle. The fault continues as a narrow zone of breccia and clay gouge in the biotite granodiorite, but is difficult to identify in many drill holes. Although there is likely some displacement of the intrusive contact, the magnitude is too small to be mappable with the present drill hole spacing.

The Lower Fault occurs as an intensely brecciated, clay gouge-rich zone within the middle or lower portion of the mineralized body, typically 200 m to 400 m below the Contact Fault. Similar to the Contact Fault, the Lower Fault can be traced westward through at least part of the biotite granodiorite dyke as a narrow zone of breccia and gouge.

Latest movement on the deposit-parallel faults post-dates both mineralization in the Hugo Dummett deposit and intrusion of the biotite granodiorite dykes. It is difficult to clearly demonstrate geological offsets on the deposit-parallel faults. The lack of apparent offset may in part reflect the absence of clear stratigraphic markers at the levels at which the faults occur, as well as the fault orientation being close to that of both stratigraphic and alteration contacts. However, in the Hugo North deposit, the Lower Fault appears to displace the Hugo North gold zone and biotite granodiorite dykes by up to 400 m.

The contact-parallel nature of the Contact and Lower faults suggests that they may have formed as gently-dipping thrusts during regional contractional deformation. These faults were localized along contacts between units with differing competencies, or along relatively weak layers within the stratigraphic sequence.

Axial Fault

The linear mineralized trend defined by the Central, Southwest, and Hugo Dummett deposits, which now measures over 6.5 km, likely reflects the presence of a deep, north-northeast-striking crustal fault or fault zone controlling magma emplacement and mineralization. This inferred structure probably also controlled emplacement of the north-northeast-striking late-mineral biotite granodiorite dyke. Although the controlling structure is largely conceptual and direct evidence for it would have been overprinted in many areas by the biotite granodiorite dyke, it is referred to for convenience as the Axial Fault.

Apparent offsets of stratigraphic contacts across the main biotite granodiorite dyke provide supporting evidence for the existence of the Axial Fault (Figure 7-4). Depending on how contacts are projected through areas with low drill hole density, the basal contact of the upper member of the Alagbayan Formation shows an apparent stratigraphic displacement of approximately 200 m to 300 m across the biotite granodiorite dyke. Because the slip direction is unknown, this represents the minimum amount of movement on the fault. There is no clear evidence for post-dyke movement on the Axial Fault. This restricts the timing of movement to the narrow time interval between deposition of upper Alagbayan Formation and intrusion of the biotite granodiorite.

West Bat Fault

The West Bat Fault is a north-northeast-striking, subvertical structure that extends along the west side of the Hugo Dummett deposit. It cuts the northwestern edge of the Hugo North deposit, but is well west of the main part of the Hugo South deposit. The structural character of the fault in drill hole intersections varies with both depth and stratigraphic level. In deeper intersections, where the fault juxtaposes massive volcanic conglomerates (upper Sainshandhudag Formation) against quartz monzodiorite, biotite granodiorite, or lower Alagbayan Formation, it occurs as a weakly to moderately foliated gouge and breccia zone up to a few metres wide. At shallower levels, the fault forms a much broader tectonized zone and commonly splits into several subparallel splays.

The West Bat Fault juxtaposes significantly lower stratigraphic levels to the east against higher stratigraphic levels to the west. If the base of the upper Sainshandhudag Formation is used as a marker, stratigraphic offset, and therefore the minimum net slip, is over 1,500 m. Determination of true net slip amount and direction on the West Bat Fault is complicated by the probable multiple periods of movement on the fault, and available data do not uniquely constrain the fault movement history.

East Bat Fault

The East Bat Fault is a north-northeast-striking, subvertical structure occurring along the east side of the Hugo Dummett deposit. Although contact positions adjacent to the fault imply a minimum of a few hundred metres displacement, the fault expression in drill core can be subtle, often amounting to only decimetres of foliated gouge or cataclasite. The East Bat Fault occurs well east of the mineralization defined within the Hugo South deposit. Stratigraphic contacts within the Sainshandhudag Formation show around 200 m to 300 m of east-side-down stratigraphic offset across the East Bat Fault. There is no kinematic information available for the fault, so the true slip direction and amount are uncertain. Much, if not all, movement would have been post-mineral: the fault cuts carboniferous strata of the Sainshandhudag Formation, but is itself cut by the East-West Fault.

East Hugo Fault

The East Hugo Fault occurs as a north- to north-northwest-striking, steeply east-dipping zone of strong to intense brecciation and clay gouge occurring along the east limb of the Hugo South and Hugo North deposits. At Hugo South it cuts across stratigraphic contacts at moderate angles and forms a sharp break in alteration intensity and copper grade. It displaces mineralization, and there is no evidence in grade distribution or alteration to suggest that the fault was present at the time of mineralization. Drill hole data suggest that the East Hugo Fault cuts the 110 Fault but is displaced dextrally by the East-West Fault. Sections where fault and contact geometry are best constrained show apparent east-side-down displacement of the Alagbayan Formation contacts ranging from about 200 m to as much as 400 m. The true slip direction, and thus the amount of net slip, is not constrained.

Folding History

Bedding measurements obtained from oriented drill core, mainly from bedded intervals within the upper Alagbayan Formation, define two orientations of folds in the Hugo South deposit area: a dominant set of north-northeast-trending folds, and a subordinate set of northwest-trending folds.

Both of the dominant fold orientations also occur in carboniferous post-mineral strata, indicating that both events post-date mineralization and may have modified the form of the deposit.

Within the upper Alagbayan Formation, north-northeast-trending folds have wavelengths and amplitudes on the scale of metres to tens of metres. The far greater abundance of east-dipping bedding measurements implies that the fold geometry is strongly asymmetric, characterized by west-verging folds. In contrast, northwest-trending folds have wavelengths of hundreds of metres and open, symmetric forms. Together, the two fold sets define an elongate dome and basin interference pattern. Because the axial surfaces and fold axes of the two sets are at a high angle to one another, and no penetrative cleavage fabrics formed during either event, it is not possible to determine their relative ages in the deposit area.

Reversals in sedimentary facing direction occur locally in the upper part of the Alagbayan Formation along the east flank of the Hugo South deposit. These reversals suggest the presence of tight to isoclinal folds affecting at least the Alagbayan Formation. These same overturned folds occur in the Hugo North deposit, where they are cut by the Late Devonian biotite granodiorite dyke. These cross-cutting relationships effectively bracket the timing of folding to Late Devonian, roughly contemporaneous or close in age to mineralization.

7.5.2 Hugo North Deposit

Host Rocks

The Hugo North deposit occurs within a geological setting similar to that at Hugo South. Host rocks are an easterly-dipping sequence of volcanic strata correlated with the lower part of the Devonian Alagbayan Formation and quartz monzodiorite intrusive rocks. Stratigraphically lowest rocks in the sequence consist of basalt flows and minor volcaniclastic strata overlain by a dacite tuff and breccia sequence. The dacite sequence includes a lower lapilli tuff unit, with overlying coarser tuffs and breccias. Weakly-altered to unaltered sedimentary and volcanic rocks of the upper Alagbayan Formation and Sainshandhudag Formation overlie the mineralized sequence along the eastern flank of the deposit. Farther to the east and up-section, Sainshandhudag Formation rocks unconformably overlie and are locally faulted against the Alagbayan Formation.

Intrusive rocks at Hugo North are dominated by quartz monzodiorite bodies that underlie the entire deposit area and host a significant portion of the copper and gold mineralization. Quartz monzodiorite contacts are irregular, but overall show a preferred easterly dip, subparallel to stratification in the enclosing rocks. The quartz monzodiorite is contemporaneous with alteration and mineralization, and several varieties are distinguished on the basis of alteration characteristics and position within the deposit: 1) an intensely quartz-veined phase that occurs along the upper margin of the main intrusive body or as a separate east-dipping tabular body in the overlying strata; 2) a gold-rich phase, restricted to the western part of the main intrusion in the northern part of the Hugo North deposit; and 3) the main intrusive body, which typically has lower vein density and lower copper and gold grades. Cross-cutting relationships between the different phases are ambiguous, and it is uncertain whether they represent a temporally distinct intrusive events or simply variations in alteration intensity related to position within the deposit.

Late- to post-mineral biotite granodiorite intrusions form a voluminous, northerly-striking dyke complex cutting across the western edge of the deposit. Although these intrusions locally contain elevated copper grades adjacent to intrusive contacts or associated with xenolithic zones, they are essentially non-mineralized. The positions and orientations of dyke contacts are now well established in the Hugo North deposit area on the basis of correlations between drill hole intersections and measurements of individual contacts using oriented drill core. Dominant dyke orientation varies with depth. At levels above approximately 250 m, where it cuts through the non-mineralized hangingwall strata, the biotite granodiorite occurs as a single intrusive mass with contacts dipping moderately to steeply to the west. Below this level, the biotite granodiorite is more complex, occurring as multiple, subparallel to anastamosing dykes that cut through the quartz monzodiorite intrusion and mineralized Alagbayan Formation strata. Drill hole correlation suggests that this lower portion contains a wide, steeply-dipping central dyke, from which emanate numerous moderately- to steeply-dipping apophyses.

Younger intrusions include rhyolitic, hornblende biotite andesite, dacite, and basalt/dolerite compositional varieties. These intrusions usually occur as dykes with subvertical orientations or less commonly as easterly-dipping sills emplaced along stratigraphic contacts. They are non-mineralized and not volumetrically significant in most of the deposit.

Structural Geology

The Hugo North deposit occurs within easterly-dipping homoclinal strata contained in a north-northeasterly elongate fault-bounded block. The northern end of this block is cut by several northeast-striking faults near the northern boundary of the Oyu Tolgoi property, but the deposit remains open along trend north of these faults. Other than these northeasterly faults, the structural geometry and deformation history of the Hugo North deposit are similar to those of the Hugo South deposit.

Deformation of the Hugo North deposit is dominated by brittle faulting (Figures 7-5 and 7-6). Major faults cutting the deposit can be grouped on the basis of orientation into four sets: 1) east-west-striking, moderately north-dipping faults (110 Fault); 2) steep north-northeast-striking faults (East and West Bat, East Hugo, and Axial faults); 3) north-northeast-striking, moderately east-dipping faults subparallel to lithologic contacts (Contact, Lower faults); and 4) the east-northeast-striking faults cutting across the northern end of the deposit (Boundary Fault System).

110 Fault

The 110 Fault defines the division between the Hugo North and Hugo South deposits. The Hugo North deposit diminishes in size and grade southward approaching the fault. The characteristics and interpretation of the 110 Fault are summarized above in the description of the Hugo South deposit.

Deposit-Parallel Faults

Moderately east-dipping faults at the Hugo North deposit include the Contact Fault and the Lower Fault. The Contact Fault is a bedding-parallel detachment zone that normally occurs at the transition between the dacite tuff (middle Alagbayan Formation) and the overlying basalt/sediment cover sequence. The structural character of the Contact Fault at Hugo North is similar to that described above for the Hugo South area. The Contact Fault does not significantly displace the biotite granodiorite dyke contact, implying that movement following emplacement of this intrusion was minor.

The Lower Fault at Hugo North occurs as an intensely brecciated to foliated, clay-rich gouge zone within the middle or lower portion of the high-grade mineralized body, typically at a level 200 m to 400 m below the Contact Fault. It often coincides with the upper contact of the easterly-dipping portion of the biotite granodiorite dyke and extends updip within the dyke as well. In many drill holes, the Lower Fault occurs at an abrupt downhole discontinuity in copper and/or gold grades, indicating that latest movement displaced mineralized zones. Cross-sections through the Hugo North gold zone show apparent thrust offsets of around 300 m to 400 m, based on displaced high gold grades.

West Bat Fault

The subvertical, north-northeast-striking West Bat Fault occurs along the west side of the Hugo North deposit and cuts the western edge of the northern part of the deposit. Its orientation and structural character are similar to those at Hugo South, except that it splays upwards and northwards into several subparallel strands. Drill hole intersections in the northern part of Hugo North indicate an irregular fault surface, although this irregularity may be in part due to inaccurate surveys, compounded by the great depths of the fault-piercing points. The West Bat Fault is truncated at its northern end by the northeast-striking Boundary Fault System.

The stratigraphic offset of the base of the upper Sainshandhudag Formation across the West Bat Fault is over 1,500 m. The fault movement direction is unknown, and the total offset may be significantly greater than the stratigraphic offset.

Figure 7-5: Simplified Interpretation of Section 7100N, Hugo North Deposit

Notes: Shows distribution of major lithologic units, principal faults, and Cu mineralization

Figure 7-6: Simplified Interpretation of Section 7400N, Hugo North Deposit
Note: Shows distribution of major lithologic units, principal faults, and Cu mineralization

East Bat Fault

The north-northeast-striking East Bat Fault follows the east flank of the Hugo Dummett deposit, well east of the known deposit extents. It is intersected in only three drill holes at Hugo North, all of which are in the southernmost part of the deposit. The fault is assumed to continue northward along the edge of the deposit, but its existence is unproven. Based on constraints in the Hugo South area, the East Bat Fault has several hundred metres of apparent east-side-down displacement.

East Hugo Fault

The East Hugo Fault can be traced northward from the Hugo South deposit up to approximately Section 4767500N. In the southern and central part of Hugo North, it cuts across stratigraphic contacts at moderate angles and forms a sharp break in alteration intensity and copper grade. The fault gradually loses expression northward, suggesting a gradual decrease in displacement.

The East Hugo Fault strikes north to north-northwest (subparallel to the deposit trend) and dips steeply to the east. The northernmost segment has a slightly more northerly strike than the fault to the south. The fault cuts and displaces mineralization, and there is no evidence that the fault was present at the time of mineralization.

Northeast-Striking Faults (Boundary Fault, Others)

Several northeast-striking faults cut across the northern end of the Hugo North deposit near where it crosses the Oyu Tolgoi property boundary. These include the North Boundary Fault, which juxtaposes carboniferous granitic rocks against carboniferous strata to the south, an unnamed, more gently-dipping splay of the North Boundary Fault, and the Boundary Fault, which occurs slightly to the south.

The North Boundary Fault has been intersected in several drill holes and usually occurs as a zone of intensely developed, foliated clay gouge up to several tens of metres wide. Its strike varies from east-northeast to nearly north-south, but dips are consistently around 70° to the northwest. The Boundary Fault follows the intrusive contact of the granitic complex in the northwest part of the Oyu Tolgoi Property and likely represents reactivation of that surface during regional deformation.

A moderately northwest-dipping splay of the North Boundary Fault juxtaposes carboniferous strata over the deposit sequence in several drill holes in the northern part of the property. This splay diverges upward from the North Boundary Fault well above the level of mineralization and thus does not cut the deposit.

The steep, northeast-striking Boundary Fault juxtaposes strongly-mineralized rocks against post-mineral carboniferous strata near the northern property boundary. This fault truncates the West Bat Fault and likely displaces it and the northern end of the Hugo North deposit to the northeast. At higher levels, the Boundary Fault is cut by the splay of the North Boundary Fault.

Folding History

Bedding measurements indicate that fold style and orientation in the Hugo North deposit are similar to those at Hugo South, with most folding restricted to the upper part of the Alagbayan and overlying Sainshandhudag Formation.

The inverted sedimentary facing directions found in the upper part of the Alagbayan Formation at Hugo South occur at similar stratigraphic levels at Hugo North. However, at Hugo North, they define tight folds that are clearly truncated by the biotite granodiorite dyke. This narrowly restricts the age of folding to Late Devonian, in roughly the same time period as mineralization.

SECTION 8 DEPOSIT TYPES

Section 8 has been copied verbatim from the May 2005 Technical Report on the Oyu Tolgoi Mineral Resource estimate (Juras, 2005).

The Oyu Tolgoi deposits display copper-gold porphyry and related high-sulphidation copper-gold deposit styles. Copper-gold porphyry deposits are low-grade bulk tonnage deposits, where copper sulphides are finely disseminated or deposited in anastamosing veins and fractures in a large volume of rock. These deposits are amenable to large-scale open-pit or underground bulk mining methods.

The Oyu Tolgoi deposits are older than typical porphyry copper systems and as a result have been subjected to post-mineral deformation associated with terrane accretion and intracontinental deformation events. Recognition of how this deformation has affected the form and distribution within the deposits has been an important factor in both exploration and resource modelling. One aspect of the deformational history that is unusual in porphyry systems involves large-scale rotation of the deposits from their original positions. Several lines of evidence suggest that the deposits have undergone moderate amounts (30° to 60°) of easterly tilting since their formation:

> Post-mineral carboniferous strata flanking the deposits are folded but show consistent easterly to northeasterly dip directions, subparallel to those in the underlying Devonian strata. This implies that despite the time gap between the sequences, there is little angular discordance at the unconformity, and therefore the porphyry deposits formed within gently-dipping Devonian strata.
>
> The distribution of alteration, copper and gold grades, and sulphides in the Hugo Dummett deposit are most consistent with a source below and to the west of the deposit axis.
>
> In the Central and Southwest deposits, mineralized veins and high-grade core zones are more vertical than their present orientations if the enclosing Devonian strata are considered to have been subhorizontal during deposit formation.

The Oyu Tolgoi porphyry copper deposits display a range in mineralization styles, alteration characteristics, and deposit morphologies despite having formed in close spatial and temporal association. These distinctions likely reflect differences in structural controls, host rock lithology, and depth of formation. Structural influences account for the most part for the differences in shape and distribution of mineralization within the deposits. In general, high-sulphidation mineralization and associated advanced argillic alteration are most common within the dacite tuff, the upper parts of the quartz monzodiorite, where it intrudes to levels high in the stratigraphic succession, and in narrow structurally controlled zones. In contrast the more typical copper-gold porphyry style alteration and mineralization tend to occur at deeper levels, predominantly within basalt and quartz monzodiorite.

The Southwest deposit, particularly the gold-rich core zone, occurs as a steep cylindrical body typical of many porphyry copper deposits. Southwest is localized within a dilational transfer zone linking movement between the northeast-striking West Bounding and East Bounding faults. The strong structural control exerted by these faults is reflected in the abundant sheeted veins showing a high degree of preferred orientation, the pipe-like form of the gold-rich core to the deposit, and the spreading of low-grade copper and gold values along the bounding fault zones.

The Central deposit occupies a structurally intact block within which no significant internal fault disruption has been identified. It forms an irregular to slightly funnel-shaped zone of mineralization characterized by high-sulphidation (pyrite-covellite-chalcocite-enargite) and copper-gold (chalcopyrite-gold) porphyry styles, as well as a chalcocite enrichment blanket. Although the preferred orientation of quartz veins implies strong structural control within the deposit, the geometry of intrusive phases is irregular. Weathering of the Central deposit has produced an oxide zone 40 m to 60 m thick, usually devoid of mineralization, overlying a chalcocite enrichment zone up to 80 m thick.

The South and Wedge deposits are located on the eastern flank of the north-northeast-trending mineralized corridor at Oyu Tolgoi, within several structural blocks cut and bounded by minor northeast-striking subvertical faults. Despite the numerous faults cutting these deposits, the lesser degree of preferred vein orientation relative to other deposits implies that structural control was weaker during mineralization.

The Hugo Dummett deposits have several features unusual to porphyry copper systems, including: 1) the anomalously high copper and gold grades, particularly in the northern part; 2) an unusually weakly altered pre-mineral sedimentary cover sequence that lies just above the porphyry system; 3) quartz + sulphide vein contents always exceeding 15%, and commonly over 90%, in the high-grade portion of the deposit; and 4) a highly-elongate gently-plunging tabular shape to the high-grade stockwork system.

The formation of the high-grade portion of the Hugo Dummett deposits as a tabular, intensely veined, subhorizontal body contrasts markedly with most porphyry copper deposits, which tend to have steep, roughly cylindrical or elongate forms. This unusual form likely results from at least two geological influences: 1) the presence of low-permeability overlying sedimentary rocks; and 2) emplacement within a passive to slightly compressional horizontal stress regime, synchronous with thrust faulting. Both of these factors would serve to inhibit the upward migration of hydrothermal fluids, leading to the formation of a broad subhorizontal zone of fluid overpressuring and attendant hydraulic fracturing and vein formation. This fluid trapping likely also contributed to the unusually high copper grades in these deposits.

SECTION 9 MINERALIZATION

This section has been copied verbatim from the May 2005 Technical Report on the Oyu Tolgoi Mineral Resource estimate (Juras, 2005).

9.1 Southern Oyu Deposits

9.1.1 Southwest Deposit

Copper-gold porphyry style mineralization at the Southwest deposit consists of a cylindrical high-grade core roughly 250 m in diameter enclosed within a broad zone of lower-grade mineralization. The high-grade core is centred on a 10 m to 30 m wide, vein-rich quartz monzodiorite dyke and extends for over 100 m into the adjacent massive porphyritic augite basalt. The high-grade core is characterized by 1 cm to 50 cm wide contorted milky white quartz veins in sericite, albite, minor tourmaline altered quartz monzodiorite and biotite-magnetite altered augite basalt, overprinted by chlorite + sericite. Chalcopyrite with subordinate pyrite, bornite, and molybdenite occur as late veinlets filling fractures in quartz veins and disseminated through wall rocks.

Low-grade copper mineralization peripheral to the high-grade core is characterized by lower vein densities, hosted in chlorite+epidote altered basalt and lesser sericite+albite altered quartz monzodiorite. Magnetite veinlets post-date the quartz veins but predate the main sulphide event. Chalcopyrite, bornite, and pyrite are mainly disseminated, with fracture or vein controlled sulphides being less prominent. These peripheral zones include the informally defined Far South zone, which encompasses mineralized basalt with 1:1 gold copper ratios on the southwest margin of the deposit area, and the Bridge zone, consisting of copper mineralized basalt and quartz monzodiorite between the Southwest and Central deposits. Although these two subzones are used in resource modeling, there is no clear geological boundary distinguishing them from the adjacent peripheral zone mineralization.

Gold in the Southwest deposit is closely associated with chalcopyrite, and occurs intergrown with chalcopyrite, as inclusions and fracture infills within pyrite, or on grain boundaries of pyrite. Lesser gold occurs on grain boundaries with bornite or as inclusions in bornite, quartz or carbonate. The gold to copper ratios range from 2:1 to 3:1 within the high-grade core, decreasing to 1:1 in the low-grade margins of the deposit.

The Southwest deposit is capped by an oxidized zone that varies from 50 m to 60 m thick, and consists of black copper oxide (neotocite or tenorite) as fractures coatings and speckled throughout the oxidized limonite stained basalt.

Alteration styles at the Southwest deposit are typical of copper-gold porphyry systems. Augite basalt in the high-grade core of the deposit contains biotite + magnetite alteration, overprinted by chlorite + sericite. Biotite alteration occurs pervasively in the core of the deposit and grades outwards to selvage controlled within pervasive chlorite + epidote alteration. Minor albite alteration occurs as selvages along veins or fractures. Locally brown carbonate alteration is present in the basalt.

Vein-rich quartz monzodiorite (OT-Qmd and xQmd phases) in the high-grade core contains sericite + biotite + albite alteration with minor tourmaline and montmorillonite. Pink albite alteration commonly occurs as selvages on veins or fractures, and sericite overprints biotite and albite.

In the low-grade peripheral portions of the deposit, augite basalt is pervasively chlorite + magnetite altered, with epidote occurring in patches and sericite and pink albite on vein or fracture selvages. Pink albite may form reaction rims around irregularly shaped epidote patches. Biotite alteration occurs locally. Late calcite or ankerite veins cross-cut the assemblage. Quartz monzodiorite within the low-grade margin contains pervasive sericite alteration, with albite occurring along quartz vein or fracture margins. Spotty biotite alteration occurs locally.

9.1.2 South Deposit

Mineralization in the South deposit is hosted dominantly in quartz monzodiorite in the southwestern portion of the deposit, in basalt throughout the central portion of the deposit, and in a minor zone of dacite tuff on the northern margin. Contorted quartz veins are present at South, but there is no clearly defined zone of high quartz vein density such as at the Southwest deposit. Consequently, fracture-controlled sulphide veins are minor, and sulphides occur dominantly as disseminated chalcopyrite, bornite, and molybdenite. Chalcopyrite is the principal copper sulphide, but in higher-grade areas bornite locally exceeds chalcopyrite in abundance. Magnetite occurs disseminated and as veins. Small zones with elevated gold values occur locally.

A small zone of high sulphidation mineralization occurs within a quartz monzodiorite breccia in the western part of the deposit, adjacent to the South Fault. Mineralization here consists of pyrite, chalcopyrite, bornite, covellite, and primary chalcocite in quartz sericite kaolinite alteration, with late dickite veins.

An oxide zone approximately 60 m thick overlies the South deposit and consists of malachite, azurite, cuprite, chrysocolla, neotocite, or tenorite hosted within basalt and quartz monzodiorite.

Alteration within the basaltic rocks at South consists of moderate chlorite, biotite hematite/magnetite, weak sericite, and pink albite fracture and vein selvages. Hematite overprints magnetite. Quartz monzodiorite is typically pervasively altered with quartz, sericite, and pyrite, as well as albite within vein selvages, small radiating clusters of tourmaline, and fluorite in quartz veins. Advanced argillic alteration consisting of quartz, sericite, and kaolinite with late dickite veins is associated with the high-sulphidation mineralization in the quartz monzodiorite breccia.

9.1.3 Wedge Deposit

The Wedge deposit contains a zone of high-sulphidation mineralization hosted principally in dacite tuff, grading downward and southward into chalcopyrite mineralization in basalt and quartz monzodiorite host rocks.

High-sulphidation mineralization consists of pyrite, chalcopyrite, bornite, enargite, covellite, and primary chalcocite in advanced argillically altered host rocks. Higher grades of copper (>0.8% Cu) occur in a shallowly east-dipping zone in the upper hundred metres of dacite tuff. Gold is absent, except locally in drill holes adjacent to the South Fault. Mineralization is open down dip and to the north.

High-sulphidation mineralization grades downward into chalcopyrite, with lesser bornite within basalt host rocks, and pyrite + chalcopyrite mineralization in quartz monzodiorite.

Dacite tuff within the Wedge deposit is characterized by advanced argillic alteration consisting of kaolinite, zunyite, pyrophyllite, muscovite, illite, topaz, diaspore, alunite, montmorillonite, late dickite, and fluorite. A barren, specular, hematite-rich zone occurs marginal to advanced argillic alteration and is progressively overprinted by advanced argillic alteration assemblages with increasing copper grades towards the centre of the deposit. The advanced argillic alteration grades downward into biotite + chlorite alteration with hematite overprinting magnetite, mainly within basalt host rocks underlying the dacite tuff. In the southern part of the Wedge deposit, sericite + pyrite alteration occurs within the quartz monzodiorite.

9.1.4 Central Deposit

Mineralization in the Central deposit is characterized by an upward-flaring, high-sulphidation zone that overprints and overlies porphyry-style chalcopyrite-gold mineralization. A secondary-enriched supergene chalcocite blanket tens of metres in thickness overlies the high-sulphidation covellite-pyrite zone.

Chalcopyrite-gold mineralization is dominant on the south and western margins of Central within either basalt or quartz monzodiorite adjacent to intrusive contacts with basalt. Higher grades are associated with zones of intensely contorted quartz stockwork veins, where the gold (ppm) to copper (%) ratios reach 2:1. Peripheral, lower-grade mineralization has gold:copper ratios of less than 1:1. Hematite, pyrite, chalcopyrite, bornite, magnetite, and gold occur disseminated in the zone and as fracture fillings. Hematite is pervasive and overprints magnetite.

The high-sulphidation part of the Central deposit lacks significant gold and contains a mineral assemblage of pyrite, covellite, chalcocite/digenite, enargite, tennantite, cubanite, chalcopyrite, and molybdenite. Dominant host rocks are dacite tuff and quartz monzodiorite. Higher-grade mineralization is associated with disseminated and coarse-grained fracture-filling sulphides in zones of intense contorted quartz stockwork veins and anastamosing zones of hydrothermal breccias. Hydrothermal breccia consists of quartz vein and quartz monzodiorite fragments within an intensely sericitized matrix. The sulphide-filled fractures cut both the quartz veins and enclosing wall rock.

High-grade mineralization grades outward to a broad, weakly veined, low-grade halo of dominantly disseminated sulphides. Pyrite, chalcopyrite, bornite, and enargite occur here as relic grains replaced by chalcocite, and covellite, and pyrite also hosts small inclusions of covellite. Covellite, chalcocite and enargite occur as intimate intergrowths or as free disseminations. Cubanite and tennantite occur intergrown with or replacing enargite, and molybdenite occurs locally in quartz.

A supergene enrichment zone overlies the high sulphidation assemblage and underlies a 20 m to 60 m thick, hematitic limonite, goethite-rich leached cap. The supergene zone consists of pyrite, hematite, and chalcocite/digenite, with lesser amounts of colusite, enargite, tenorite, covellite, bornite, chalcopyrite, cuprite, and molybdenite. Pyrite is the dominant sulphide and occurs as disseminated crystals. Sooty chalcocite occurs as rims or microveinlets in pyrite and covellite, and as independent disseminations. Colusite occurs as single grains or intergrown with chalcocite/digenite and/or pyrite. Tenorite occurs interstitial to silicate-iron oxide grain boundaries. Micrograins of chalcopyrite replaced by bornite and covellite occur as small inclusions within pyrite.

Minor exotic copper oxide mineralization occupies a bedrock depression on the northeastern flank of Central. Chrysocolla, malachite, and neotocite mineralization occur over a 400 m x 300 m area as a thin 2 m to 4 m thick layer at the base of the gravels. The leached cap is generally devoid of mineralization except off the eastern and southern flanks of the deposit, where patchy malachite and neotocite occur.

Alteration in the Central deposit shows a close spatial relationship to mineralization and original host lithology. Biotite-chlorite and intermediate argillic alteration coincide with chalcopyrite-gold mineralization within basalt. Advanced argillic and sericite alteration coincides with the high-sulphidation mineralization within quartz monzodiorite and ignimbrite.

The biotite-chlorite zone consists of an assemblage of biotite, chlorite, epidote, sericite, albite, carbonate, and anhydrite. Hematite and minor magnetite occurs in veins and disseminated. Biotite has been overprinted by chlorite and sericite, and magnetite has been altered to hematite. Anhydrite and carbonates occur as late veins. K-feldspar alteration increases at depth beneath Central, occurring as vein selvages within biotite-altered basalt.

Intermediate argillic alteration forms a narrow zone separating the advanced argillic and sericite alteration from the biotite chlorite alteration. Intermediate argillic alteration is characterized by a creamy yellow to pale green coloured assemblage of kaolinite, chlorite, pyrophyllite, and illite.

Advanced argillic and sericite alteration are associated with high-sulphidation mineralization, hosted primarily within dacite and quartz monzodiorite. The advanced argillic assemblage consists of topaz, quartz, zunyite, diaspore, alunite, illite, andalusite, late kaolinite, and dickite. There is a zonation from an advanced argillic assemblage of zunyite, andalusite, and alunite associated with higher-grade hydrothermal breccia-hosted mineralization, to a muscovite, sericite-dominant peripheral zone associated with lower-grade disseminated mineralization.

Alteration within the supergene zone is characterized by illite, muscovite, kaolinite, alunite and pyrophyllite. Montmorillonite, smectite, kaosmectite, illite and kaolinite are the dominant clay minerals in the leached cap.

9.2 Hugo Dummett Deposits

9.2.1 Hugo South Deposit

Copper mineralization at the Hugo South deposit is centred on a high-grade (typically > 2% Cu) zone of intense quartz stockwork veining, which in much of the deposit is localized within narrow quartz monzodiorite intrusions and extends into the enclosing basalt and dacite tuff. The intense stockwork zone has an elongate tabular form, with a long axis plunging shallowly to the north-northwest, and an intermediate axis plunging moderately to the east. Copper grades gradually decrease upwards from the stockwork zone through the upper part of the basalt and the dacite tuff, and a broader zone of lower grades occurs below and to the west in basalt and quartz monzodiorite.

Dominant sulphide minerals at Hugo South are chalcopyrite, bornite, chalcocite, and pyrite, with minor molybdenite, enargite, tennantite, and covellite. Rarely, sphalerite and galena occur. Sulphides are zoned (Figure 9-1) with bornite ± chalcopyrite, chalcocite, and tennantite comprising highest grades (>2.5% Cu), grading outwards to chalcopyrite (1% to 2% Cu). Pyrite-chalcopyrite ± enargite, tennantite, bornite, chalcocite, and rarely covellite occur with low-grades (<1% Cu), mainly in advanced argillically altered dacite tuff.

Drill hole assays (Cu, Au, Ag, As) and selected ICP-MS multi-element data (Pb, Zn, Se, Te, Tl, Bi) show distinct geochemical zoning coincident with sulphide zoning. Copper shows a strong correlation with Au, Ag (up to 9 ppm), Se (up to 33 ppm), Bi, and, to a lesser extent, Tl. High As values (up to 2,850 ppm) occur mainly with high pyrite and enargite in the dacite tuff, and Zn (up to 3,530 ppm) occurs with chalcopyrite at the top of the mineralized zone.

Alteration in the Hugo South deposit is typical of copper porphyry systems, including K-silicate (minor), advanced argillic, muscovite/sericite, and intermediate argillic styles. The mineral groupings used to define individual zones are not necessarily true assemblages that formed contemporaneously, but are associations that may represent several paragenetic stages.

The following alteration zones have been defined at Hugo South (Figure 9-2):

- *Chlorite-illite* alteration occurs in the uppermost part of the dacite tuff. This alteration is not texturally destructive, and primary volcanic textures are clearly visible. No mineralization is associated with this weak outermost alteration zone.

- *Advanced argillic* alteration is dominant in the dacite tuff and is characterized by the minerals quartz, pyrophyllite, kaolinite, topaz, diaspore, zunyite, alunite, and dickite. Because the advanced argillic alteration is widespread and consists of a complex mineral assemblage, it is divided into subzones:
  - Pyrophyllite-kaolinite: This is the most widespread subgroup of the advanced argillic alteration. It occurs dominantly in the dacite tuff, but also in the upper parts of the basalt and quartz monzodiorite. Late white to pink dickite on fractures is ubiquitous.

  - Quartz-alunite: The quartz-alunite zone typically occurs in the dacite tuff in bedding-parallel lenses. The lenses are parallel to, and occur just above and east of, the high-grade, vein-rich deposit core. It is whitish-pink to brown in colour.

  - Topaz alteration occurs as an intense, completely texturally destructive zone and is typically of limited extent. Topaz-altered zones are vuggy and whitish-brown in colour. They are most common in the dacite tuff, but occur locally in the basalt.
- *Pyrophyllite-kaolinite-dickite-muscovite/illite* (intermediate argillic) alteration occurs in the upper parts of the basalt at the contact with the dacite tuff and is the dominant alteration type in the high-grade deposit core. It is brownish-yellow in colour but turns pinkish where pyrophyllite is the dominant mineral. It is not texturally destructive. Hematite is common as fine specularite.

- *Chlorite-muscovite/illite-hematite* alteration is the dominant alteration in the basalt. It is characterized by its green colour, and the original texture of the basalt is still visible (e.g., relict pseudo-hexagonal augite crystals). Locally, particularly at depth, biotite occurs in the zone. Relict magnetite occurs either disseminated or in veins.

Figure 9-1: Sulphide Distribution in the Hugo South Deposit (Section 6200N)

Note: Shows bornite+chalcocite core zone, grading outward through bornite, chalcopyrite+bornite, chalcopyrite, and pyrite zones

Figure 9-2: Cross-Section 6200N in the Hugo South Deposit
Note: Shows distribution of alteration zones

> *Muscovite/illite* alteration occurs mainly in quartz monzodiorite intrusions. It is pale green to gray in colour and in most cases texturally destructive, although in places original feldspar crystals can still be observed. Locally, topaz occurs with muscovite, and a subgroup of muscovite-topaz alteration was recognized.

The distribution of the alteration is strongly lithologically controlled: dacite tuff typically shows strong advanced argillic alteration, whereas basalt tends to be chlorite-muscovite-hematite altered with pyrophyllitic advanced argillic alteration in its uppermost parts. Pockets of advanced argillic alteration occur locally in the high-grade zone in the quartz monzodiorites.

9.2.2 Hugo North Deposit

The highest-grade copper mineralization in the Hugo North deposit is related to a zone of intense stockwork to sheeted quartz veins. The high-grade zone is centred on thin, east-dipping quartz monzodiorite intrusions or within the upper part 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 in its high Au (ppm) to Cu (%) ratios (0.5:1). In other respects the Hugo North and Hugo South deposits have similar mineralogy and zonation patterns.

Bornite is dominant in highest-grade parts of the deposit (3% to 5% Cu) and is zoned outward to chalcopyrite (2%). At grades of <1% Cu, pyrite-chalcopyrite ± enargite, tennantite, bornite, chalcocite, and rarely covellite occur, hosted mainly by advanced argillically altered dacite tuff.

The high-grade bornite zone comprises relatively coarse bornite impregnating quartz and disseminated in wall rocks, usually intergrown with subordinate chalcopyrite. Pyrite is rare or absent, except in local areas where the host rocks are advanced argillically altered. Whereas chalcocite is commonly found with bornite at Hugo South, it is less common at Hugo North. In addition, high-grade bornite is associated with minor amounts of tennantite, sphalerite, hessite, clausthalite, and gold. These minerals occur as inclusions or at grain boundaries.

Elevated gold grades in the Hugo North deposit occur within the up-dip (western) portion of the intensely veined, high-grade core, and within a steeply-dipping lower zone cutting through the western part of the quartz monzodiorite. Quartz monzodiorite in the lower zone exhibits a characteristic pink to buff colour, with a moderate intensity of quartz veining (25% by volume). This zone is characterized by finely disseminated bornite and chalcopyrite, although in hand specimen the chalcopyrite is usually not visible. The sulphides are disseminated throughout the rock in the matrix as well as in quartz veins. The fine-grained sulphide gives the rocks a black sooty appearance. The red colouration is attributed to fine hematite dusting, mainly associated with albite.

Similar to Hugo South, copper in the Hugo North deposit correlates with elevated abundances of Ag, Se, and Te. Arsenic occurs at low levels in the high-grade zone and is related to tennantite. Zinc (about 300 ppm) occurs mainly as sphalerite. Se and Te are attributed to hessite and clausthalite inclusions in bornite. Pb occurs at levels of up to several hundred ppm peripheral to the high-grade zone in dacite tuff. Low levels of Hg (0.2 ppm) occur in the upper part of the ore body.

The Hugo North deposit is characterized by copper-gold porphyry and related styles of alteration similar to those at Hugo South (Figure 9-3). This includes biotite-K-feldspar (K-silicate), magnetite, chlorite-muscovite-illite, albite, chlorite-illite-hematite-kaolinite (intermediate argillic), quartz-alunite-pyrophyllite-kaolinite-diaspore-zunyite-topaz-dickite (advanced argillic), and sericite/muscovite zones.

Figure 9-1: Section 4767500N (7500N) in Hugo North Deposit

Note: Shows typical distribution of alteration zones for the Hugo North deposit

The distribution of alteration zones is similar to that in the Hugo South deposit, except that the advanced and intermediate argillic zones are more restricted and occur mainly along the northern margin of the intrusive system (Figure 9-3).

Chlorite-illite marks the outer boundary of the advanced argillic zone. It occurs mainly in the coarse, upper part of the dacite tuff.

Quartz-pyrophyllite-kaolinite-dickite (advanced argillic) is hosted mainly in the lower part of the dacite tuff, although on some sections at Hugo North it extends into strongly veined quartz monzodiorite. The advanced argillic zone is typically buff or grey, and late dickite on fractures is ubiquitous. Within the advanced argillic zone, a massive quartz-alunite zone forms a pink-brown bedding-parallel lens.

Topaz is widespread as late alteration controlled by structures cutting both the advanced and intermediate argillic zone. As illustrated by the type section, topaz appears to replace parts of the quartz-alunite zone. In addition topaz may also occur disseminated with quartz-pyrophyllite-kaolinite. Strong topaz zones are mottled buff or light brown and sometimes vuggy.

Hematite-siderite-illite-pyrophyllite-kaolinite-dickite (intermediate argillic) is an inward zonation from the advanced argillic zone, and is commonly hosted by augite basalt but may also occur in dacite ash flow tuff. Hematite usually comprises fine specularite and may be derived from early magnetite or Fe-rich minerals such as biotite or chlorite.

Hematite-chlorite-illite-(biotite-magnetite) (chlorite) is transitional to the intermediate argillic zone and is commonly hosted by augite basalt. It is characterized by a green colour, and relict hydrothermal magnetite, either disseminated or in veins.

Muscovite-illite (sericite) generally occurs in the quartz monzodiorite intrusions and is a feature of the strongly mineralized zone. Alteration decreases with depth in the quartz monzodiorite.

SECTION 10 EXPLORATION

The following has been copied verbatim from the May 2005 Technical Report on the Oyu Tolgoi Mineral Resource estimate (Juras, 2005).

Exploration at Oyu Tolgoi has been mainly by remote sensing and geophysical methods, including satellite image interpretation, detailed ground magnetics, Bouguer gravity and gradient array induced polarization (IP), as well as extensive drilling. Gradient array IP has been conducted on north-south and subsequently east-west lines at 200 m line spacing, with electrode spacing up to 11 km. Drill holes have been targeted to test IP chargeability targets or structural zones. Outcropping prospects (Southwest, South, and Central) have been mapped at 1:1,000 scale. The central part of the exploration block was mapped at 1:5,000 scale in 2001, and the entire block was mapped at 1:10,000 scale in 2002. As described below, geophysical methods have been the most important exploration tool.

Geophysical surveying at Oyu Tolgoi was first initiated by BHP in 1996. An airborne magnetometer survey was flown at a height of approximately 100 m on 300 m spaced, east-west oriented lines over approximately 1,120 km^2 of BHP s mineral concession. The survey provided good resolution of the magnetic features to facilitate geological and structural interpretation across the concession areas. BHP also undertook an induced polarization (IP) survey utilizing a single gradient array with a 2,000 m AB and a ground magnetometer survey. Both surveys were conducted on east-west-oriented lines surveyed by a local Mongolian surveying team at 250 m spacing. The surveys covered Southern, Southwest, Central, and North Oyu exploration targets but did not extend into the Far North region that ultimately became the Hugo Dummett deposit.

Ivanhoe initiated geophysical exploration after the discovery of the high-grade, gold-rich portion of the Southwest Oyu zone in June 2001. The gold-rich, chalcopyrite-dominate mineralization discovered in drill hole OTRCD150 was clearly responsible for the IP chargeability anomalies previously delineated by the BHP survey. The presence of hydrothermal magnetite with the copper-gold mineralization was the probable source of the intense magnetic anomalies defined over SW Oyu and possibly South Oyu. Delta Geoscience of B.C., Canada, was mobilized to the property in the fall of 2001 to undertake detailed IP surveying utilizing gradient arrays with multiple electrode spacings to delineate the vertical extent of the sulphide mineralization being defined by drilling in SW Oyu. The detailed IP surveys initially covered a 3 km east-west x 4 km north-south block encompassing the Southwest, South, Central, and Far North target areas. At the same time Ivanhoe acquired two magnetometers and initiated very detailed ground magnetometer surveying using 5 m spaced readings along 25 m spaced, north-south oriented lines over the Southern Oyu target areas. An Ulaanbaatar-based geophysical team ultimately expanded this magnetic survey to cover the entire 8 km x 10 km concession. This group covered the northern half of the concession with east-west oriented lines on 50 m intervals with 25 m spaced readings.

In 2002 the geophysical program was further expanded to include a gravity survey over the Oyu Tolgoi concession block. The survey was controlled by GPS with readings taken on 50 m centres over the core of the concession and 100 m centres over the extremities. The Bouger map was reduced to residual gravity for contouring. Unfortunately no additional processing or modelling of the data has been carried out. With the density measurements that have been taken on drill core through out the deposits, detailed computer modelling of the gravity data should be possible.

Telluric Electromagnetic (TEM) surveying was also conducted over the eastern half of the concession in conjunction with extensive TEM surveying used to define the Cretaceous-aged, semi-consolidated sedimentary basins along the Galbyn Gobi and Gunii Holloi valleys, southeast and northeast, respectively, from Oyu Tolgoi. These basins developed along the East Mongolian Fault system and a splay off of the fault, and form the reservoirs for extensive water resources required to operate the Oyu Tolgoi mine. On the Oyu Tolgoi concession, the TEM work was designed to delineate smaller drainage basins that could have channelled copper-rich surficial waters from the exposed copper deposits during the Cretaceous period. These pregnant waters could potentially have precipitated copper into river gravels down stream to form secondary exotic copper deposits.

Diamond drilling ultimately has been the primary tool of exploration at Oyu Tolgoi. To the beginning of May 2005, more than 1,000 drill holes have been completed, many of which in the Hugo North deposit were multiple daughter holes navi-drilled from a single parent. Approximately 546,000 m of core has been collected and stored on the property. The amount of drilling in the individual deposit areas is tabulated below (metres).

Total Diamond Core Drilling	546,000
Hugo Dummett Deposit	249,000
Central & Bridge	95,000
Southwest	139,000
South & Wedge	62,000
Other	22,000
Entrée Ivanhoe JV	9,000

SECTION 11 DRILLING

Section 11 has been largely copied from the May 2005 Technical Report on the Oyu Tolgoi Mineral Resource estimate (Juras, 2005).

Diamond drill holes are the principal source of geological and grade data for the Oyu Tolgoi project. Ivanhoe conducted diamond drilling over the Southern Oyu deposits throughout 2003 (Central and Southwest) and 2004 (Southwest, South, and Wedge). Drilling on the Hugo Dummett deposit concentrated on the Hugo North deposit in 2004 and 2005. As of the mineral resource cutoff date of 15 April 2005, drilling totals just under 273,000 m in 583 drill holes for the Southern Oyu deposits and 200,000 m in 156 drill holes, including daughter holes, for Hugo North. The Southern Oyu holes generally range in length from 60 m to 1,200 m, averaging 470 m. The Hugo North holes range from 400 m to 2,200 m and average 1,280 m in length. A list of all drill holes used for the resource estimates is attached as Appendix A.

Drilling was done by wireline method with H-size (HQ, 63.5 mm nominal core diameter) and N-size (NQ, 47.6 mm nominal core diameter) equipment using up to 20 drill rigs. Upon completion, the collar and anchor rods were removed and a PVC pipe was inserted into the hole. The hole collar was marked by a cement block inscribed with the hole number. Hugo North drilling almost always include multiple daughter holes drilled from the parent drill hole. A bend was placed in the parent hole at the location where the planned daughter holes were to branch off. The bend was achieved by means of a Navi-Drill® (navi) bit, which was lowered down the hole to the desired depth and aligned in the azimuth of the desired bend. As the navi bit advanced, a bend was achieved at the rate of 1° every 3 m. No core was recovered from the navi-drilled interval.

Drill hole collars were located respective to a property grid. Proposed hole collars and completed collars were surveyed by a Nikon Theodolite instrument relative to 18 survey control stations established during a legal survey of the property in 2002. The drill holes were drilled at an inclination of between 45° and 90°, with the majority between 60° and 70°. Holes were drilled along 035° and 125° azimuths in Southwest and South, 0° and 180° azimuths in Central. Down-hole surveys were taken approximately every 50 m by the drill contractor using a multi-shot measurement system (RANGER survey instrument).

Standard logging and sampling conventions were used to capture information from the drill core. The core was logged in detail onto paper logging sheets, and the data were then entered into the project database. The core was photographed before being sampled.

AMEC reviewed the core logging procedures at site, and the drill core was found to be well handled and maintained. Material was stored as stacked pallets in an organized core farm. Data collection was competently done. Ivanhoe maintained consistency of observations from hole to hole and between different loggers by conducting regular internal checks. Core recovery in the mineralized units was excellent, usually between 95% and 100%. Very good to excellent recovery was observed in the mineralized intrusive sections checked by AMEC. Overall, the Ivanhoe drill program and data capture were performed in a competent manner.

SECTION 12 SAMPLING METHOD AND APPROACH

Rock sampling for resource estimation has been conducted on diamond drill core obtained from holes drilled between May 2001 and April 2005. Samples are taken at 2 m intervals down the drill holes, excluding dykes that extend more than 10 m along the core length. NQ and HQ core sizes are drilled routinely, with one-half of the core collected for analysis.

The core is split with a rock saw, flushed regularly with fresh water. Core recovery is good, with relatively few broken zones. To minimize sampling bias, the core is marked with a continuous linear cutting line before being split. Samples are placed in cloth bags and sent to the on-site preparation facility for processing.

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. Pulp samples used for assaying are kept at the assaying facility for several months and then transferred to a warehouse in Ulaanbaatar. A list of the significant composite intervals used in the resource estimate is provided as Appendix B.

SECTION 13 SAMPLE PREPARATION, ANALYSES, AND SECURITY

13.1 Sample Preparation and Shipment

Split core samples are prepared for analysis at an on-site facility operated by SGS Mongolia LLC (SGS Mongolia). The samples are then shipped under the custody of Ivanhoe to Ulaanbaatar, where they are assayed at a lab facility operated by SGS Mongolia. All sampling and QA/QC work is overseen on behalf of Ivanhoe by Dale A. Sketchley, M.Sc., P.Geo.

The samples are initially assembled into groups of 15 or 16, and then 4 or 5 quality control samples are interspersed to make up a batch of 20 samples. The quality control samples comprise one duplicate split core sample, one uncrushed field blank, a reject or pulp preparation duplicate, and one or two standard reference material (SRM) samples (one <2% Cu and one >2% Cu if higher-grade mineralization is present based on visual estimates). The two copper SRMs are necessary because SGS Mongolia uses a different analytical protocol to assay all samples >2% Cu. 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.

The SRMs are prepared from material of varying matrices and grades to formulate bulk homogenous material. Ten samples of this material are then sent to each of at least seven international testing 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 barren of any of the grade elements before they are used for monitoring contamination.

A total of 38 different reference materials have been developed and combined with two commercially purchased ones, used to monitor the assaying of six different ore types made up of varying combinations of chalcopyrite, bornite, primary and supergene chalcocite, enargite, covellite, and molybdenite.

Split core samples are prepared according to the following protocol:

The entire sample is crushed to 90% minus 3 mm.

A 1 kg subsample is riffle split from the crushed minus 3 mm sample and pulverized to 90% minus 75 µm (200 mesh).

A 150 g subsample is split off by taking multiple scoops from the pulverized 75 µm sample.

The 150 g subsample is placed in a kraft envelope, sealed with a folded wire or glued top, and prepared for shipping.

All equipment is flushed with barren material and blasted with compressed air between each sampling procedure. Screen tests are done on crushed and pulverized material from one sample taken from each batch of 15 or 16 samples to ensure that sample preparation specifications are being met.

Prepared samples are placed in wooden shipping boxes, locked, sealed with tamper-proof tags, and shipped to Ulaanbaatar for assaying. Sample shipment details are provided to the assaying facility both electronically and as paper hard copy accompanying each shipment. The assaying facility then electronically confirms sample receipt, the state of the tamper-proof tags, and assigned laboratory report numbers back to site.

13.2 Assay Method

All samples are routinely assayed for gold, copper, and molybdenum. Gold is determined using a 30 g fire assay fusion, cupelled to obtain a bead, and digested with Aqua Regia, followed by an AAS finish. Copper and molybdenum are determined by acid digestion of a 5 g subsample, followed by an AAS finish. Samples are 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.

13.3 QA/QC Program

Assay results are provided to Ivanhoe in electronic format and as paper certificates. Upon receipt of assay results, values for SRMs and field blanks are tabulated and compared to the established SRM pass-fail criteria:

- automatic batch failure if the SRM result is greater than the round-robin limit of three standard deviations
- automatic batch failure if two consecutive SRM results are greater than two standard deviations on the same side of the mean.
- automatic batch failure if the field blank result is over 0.06 g/t Au or 0.06% Cu.

If a batch fails, it is re-assayed until it passes. Override allowances are made for barren batches. Batch pass/failure data are tabulated on an ongoing basis, and charts of individual reference material values with respect to round-robin tolerance limits are maintained.

Laboratory check assays are conducted at the rate of one per batch of 20 samples, using the same QA/QC criteria as routine assays.

13.3.1 Standards Performance

Ivanhoe strictly monitors the performance of the SRM samples as the assay results arrive at site. The ability of the laboratories to return assay values in the prescribed SRM ranges has steadily improved to greater than 99% (Figure 13-1). Charts of the individual SRMs are included in Juras (2004a) and Juras (2005). All samples are given a fail flag as a default entry in the project database. Each sample is re-assigned a date-based pass flag when assays have passed acceptance criteria. At the data cutoff date of 15 April 2005, only a very small number of assayed samples still had the fail flag. The relative uncertainty introduced to the mineral resource estimate by using this very small number of temporarily failed samples is considered negligible.

Figure 13-1: SRM Failure Chart

13.3.2 Blank Sample Performance

Charts showing the assay performance of field blanks are available in Juras (2004a), and Juras (2005). The results show a low incidence of contamination and a few cases of sample mix-ups, which were investigated at site and corrected.

13.3.3 Duplicates Performance

The QA/QC program currently uses four different types of duplicate samples: core, coarse reject, pulp, and laboratory check pulps (samples sent to an umpire lab).

Core, Coarse Reject, and Pulp Duplicates

AMEC has reviewed the core, coarse reject, and pulp duplicate samples for the Southern Oyu and Hugo Dummett deposits. The pulp and coarse reject duplicates reproduce well for copper and are reasonable for gold values greater than 0.2 g/t. Relative difference charts and percentile rank charts are available in Juras (2004a) and Juras (2005). Pulp and reject duplicate types for each metal, though more so for gold, show similar high variability to good reproducibility trends from near detection values towards higher-grade value. Patterns for all metals are symmetric about zero on the relative difference charts, suggesting no bias in the assay process.

13.3.4 Specific Gravity Program

Samples for specific gravity determination are taken at approximately 10 m intervals per drill hole and tabulated by rock type. The specific gravity for non-porous samples (the most common type) is calculated using the weights of representative samples in water (W2) and in air (W1). The bulk density is calculated by W1/(W1-W2). AMEC believes this method to be appropriate for the non-porous mineralized units and barren dykes.

Less-common porous samples are dried and then coated with paraffin before weighing. Allowance is made for the weight and volume of the paraffin when calculating the specific gravity.

As a check on its method for specific gravity determinations, Ivanhoe submitted 120 samples to a commercial laboratory for independent testing. The results, reviewed by AMEC, show near-identical values to the original Ivanhoe numbers, and support the procedures and results of Ivanhoe s specific gravity program.

13.4 Concluding Statement

In AMEC s opinion, the QA/QC results demonstrate that the Oyu Tolgoi project assay database for 2005 is sufficiently accurate and precise for resource estimation.

SECTION 14 DATA VERIFICATION

As a test of assay data integrity, the data used to estimate the 2005 Southern Oyu and Hugo North mineral resources and the 2004 Hugo South mineral resources were verified with a random comparison of 5% of the database records against the original electronic assay certificates. No discrepancies were found. Collar coordinates were checked against the database entries. No discrepancies were observed in the 2005 check, but several minor discrepancies (<0.5m) were noticed in the 2004 check of Hugo South records. AMEC also checked the down-hole survey data. Camera shots and RANGER output were read for the checked drill holes and compared to those stored in the resource database. Rare minor discrepancies were observed that are probably due to arbitrary corrections made to the data because of the suspected or measured presence of magnetite. The down-hole survey discrepancies and the 2004 collar coordinate discrepancies would have neglible impact on any resource estimate. AMEC concludes that the assay and survey database transferred to AMEC is sufficiently free of error to be adequate for resource estimation.

SECTION 15 ADJACENT PROPERTIES

Adjacent properties are not relevant for the review of the Oyu Tolgoi project.

SECTION 16 MINERAL PROCESSING AND METALLURGICAL TESTING

16.1 Background

The history of metallurgical testing for Oyu Tolgoi reflects the progress in defining the resource. Testwork started in late 2001, when samples from site were shipped to SGS Lakefield Research Limited for preliminary analysis. SGS Lakefield produced seven composite samples for ore roughly corresponding to the Southwest, Central, and Hugo South orebodies as they were known at the time. Extensive mineralogical, leach, comminution, and flotation work was done on these samples in 2002 and 2003. The work was carried out by SGS Lakefield, A.R. MacPherson Consultants Ltd. (ARM), and Terra Mineralogical Services under the supervision of IMMI. A conceptual flowsheet was developed, and IMMI gained a good understanding of the potential of the property.

As exploration and mine definition advanced, the centre of interest in the mineral deposits changed, the original samples no longer represented all the ore included in the mine plan, and the metallurgical data were deemed indicative only.

In late 2003, AAJV and IMMI initiated an additional phase of metallurgical testwork, which began in early 2004 and extended through to early 2005. This program was designed to confirm the flotation and comminution response of ores from the Southwest, Central, Hugo South, and Hugo North zones. Laboratory batch-scale and pilot-plant flotation testwork programs, as well as laboratory-scale comminution testwork, were conducted at AMMTEC Ltd. in Perth. Further work to define fundamental flotation and comminution parameters was executed by MinnovEX, and SGS Lakefield carried out a SAG pilot-plant test program to confirm the laboratory-scale testwork.

An illustration of the testwork programs as they relate to the growth of the mine resource is provided in Figure 16-1.

16.2 Flotation Testwork

The bench-scale testwork was conducted in three phases. First, the flowsheet developed during the earlier test programs was verified and optimized for Southwest ore. A simple, typical flowsheet for porphyry copper ore treatment was found to work well for all ore types:

- primary grind of approximately 80% passing 150 µm
- rougher flotation using Cytec 3418A, a selective diakyl dithiophosphinate collector
- regrinding to 80% passing 25 µm
- two or three stages of cleaner flotation.

Following flowsheet verification, locked-cycle tests and batch tests were performed on composites corresponding to ore-release schedules, and batch flotation tests were performed on a large number of spatially distributed samples to gauge the variability of flotation response throughout each orebody. The test results were compared and algorithms developed to relate flotation response to mine model parameters, such as head grade and copper/sulphur ratio, to project metallurgical response to each ore block in the mine plans.

Figure 16-1: Metallurgical Testwork Programs Related to Resource Growth

Table 16-1: Sampling Density for Flotation Testwork

Zone	Ore Represented (Mt)	No. of Variability Samples
Southwest	231	152
Central	30	30
Hugo North	140	35
Hugo South	4	20

In parallel with the conventional flotation program conducted at AMMTEC, basic flotation parameters (mineral-by-mineral flotation kinetics and maximum recoveries) were measured at the MinnovEX laboratory in Toronto and entered into the MinnovEX FLEET flotation simulator to determine the required flotation residence times and circulating load parameters.

Toward the end of the test period, additional sample was collected from areas of step-out drilling to the north of the original Hugo North sample locations. This material was tested under the same flotation conditions, and results were similar and repeatable. Because of time restraints, conditions for this relatively high grade, low-sulphur ore have not been fully optimized.

Table 16-2: Anticipated Life-of-Mine Metallurgical Performance Base Case 85,000 t/d

Zone/		Grade		Distribution	
Material Type	Mt	Cu %	Au g/t	Cu %	Au %
Southwest					
Ore to plant	123.192	0.53	0.69	100.0	100.0
Concentrate	2.319	24.70	25.40	88.0	68.9
Tailings	120.873	0.06	0.22	12.0	31.1
Hugo North Lift 1					
Ore to plant	576.494	1.46	0.29	100.0	100.0
Concentrate	25.550	30.00	5.10	91.9	79.1
Tailings	550.944	0.14	0.07	8.1	20.9
Hugo North Lift 2					
Ore to Plant	578.574	1.03	0.31	100.0	100.0
Concentrate	19.270	28.10	7.40	90.0	79.0
Tailings	559.304	0.10	0.07	10.0	21.0

16.3 Comminution

Throughput rates for the concentrator were assessed using the MinnovEX CEET simulator. Simulator input data include SAG performance index, Bond ball mill work index, and crushing index, all of which were determined from small-diameter core obtained from the resource drilling program, providing a large sample suite without the need for special metallurgical drill programs. To increase confidence in the results, the simulator at the JK Metallurgical Research Centre (JKMRC) was used as a secondary comminution model. The method used to arrive at the nominal plant tonnage is illustrated overleaf.

To assess potential grinding circuit configurations, a special suite of 26 samples of large-diameter (PQ) core was taken from diamond drill holes specifically sited to intercept all of the major ore types, classified by lithology and alteration. Hardness parameters were measured for each sample, and a grinding circuit model was developed for each ore type in both CEET and JKMRC. Run-of-mine ore size was obtained from a blasting analysis done by Scott Mine Consultants Ltd. The MinnovEX, JKMRC, and AAJV databases of industrial installations were referred to extensively to assist in building and adjusting the models until IMMI and AAJV were satisfied that they provided reasonable results and agreement over the full range of ore types represented in the 26-sample suite.

The calibrated models were then applied to simulations of potential configurations for representative sample sets of Southwest and Hugo North ore. The selected configuration is open-circuit SAG with secondary pre-crushing, followed by ball mills in closed circuit with cyclones. The analysis indicated that the circuit throughput rate will be limited by the SAG mill more than 90% of the time.

The subsequent SAG mill pilot program conducted by SGS Lakefield in April 2005, using a 250-tonne bulk sample of ore from the Southwest deposit, confirmed the results of the small-scale testwork.

Figure 16-2: Throughput Assessment Method

Figure 16-3: Grinding Circuit Configuration for IDP

Table 16-3 Summary of Grinding Simulation Results

Parameter	Southwest	Hugo North
SAG Mill Feed F_{80} (mm)	52	40
Transfer Size T_{80} (mm)	4.4	4.4
Circuit Product Size P_{80} (µm)	164	195
SAG Mill Capacity (t/h)	3,519	4,128
Ball Mill Capacity (t/h)	4,186	4,259
Total Circuit Capacity (t/h) *	3,490	4,044
Pebble Circulating Load (%)	27	18

* Throughput rates are raw numbers discounted 10% for operational contingency and potential sample set bias

SECTION 17 MINERAL RESOURCE AND MINERAL RESERVE ESTIMATES

The mineral resources for Southern Oyu and Hugo North were estimated under the direction of Dr. Harry Parker, Ch.P.Geol., and Dr. Stephen Juras, P.Geo. in 2005 (Juras, 2005). The mineral resource estimate for Hugo South was also completed under the direction of Dr. Harry Parker, Ch.P.Geol., and Dr. Stephen Juras, P.Geo., but this work was done in 2004 (Juras, 2004a). Hugo South resources were not re-estimated in 2005 because no significant new drilling has been completed there since the previous estimate in June 2004.

The estimates were made from 3D block models utilizing commercial mine planning software (MineSight® for Southern Oyu and Hugo North, and Gemcom® for Hugo South). The project consists of two groups of deposits: Hugo Dummett (Hugo) and Southern Oyu (OTS), each represented by its own resource model. Hugo comprises Hugo South (HS) and Hugo North (HN), and OTS contains four deposits: Southwest (SW), South (SO), Wedge (WZ), and Central (CO). Projects limits are in truncated UTM coordinates. Project limits are 650500 to 652500 East, 4765000 to 4768200 North, and -660 to +1170 m elevation for Hugo and 649500 to 652000 East, 4762000 to 4765000 North, and -225 m to +1,170 m elevation for OTS. Cell size for the project was 20 m east x 20 m north x 15 m high. The block size for the Southern Oyu model was selected based on mining selectivity considerations (open pit mining). It was assumed the smallest block size that could be selectively mined as ore or waste, referred to the selective mining unit (SMU), was approximately 20 m x 20 m x 15 m. In this case the SMU grade-tonnage curves predicted by the restricted estimation process adequately represented the likely actual grade-tonnage distribution. For the Hugo Dummett models, mining selectivity was less of an issue because the mining method envisioned, block cave mining, does not easily yield to any selectivity. The same block size was used for ease of integrating the block models for mine planning considerations.

Only the hypogene mineralization was estimated (with the Central chalcocite blanket being the only exception). The base of sulphide oxidation surface defined the top of the hypogene mineralization in the Southern Oyu deposits.

17.1 Geologic Models and Estimation Domains

The data analyses demonstrated that all of the copper and gold grade shells in the Southern deposits should be treated as separate domains with respect to copper and gold. Additionally, the mineralized volcanic (Va) and Qmd units will be treated as separate sub-domains in Southwest for both copper and gold. Grades for blocks within the respective domains in each deposit or zone will be estimated with a hard boundary between them; only composites within the domain will be used to estimate blocks within the domain. Soft boundaries will be used between Qmd units and mineralized volcanic units in Central, South, and Wedge deposits.

At Hugo North, the data analysis showed that the mineralized and grade shells for copper and gold should be treated as separate domains with respect to grade interpolation. No distinctions were deemed necessary between inter-domain lithologic units. Some grade softening along the Quartz Vein domain and 0.6% Cu shell was implemented to reflect the transitional nature across that contact over 15 to 30 m. Hugo South results showed that the 0.6% and 2.0% shells for copper should be treated as separate domains with respect to grade interpolation. The 1.0% shell is more artificial, and some grade softening along its contact is necessary to avoid creating different distribution patterns relative to the composite data. Future modelling work at Hugo South, likely to happen only after the next phase of drilling, i.e. in-fill drilling to convert of indicated resources, should plan to use a philosophy more akin to that used at Hugo North: a mineralogy based higher grade copper domain (e.g. quartz veining) and a grade based lower grade domain (around 0.5%). The 1% shell should be eliminated. Finally a gold domain should also be constructed (0.2 to 0.3 g/t Au).

17.2 Grade Interpolation

Modelling consisted of grade interpolation by ordinary kriging (KG). The chalcocite blanket in Central was interpolated by grade averaging because of the small data population in this domain. Only capped grades were interpolated. Nearest-neighbour (NN) grades were also interpolated for validation purposes. Blocks and composites were matched on estimation domain. To reduce the impact of locally inaccurate block grades due to conditional bias at the grade shell boundaries, all blocks straddling those contacts were estimated twice with each of the composite sets on either side of the contact. The final block grade was calculated with a volume-weighted average of the two domain grades in that block. The effect is to slightly smooth the grades at the hard grade shell boundary so that the distribution of block grades more closely approximates the shape of the composite distribution.

The search ellipsoids were oriented preferentially to the orientation of the respective zone as defined by bounding structures or to the attitude of the relevant copper or gold grade shell. A two-pass approach was instituted for interpolation. The first pass allowed a single hole to place a grade estimate in a block, and the second pass required a minimum of two holes from the same estimation domain. This approach was used to enable most blocks to receive a grade estimate within the domains, including the background domains. The number of composites used in estimating grade into a model block followed a strategy that matched composite values and model blocks sharing the same ore code or domain. The minimum and maximum number of composites were adjusted to incorporate an appropriate amount of grade smoothing. This was done by change-of-support analysis (Discrete Gaussian or Hermitian polynomial change-of-support method).

For both metals, an outlier restriction was used to control the effects of high-grade composites within each of the domains in Southern Oyu and Hugo North, particularly in background domains and poorly mineralized units (e.g., Southwest Qmd). The threshold grades were generally set as the grade of the relevant grade shell, or the distinct break in the CDF curves in the case of poorly mineralized units. The restricted distances were 40 m in Southern Oyu and 50 m in Hugo North and Hugo South.

Final resource grade values for Southern Oyu and Hugo North were adjusted to reflect likely occurrences of internal and contact dilution from the unmineralized post-mineral dykes. The estimated mineral resources for Hugo North and Southern Oyu deposits were tabulated and reported using these adjusted or diluted grade values (whereas the 2004 Hugo South grades are undiluted and would need to incorporate additional dilution and allowances for mining recovery prior to conversion to mineral reserves).

17.2.1 Validation

AMEC completed a detailed visual validation of the Southern Oyu and Hugo Dummett resource models. Models were checked for proper coding of drill hole intervals and block model cells, in both section and plan. Coding was found to be properly done. Grade interpolation was examined relative to drill hole composite values by inspecting sections and plans. The checks showed good agreement between drill hole composite values and model cell values. The hard boundaries between grade shells appear to have constrained grades to their respective estimation domains. The addition of the outlier restriction values succeeded in minimizing grade smearing in regions of sparse data and, in general, all background domains.

An independent check on the smoothing in the estimates was made using the Discrete Gaussian or Hermitian polynominal change-of-support method. The grade-tonnage predictions produced for the various Oyu Tolgoi models show that grade and tonnage estimates are validated by the change-of-support calculations over the likely range of mining grade cutoff values (equivalent to about 0.4% to 0.6% Cu).

The block model estimates were checked for global bias by comparing the average metal grades (with no cutoff) from the kriged model (KG) with means from nearest-neighbour estimates. Results show no problems with global bias in the estimates. Local trends in the grade estimates (grade slice or swath checks) were also checked. This was done by plotting the mean values from the nearest-neighbour estimate versus the kriged results for benches (in 30 m swaths), northings and eastings (both in 40 m swaths). Results for copper and gold for Southern Oyu and Hugo Dummett domains show that the trends behave as predicted and show no significant trends of copper or gold in the estimates.

17.3 Mineral Resource Classification

The mineral resources of the Oyu Tolgoi project were classified using logic consistent with the CIM definitions referred to in National Instrument 43-101. Inspection of the model and drill hole data on plans and sections in the Southwest gold zone area, combined with spatial statistical work and investigation of confidence limits in predicting planned quarterly production, showed good geologic and grade continuity in areas where sample spacing was about 50 m. When taken together with all observed factors, AMEC decided that blocks covered by this data spacing in the Southwest gold zone area may be classified as Measured Mineral Resource. A three-hole rule was used where blocks containing an estimate resulting from three or more samples from different holes (all within 55 m and at least one within 30 m) were classified as Measured Mineral Resource.

The Indicated Mineral Resource category is supported by the present drilling grid over most of the remaining part of the Oyu Tolgoi Southern deposits. The drill spacing is at a nominal 70 m on and between sections. Geologic and grade continuity is demonstrated by inspection of the model and drill hole data in plans and sections over the various zones, combined with spatial statistical work and investigation of confidence limits in predicting planned annual production. Considering these factors, AMEC decided that blocks covered by this data spacing may be classified as Indicated Mineral Resource. A two-hole rule was used where blocks contained an estimate resulting from two or more samples from different holes. For the Southwest deposit the two holes needed to be within 75 m, with at least one hole within 55 m. For the remaining deposits, both holes needed to be within 65 m, with at least one hole within 45 m to be classified as Indicated Mineral Resource.

The Indicated Mineral Resource category is supported at Hugo North where the drill spacing is approximately 125 m x 75 m centres. Geologic and grade continuity is demonstrated by inspection of the model and drill hole data in plans and sections over the various zones, combined with spatial statistical work and investigation of confidence limits in predicting planned annual production. Considering these factors, AMEC decided that blocks covered by this data spacing may be classified as Indicated Mineral Resource. To help define the area outlined by this drill spacing, AMEC utilized an indicator variogram method (based on the Quartz Vein domain) where a suitable threshold value was selected by inspection relative to the observed drill hole locations.

All interpolated blocks that did not meet the criteria for either Measured or Indicated mineral resource at Southern Oyu or Hugo North were assigned as Inferred Mineral Resource if they fell within 150 m of a drill hole composite. Hugo South mineral resources only support being categorized as Inferred mineral resources. Interpolated Hugo South model blocks that fell within 150 m of a drill hole composite were assigned as Inferred mineral resources.

17.4 Mineral Resource Summary

The mineralization of the Oyu Tolgoi Project as of 3 May 2005 is classified as Measured, Indicated, and Inferred mineral resources. The total project mineral resources are shown in Table 17-1, reported at a copper equivalent cutoff grade of 0.6%.

The equivalent grade was calculated using assumed metal prices of US$0.80/lb for copper and US$350/oz for gold. For convenience the formula is:

CuEq = %Cu + (g/t Au*11.25)/17.64

The contained gold and copper estimates in the table have not been adjusted for metallurgical recoveries.

Table 17-1: Oyu Tolgoi Project Mineral Resources based on a 0.6% Cu Eq. Cutoff, 3 May 2005

		Grades			**Contained Metal**	
Mineral Resource Category	**Tonnes**	**Cu %**	**Au g/t**	**Cu Eq. %**	**Cu 000 lb**	**Au oz**
Southern Oyu Deposits						
Measured	101,590,000	0.64	1.10	1.34	1,440,000	3,580,000
Indicated	465,640,000	0.62	0.43	0.89	6,360,000	6,400,000
Measured+Indicated	567,230,000	0.62	0.55	0.97	7,810,000	9,980,000
Inferred	88,500,000	0.47	0.41	0.73	920,000	1,170,000
*Hugo Dummett Deposits**						
Indicated	581,930,000	1.89	0.41	2.15	24,250,000	7,600,000
Inferred	1,071,620,000	1.07	0.21	1.20	25,220,000	7,310,000
Total Oyu Tolgoi Project						
Measured	101,590,000	0.64	1.10	1.34	1,440,000	3,580,000
Indicated	1,047,570,000	1.33	0.42	1.59	30,610,000	14,070,000
Measured+Indicated	1,149,160,000	1.30	0.47	1.54	32,850,000	17,340,000
Inferred	1,160,120,000	1.02	0.23	1.16	26,200,000	8,400,000

* Hugo South values based on June 2004 Juras report

SECTION 18 OTHER RELEVANT DATA AND INFORMATION

Not used.

SECTION 19 REQUIREMENTS FOR TECHNICAL REPORTS ON PRODUCTION AND DEVELOPMENT PROPERTIES

19.1 Framework for IDP

The following summary provides an outline of the framework that guided the work on the IPD.

The Oyu Tolgoi property contains a large copper-gold resource recoverable by a combination of open pit methods and large-volume block-cave mining. The open pit mine designs were developed from a mineral resource model with 92% of the tonnage in the Measured or Indicated category (at 0.3% Cu equivalent cutoff grade). The primary underground mine resource, Hugo North, contains the majority of the economic value of the property. The underground block-cave mine designs were developed from a mineral resource model with 50% of the tonnage classified as Indicated and 50% as Inferred (at 0.6% Cu equivalent cutoff grade).

Ongoing drilling has encountered mineralized intersections that suggest the presence of an extension to the physical boundaries of the current resource.

Initial production from the open pit will be processed through a conventional 70,000 t/d crushing, grinding, and flotation circuit using proven technology and equipment sizing developed from extensive mineral processing testwork. Testwork has also confirmed that this circuit can process the higher-grade Hugo North ore at a rate of 85,000 t/d if additional capacity is added to the flotation and filtration circuits.

The open pit mine design is complete and optimized. It will provide the primary feed to the mill for the first few years until production from Hugo North ramps up. Stockpiled open pit material also tops up production from the underground for several years. Open pit mining will be done with a fleet of 220 to 240 tonne trucks and hydraulic shovels operated by IMMI. IMMI employees will be trained in block-cave mining methods for Hugo North, which, when combined with open pit ore, will provide feed to the mill for 40 years. This development and production scenario represents the ***base case*** for project assessment.

Construction of an exploration/early development shaft for Hugo North has begun. To maximize project value from the high-grade Hugo North deposit, this evaluation assumes that construction of a second production shaft will commence in 4Q 2005 and of a third 18 months later, both prior to obtaining results from the initial exploration shaft program.

A major ***expanded case*** was evaluated in which plant production increases to 140,000 t/d after Hugo North reaches its peak base case mining rate. The assessment of project economics for the expanded case is based on preliminary capital and operating cost estimates. To achieve this feed rate, production from Hugo North would be increased to over 90,000 t/d, the Hugo South deposit would be mined at a rate of 50,000 t/d, and open pit push-backs would be developed.

Planning associated with the initial phase of project development the Southwest open pit, concentrator, and infrastructure component is well advanced. However, commencement of development will need to be coordinated with the conclusion of current negotiations and discussions related to:

- the Special Stability Agreement with the Government of Mongolia
- a reliable electrical power supply
- VAT and import duty payments on materials and equipment
- a location on the Chinese mainline rail system for concentrate transfer from trucks loaded at Oyu Tolgoi
- Mongolian and Chinese government agreement to continuously open the border crossing at Gushaan Sukhait / Ganqimaodao.

Oyu Tolgoi is located in an isolated region of Mongolia with little developed infrastructure. The site is, however, only 80 km from the Chinese border, where resources do exist to support the project in the energy, transportation, manufacturing, and construction areas. The development plan for the project is therefore based on the principle of maximizing Mongolian content while involving and realizing the benefits of the resources in China. Balancing the dual objectives is seen as achievable.

Western companies with recent experience on major industrial developments in China have confirmed the presence of an experienced construction industry capable of working to international standards of quality and completing projects on schedule. The implementation plan assumes that Chinese construction capacity and experience will fill the gaps where Mongolian resources need to be augmented.

It is also assumed that the Chinese road and rail transportation systems can accommodate the movement to site of imported materials required for construction and operations and the shipment off site of all concentrate produced at the process plant. This will need to be confirmed.

The rail system between the southern Gobi area and northern China is expected to be augmented by the construction of a new rail line connecting the anticipated coal field development at Tavan Tolgoi, 140 km northwest of Oyu Tolgoi, to an existing Chinese railhead. Construction of a rail link to this new line is an important requirement for the project in about Year 4 of operations, when concentrate production will exceed the reasonable capacity of the early trucking system. Under the expanded case, three or more trains would be loaded with concentrate every day. Completion of these related developments in time to support Oyu Tolgoi is one of the base assumptions for the IDP.

The Mongolian population generally has a strong basic education, although experienced mine labour is scarce. IMMI is committed to operating the project with a 90% Mongolian workforce within five years of start-up. To make this possible, IMMI has identified the need and allowed funding for a major training initiative that encompasses a dedicated facility, experienced trainers, and modern equipment. During the early production years, experienced expatriate personnel will provide commissioning and training support to help bring the capacity and productivity of Mongolian employees to equivalent Western standards.

The results of a significant program of environmental and socioeconomic assessment suggest that environmental concerns can be managed and that the socioeconomic benefits to Mongolia will be substantial. Two of three Environmental Impact Assessment reports for the project have been submitted. The first was approved by the Mongolian government in May 2004. The second was submitted at the end of June 2005, and the third will be ready later in the year. Approvals of these reports are expected to be a prerequisite to project approval. Regulatory review and approval is assumed to support the proposed project development schedule.

To date no environmental or socioeconomic baseline or assessment work has been conducted for China-related components of the project. The Chinese regulatory approval processes and subsequent construction period associated with rail facilities are also expected to support the project development schedule.

A project risk assessment concluded that although IMMI must address and resolve several critical issues before commencing project development, no risks have been identified that, if managed to a reasonable conclusion, would jeopardize the successful development and operation of the project. It is assumed that a risk mitigation and management system will be implemented.

19.2 Mine Plan

The mine plan for Oyu Tolgoi is based on initial open pit mining followed by an emphasis on underground mining to provide the majority of plant feed over the life of the project. Open pit mining after the initial production period is scheduled to suit the priorities of the underground mine and varies for the two project scenarios (base case and expanded case).

Block modelling and optimization have identified nine open pit stages at the Southern Oyu deposits and three block caves at the Hugo Dummett deposit.

From analysis of various open-pit-only, underground-only, and combined mining schedules, the relative ranking of the deposits in terms of highest to lowest value is Hugo North, Southwest, Hugo South, and Central. However, considering the lead-time required to develop and bring the block caves to full production, the following life-of-mine mining sequence was developed:

Open Pit	Southwest (stages 1 & 2)
Underground	Hugo North Lift 1
Open Pit	Southwest (stages 3 & 4)
Underground	Hugo North Lift 2
Underground	Hugo South
Open Pit	Southwest & Central (stages 5 to 9)

Not all open pit stages are used in the present mine plan.

19.3 Scheduling Scenarios

The IDP examines two scenarios:

Phase 1 base case, 70,000 to 85,000 t/d.
Plant feed is from two Southwest open pit stages and two Hugo North block caves.

Phase 2 expanded case, nominal 140,000 t/d.
Plant is essentially doubled in size and feed is from the first four open pit stages, two Hugo North block caves, and one Hugo South block cave.

Figure 19-1: Open Pit and Underground Scheduling Blocks for Expanded Case

In both cases, timely underground development is the critical path for ore production from Hugo North Lift 1.

The mining rate from the open pit stages and block caves was based on the blending requirements for plant feed. The following metallurgical ore types have been defined:

Ore Type	*Deposit*	
1	Southwest	
2	Central	chalcocite
3	Central	covellite
4	Central	chalcopyrite
5	Hugo South	
6	Hugo North	

The base case limits production from Hugo North Lift 1 to 30 Mt/a and defers the latter stages of the open pits until after Hugo North Lift 2 comes into production. For these reasons Phase 2 has been examined as a production scenario that could maximize the project value. The decision to proceed or not with Phase 2 can be made as Hugo North Lift 1 production is ramping up to its Phase 1 rate.

Other scenarios, such as scheduling the entire underground and open pit inventories, are yet to be completed. The number of open pit stages that have been identified provides opportunity for risk reduction if underground development should be delayed.

Mine planning work for the open pits is based on Measured and Indicated resources only, while the underground mine planning uses both Indicated and Inferred resources to generate production schedules.

19.3.1 Approach to Scheduling

The approach to production scheduling was based on balancing mining, milling, and stockpiling quantities:

> Timing of the mining stages and block caves is determined by the plant throughput rate for each blended ore type. Plant capacity ramps up over the first 18 months after commissioning.
>
> Underground production is considered the priority mill feed because of its higher NSR values. Open pit production is scheduled around the underground mining requirements.
>
> The underground production schedule incorporates development requirements and initiation of the block caves.
>
> Open pit mining rates are based on the number of shovels available and required throughput of mid-value NSR cutoff ore. Mining inventories are reported by bench within the selected pit shells.
>
> In Phase 2, production from different pit stages is balanced to obtain an operationally practical mining schedule with smooth waste and ore production rates throughout the mine life. The mining rate is balanced by using low-grade stockpiles where necessary.
>
> Material from the low-grade stockpiles supplements underground ore after exhaustion of the open pits.

19.3.2 Base Case Production Schedule

First ore treatment in the plant is scheduled for mid-2008. Open pit mining commences the year before to match the staggered delivery and commissioning of shovels and other equipment. Underground access and development continue from Hugo North Shaft 1, which is currently being constructed. Development of Shaft 2 begins in 2006. Medium- and high-grade ore from open pit preproduction is stockpiled and processed in 2008. Low-grade ore is stockpiled separately for feed at the end of open pit mining. Only materials from Southwest (ore type 1) and Hugo North (ore type 6) are processed in the base case. The average mining rate is 25.5 Mt/a from the open pit and 30 Mt/a from Hugo North over a mine life of 40 years.

The high gold grades from the pit and very high copper grades from underground indicate the source of early gold production from the combined feed and reinforce the high value of the underground ore. Lower copper and gold grades after 2013 are from low-grade stockpiled material from the open pit.

Figure 19-2: Ore Processing by Metallurgical Ore Type Base Case

Note: Bars show kt feed to the mill from stockpile

Figure 19-3: Copper Feed Grades Base Case

Figure 19-4: Gold Feed Grades Base Case

19.3.3 Expanded Case Production Schedule

The preproduction and initial years of the expanded case are the same as the base case. The difference is that open pit mining continues with the stripping of stage 3 and plant capacity is expanded as Hugo North Lift 1 production reaches and passes 30 Mt/a. Hugo South is developed and begins production to replace the open pit resources.

The average mining rate is 52.5 Mt/a from all ore sources over a mine life of 35 years.

In the expanded case two additional Southwest pit stages and increased production from Hugo North Lift 1 provide the ore for the larger plant. The expansion also allows Hugo South to be mined much earlier than would be possible in the base case. The remaining open pit stages (5 to 9) are not included but would be available to expand the project life beyond the current schedule.

Figure 19-5: Ore Processing by Metallurgical Ore Type Expanded Case

Figure 19-6: Copper Feed Grades Expanded Case

Figure 19-7: Gold Feed Grades Expanded Case

19.4 Open Pit Mining

The open pit design work was performed by GRD Minproc Limited, focusing on the Southern Oyu deposits. Recognizing the ultimate benefit to the project of exploiting the underground resources in Hugo Dummett, the plan provides for flexibility in grade and tonnage scheduling. The open pit mine plan is based on a mineable resource of Measured and Indicated material.

Key geotechnical design parameters were provided by Steffen Robertson Kirsten (Australiasia) Pty Ltd based on extensive geotechnical studies. The geotechnical assumptions will be validated by the implementation of a slope management programme including the collection and review of pit wall piezometric data and pit slope performance using extensometers, survey prisms monitoring or slope radar.

19.4.1 Pit Optimization

Pit optimization and mine design were carried out on a preliminary resource model prepared by IMMI in February 2005. This model formed the basis for the AMEC model produced in May 2005. A comparison of the two models showed only a small difference in mining inventory within pit shells that were essentially the same. Only resources classified as Measured or Indicated in the block model were used in the optimization and production scheduling. Inferred resources were treated as waste. The resource model grades incorporate dilution, including the small-scale dykes that intersect the mineralized zones.

Using the model grades, the net smelter return (NSR), or revenue paid for the concentrate at the mine gate, was calculated for each block. Silver was not included in the pit optimization but was included in the production schedules. The NSR calculation excludes costs for mining, process, and G&A and is the in-situ value after:

- recovery to concentrate
- smelter deductions
- concentrate transport
- smelter treatment and refining charges
- impurities
- royalties.

The resulting NSR values were used to classify the ore blocks in the pit optimization and also as economic cutoffs as reported in the mining inventories.

Based on the NSR values, the open pit optimization was completed in the Whittle Four-X software program, which is considered a standard mining industry tool.

19.4.2 Open Pit Mine Design

Based on the pit optimization results, the objective of the pit development strategy was to minimize the early mining costs and maximize the early return from the open pit operation. Nine open pit mining stages, all within the Southwest and Central deposits only, were identified to allow for all life-of-mine options. Only designs for stages 1 to 7 were considered for production scheduling. Stages 8 and 9 are pit optimization shells that require further work as mine planning proceeds. The open pit inventory by stage is shown in the table overleaf.

Preproduction ore is from stage 1 only. The base case production schedule is generated from mining stages 1 and 2, while the expanded case uses stages 1 to 4.

Basic Design Criteria

Average cutback width	150 m
Minimum mining width	40 to 50 m
Bench height	15 m
Bench stack height limit	
Weathered rock	60 m
Unweathered rock	90 m
Berm width	7.0 to 11.5 m
Bench face angle (assuming drained slopes):	
Weathered rock	65°
Unweathered rock	75°
Wall slopes (LOSA)	40° to 50°
Horizontal drainage (behind pit wall)	100 to 200 m

Table 19-1: Open Pit Resource Inventory by Stage

Stage	Total Movement kt	Waste kt	Ore kt	NSR $/t	Cu %	Au g/t	As g/t	Ag g/t	F ppm
1	125,635	74,742	50,892	15.39	0.58	0.89	9.97	1.42	2,124.28
2	197,635	125,312	72,323	11.11	0.49	0.56	12.41	1.31	1,981.79
3	259,784	176,222	83,562	9.91	0.45	0.49	19.00	1.35	1,615.07
4	83,196	44,009	39,187	9.21	0.61	0.19	76.49	1.88	1,898.57
5	35,163	20,505	14,658	7.43	0.40	0.32	20.25	1.05	1,374.76
6	33,042	19,526	13,516	10.56	1.01	0.12	252.42	1.46	2,189.26
7	312,355	171,644	140,711	8.42	0.65	0.16	168.42	1.38	1,914.54
8	315,765	169,459	146,306	8.18	0.40	0.40	21.46	1.19	1,596.48
9	1,302,292	984,298	317,995	8.12	0.48	0.29	86.61	1.13	1,743.69
Total	2,664,866	1,785,717	879,150	9.09	0.51	0.36	72.89	1.27	1,783.53

Waste Dumps and Stockpiles

Dumps and low-grade stockpiles will be constructed as required for each stage of open pit mining. Dump heights will vary between 50 m and 60 m depending on topography and waste volumes.

The low-grade stockpile area has a capacity of approximately 100 Mt at 40 m height to accommodate all mining scenarios. An overall slope of 18° was considered in the preliminary design of the waste dumps and stockpiles. In the calculation of the waste dump capacities, it is assumed that the swell of bank volume would be 30% after taking into account some natural sorting and compaction on the dumps.

Because Oyu Tolgoi is in an arid area with very low rainfall, no significant acid rock drainage (ARD) issues are expected. The base of the dumps will be sealed by working the subsurface clay materials. Potentially acid forming (PAF) material will be encapsulated within non-acid-forming (NAF) material, and the final surfaces will be capped with rock armouring. This methodology will be suitable for progressive construction and rehabilitation of the dumps.

19.4.3 Open Pit Mining Operations

Open pit mining at Oyu Tolgoi will be a conventional shovel-truck operation. Drilling, loading, hauling, and dumping will be carried out by the Owner s workforce. Blasting products and services will be provided by a contractor, and equipment maintenance will be performed under a MARC arrangement. The open pits will be operated 24 h/d, on two 12-hour shifts, nominally 340 d/a. It was assumed that 25 days per year will be lost due to unscheduled delays such as weather conditions. The total workforce is estimated to vary from approximately 400 to 448 personnel, including management and labour, from start-up to peak requirements.

Table 19-2: Open Pit Mining Equipment Requirements

Equipment	Start-up	Peak
Hydraulic Shovels	2	3
Mining Trucks	13	23
Rotary Drill	2	3
Hydraulic Excavator (Phase 2 only)		1
Wheel Dozers	1	1
Track Dozers	3	4
Graders	2	2
Loaders	1	1
Water Carts	2	2

Drilling and Blasting

Rotary blasthole drills will be used to drill 17 m deep, 305 mm diameter blast holes. A secondary drill is provided for pre-split blasts, secondary drilling, and the horizontal drain holes specified in the geotechnical recommendations. ANFO will be used in dry holes and heavy ANFO in wet holes. Given the prevailing conditions, most blasting is expected to be dry.

Loading and Hauling

The primary loading unit will be 28 m^3 bucket diesel hydraulic shovels. In normal operation, one shovel will be mining mainly ore and the other(s) will be stripping waste. The shovels will load to 220 to 240 tonne diesel mechanical trucks for transport to the mill site or the waste dumps

The ore will be dumped directly to the crusher or stockpiled for reclaim. Waste will be distributed to the dump areas either through temporary ramps accessing the upper levels of the pits or via the final designed ramps in the pit stages. An 18 m^3 front-end loader will be used for dropcut excavation and backup loading capacity.

Support Equipment

Conventional ancillary equipment will support the loading and hauling operations. Pit dewatering will be by diesel-powered pumps from in-pit sumps to a tank at the crusher. Pit dewatering is not expected to be a major issue at Oyu Tolgoi.

19.5 Underground Mine Development

The Hugo Dummett deposit will be mined by block caving, a cost-effective method where applied under suitable conditions. The deposit has two zones, North and South, both having dimensions, tonnages, and grades comparable to other deposits currently exploited by block-cave mining elsewhere in the world. Hugo North is the most attractive target for mining.

McIntosh s assessment for the IDP is based on the results of exploration and development drilling to March 2005, from which IMMI and AMEC derived the currently defined resource tonnage and grades. SRK Consulting (Canada) reviewed geotechnical data and conducted the necessary geotechnical analyses of data collected and collated from all drill core. SRK s findings are supportive of the block-cave mining method and integral to McIntosh s assessment.

Presuming that the current defined resource tonnages and grades are substantiated during underground development and operations, the assessment indicates that block-cave mining at Hugo North could produce 1,155 Mt averaging 1.249 % Cu and 0.299 g/t Au over a 43-year mine life. For the base case evaluation, peak ore production is 30 Mt/a, or approximately 85,000 t/d.

Further increases could be realized in the Indicated and Inferred resources of Hugo North. Two adjacent areas with resource potential have been identified: a northern extension on strike, down plunge, and on approach to and within property held in joint venture with Entrée Gold Inc.; and additional deposits on the south and west fringes of Hugo North. An IMMI drilling program is currently underway in the northern extension area.

Table 19-3: Summary of Hugo North Assessment Base Case 85,000 t/d (June 2005)

Mined Resource	
Hugo North Lift 1	
Tonnes (including development)	576.5 M
NSR ($/t)	24.89
Cu Grade (%)	1.463
Au Grade (g/t)	0.286
Hugo North Lift 2	
Tonnes (including development)	578.6 M
NSR ($/t)	17.81
Cu Grade (%)	1.035
Au Grade (g/t)	0.312
Production Schedule	
Hugo North Lift 1 Start	2010
Lift 1 Life (years)	25 years
Hugo North Lift 2 Start	2028
Lift 2 Life (years)	24 years
Peak Ore Production Start	2015
Peak Ore Production End	2050
Mine Ore Production End	2051
Total Mine Life (years)	43 years

19.5.1 Deposit Assessment

A critical consideration for development of the deposit is assurance that the resource will cave. SRK has visited the Oyu Tolgoi site several times to inspect and log certain drill core and to guide IMMI s, collection and collation of geotechnical data. SRK and McIntosh concur that the Hugo North zone will cave productively.

SRK reached the following conclusions in its analyses:

> The mineralized rock mass of the Hugo North orebody is cavable at a hydraulic radius of 20 to 27 m. This is the equivalent of a footprint of approximately 80 m x 80 m to 110 m x 110 m. The current footprint of the caving envelope for both lifts greatly exceeds this hydraulic radius.

> The rock mass is characterized as an average cavable rock mass (not Palabora and not Cassiar) ...the Hugo North rock mass is less competent than Northparkes or Ridgeway, which caved at a smaller hydraulic radius.
>
> It is estimated that shear zones and faults will further improve the cavability by at least 5% to 10%.

AMEC s estimates of copper and gold grades within the Indicated and Inferred resources of Hugo North at an equivalent cutoff of 0.6% Cu suggest metal content of more than 38 billion pounds of copper and more than 13 million ounces of gold, representing one of the largest such deposits in the world. The combined Indicated and Inferred resources for Hugo North and Hugo South exceed 1.5 billion tonnes.

A high-grade starter zone has been identified within Hugo North. Scoping-level studies have been performed based on resource estimates by IMMI and AMEC, mining assessments by McIntosh, and processing and administration assessments by AAJV and others. These studies support the contention that the Indicated resource of 184 Mt grading 1.987% Cu and 0.419 g/t Au can be mined and processed over the first 10 years to enhance project economics.

The Hugo North mineral resource plunges to the northeast. Its current base is near the minus 400 m elevation (1,600 m below surface). The caving shapes foreseen are 1,500 m long x 200 to 700 m wide x 300 to 500 m high. The resource dimensions are considered suitable for block caving and place the mine into the category of deep caving.

19.5.2 Lift 1 Development Plan

It is proposed to construct and operate Hugo North Lift 1 in a way that permits increasing ore production in a sequence of steps from approximately 15,000 t/d to 60,000 t/d and finally to 85,000 t/d. This sequence takes 11 years to execute from the date of project approval, or 6 years from initial to full production. Timely completion of shafts, primary development, underground installations, and secondary mine development is critical to achieving the forecast tonnages.

To enable production ramp-up, the following major tasks will need to be executed concurrently or sequentially:

- constructing and commissioning:
  - Shaft 2 (one friction-type service hoist and one friction-type production hoist)
  - Shaft 3 (two production hoists)
  - Shaft 4 (one production hoist)
- annually constructing 60, then 96, and eventually 120 drawpoints on Lift 1.

It should be noted that to meet the schedule, Shafts 2 and 3 and some associated lateral work will need to be developed before the necessary information for a feasibility study on Hugo North is obtained from the Shaft 1 exploration program.

Assuming Hugo North is developed to produce 85,000 t/d of ore, it will be one of the world s largest block-caving operations exploiting a single, contiguous mineralized block.

19.5.3 Underground Mining Method

Block caving is a safe, proven, and highly productive method for extracting bulk ore tonnages from underground mines. It involves undercutting part of the orebody across a plan area, causing the overlying rock to collapse. The collapse of the ore, or cave, is by design and is accomplished in a deliberate, controlled, and predictable manner. Initially, the ore is undercut and induced to cave by blasting. Thereafter, the blasted ore falls into an array of drawpoints beneath the initial cave area and is removed by load-haul-dump (LHD) equipment. As broken ore is removed, the pile within the cave slumps, creating a void, which in turn promotes further caving.

The cumulative plan area overlying the drawpoints is called the cave footprint. Four sublevels will be developed under and adjacent to the orebody. The first two, undercut and extraction, are necessary to initiate and sustain ore production. The others are known as the ventilation and haulage sublevels.

Figure 19-8: Block Cave Mining Method

Offset Herringbone Pattern

El Teniente Pattern

19.5.4 Design and Planning Considerations

Block caving is expected to result in surface subsidence. To preserve the integrity of the mine shafts and principal infrastructure, the shafts and infrastructure will be grouped together in a farm approximately 1,500 m due west of the centreline of the resource.

All mining crews, materials, and supplies required to construct and operate the block cave will be lowered and/or raised 1,300 m within a service shaft.

All ore and waste rock will be lifted 1,500 m to surface by one of four friction hoists after being hauled 1,100 m from the block cave by a combination of underground loader, train, and conveyor.

Collar-to-collar, the mining crews will transit roughly 6,000 m. From collar to workplace, materials and supplies will transit 3,000 m.

Mongolia is a developing country and Oyu Tolgoi is an extremely remote frontier site. In addition to the challenge of attracting and retaining a qualified workforce of both national and expatriate personnel, arranging vendor support for mining equipment will need particular attention.

19.5.5 Cost and Schedule Issues

Costs have been estimated to a scoping level of study for the following:

- hoisting plants
- underground primary mine development and equipment, including ventilation and haulage drifting, crushing, conveying, bins, skip loading, shops, warehouses, explosives magazines, shaft bottom access, and mid-shaft roping arrangements
- undercutting, panel drifting, drawpoint construction, and ore production loading operations
- mine operations.

The costs and schedules to complete these requirements are considered achievable, recognizing that substantial contractor/expatriate participation will be required until Mongolian employees are able to consistently demonstrate the necessary skills and performance standards. The construction and development schedule is critical, however, and is without slack. The proposed hoists, shaft conveyances, and payloads have been proven in operation at other mines, but will be among the largest ever constructed. Given sufficient time to stabilize production and crew performance, operating costs could be below the mid-point of those at all other existing block-cave mines.

19.5.6 Geotechnical

A significant amount of geotechnical information is available about the Hugo North mineralized resources, but the actual underground setting has not been observed, and the resource has never been blocked out from a drift.

Little drill core has been obtained from the proposed locations of the mine shafts and primary underground development. At this stage, assumptions for shaft and development advance rates and ground support are preliminary. Geotechnical core drilling is currently underway.

As yet, there are no data to characterize the groundwater regime in the underground mine area. Groundwater quality, quantity, source points, and durations of influence have implications for several operating conditions:

- potential inrush and/or mudrush
- dust control
- mine pumping
- water treatment
- process water quality and quantity
- corrosion
- shaft maintenance
- hoist rope life.

19.5.7 Caving Predictability

If the orebody does not cave as effectively as predicted, or if it does cave but the cave muck is exceedingly fine, then recovery of mineral resources may be slowed, and, in severe cases, some resources could be lost. Although drawpoint control and cave management are intended to mitigate this possibility, it could take some time to recognize that caving is not taking place as expected.

On the other hand, more-effective caving than predicted could accelerate mine production.

19.6 Process Facilities

The largest conventional and industry-proven components were selected for the initial production rate of 70,000 t/d. The grinding circuit consists of a single 12.2 m x 7.5 m (40 ft x 24.5 ft) SAG mill, equipped with a 24.5 MW drive, feeding a pair of 8.2 m x 13 m (27 ft x 43 ft) ball mills, each driven by a 18.6 MW gearless drive. As the softer Hugo North ores displace Southwest ore, the capacity of the grinding circuit increases to 85,000 t/d. Grinding and flotation capacity will be increased to more than 140,000 t/d for the expanded case.

All aspects of facility design are focused on minimizing water consumption as much as practicable.

No new technology is employed in the design, and all the equipment specified for the process is proven. Use of the largest available machinery will minimize the number of equipment units, thereby reducing the footprint and complexity of the facility. The plant will employ advanced communications and control methods.

The sampling densities used in the metallurgical test program were sufficient to describe the ore within reasonable limits, and the plant specified will be able to attain the target production with this ore.

Figure 19-9: Concentrator Facilities

19.6.1 Process Description

Primary Crushing and Conveying

During the 70,000 t/d phase, the primary source of ore will be the Southwest open pit. Ore will be hauled to a gyratory primary crusher. A run-of-mine (ROM) ore stockpile near the crusher will absorb fluctuations in mine production and facilitate the blending of different ore types. Crushed ore from the primary crusher will be conveyed to a covered stockpile near the concentrator. The stockpile building will have a maximum capacity of three days supply of ore for the mill; the maximum live load capacity will be one day.

Ore released during development of the underground mine and initial underground production will be trucked to the open-pit primary crusher and blended with open-pit ore. During the 85,000 t/d phase, underground ore will be delivered to a half-day surge pile near the mine shaft farm and conveyed overland to the coarse ore stockpile.

Secondary Crushing

Coarse ore will be reclaimed from the stockpile by four belt feeders and be discharged over a vibrating grizzly with bars at 65 mm spacing. Undersize from the grizzly (approximately half of the coarse ore) will fall onto the grinding mill feed conveyor, and the oversize will be conveyed to two secondary cone crushers with closed-side settings of 50 to 65 mm. The crusher discharge will join the grizzly undersize on the feed conveyor to the SAG mill. This circuit will accommodate both the 70,000 t/d and 85,000 t/d cases.

Figure 19-10: Oyu Tolgoi Simplified Flowsheet

Grinding

The grinding equipment will be based on the largest units currently in use (at Collahuasi in Chile). The SAG mill will be a single unit 12.2 m x 7.5 m (40 ft x 24.5 ft) in size with a 24.5 MW wrap-around variable-speed drive.

SAG mill discharge with a top size of 75 mm will pass through a trommel screen with 13 mm openings, where the bulk of the water and fine solids will be removed. The oversize will be washed over a vibrating screen, also equipped with a 13 mm screen deck. Undersize from the trommel and vibrating screens will collect in a pumpbox for transfer to the ball mill circuit. The washed pebbles will be conveyed to a bin ahead of two 746 kW cone crushers.

Self-cleaning electromagnets on the conveying system will protect the cone crushers from tramp grinding steel. Crushed pebbles will report to a vibrating screen with a 13 mm deck located above the SAG mill discharge pumpbox. Water sprays will thoroughly wet and slurry the screen undersize, which will then mix in the SAG mill discharge pumpbox with the undersize from the other screen.

Grinding circuit throughput will normally (90% to 95% of the time) be limited by the SAG mill capacity. When the crushers are not available, or when pebble production is excessive, a bypass feeder will draw uncrushed pebbles from the bin and deposit them on the SAG mill feed belt.

Figure 19-11: Crushed Ore Conveyor and Stockpile

Figure 19-12: Grinding Circuit

Pressure distributors will divide undersize from the SAG mill circuit screens between two ball mills in closed circuit with 838 mm cyclones. The ball mills will be 8.23 m diameter x 12.95 m long (27 ft x 43 ft), with 18.6 MW variable-speed wrap-around drives. Cyclone overflow, at about 33% solids and an average 80% passing particle size of 150 µm, will report to the flotation circuit. The grinding circuit will accommodate both the 70,000 t/d and 85,000 t/d cases due to the differences in grinding energy required for the Southern and Hugo ores.

Flotation

The testwork programs have led to a simple, typical porphyry copper flotation circuit with no unusual features or equipment. Ball mill cyclone overflow will gravitate to three rows of eight 160 ^{3} tank-type rougher flotation cells. Rougher concentrate will be combined with cleaner-scavenger concentrate, classified, and reground by four 1,119 kW vertical stirred mills in closed circuit with a cluster of twelve 508 mm cyclones. Regrind cyclone overflow, at a particle size of 80% passing 25 µm, will be cleaned in two parallel rows of four 160 m^3 cleaner cells followed by four 160 m^3 scavenger tank-type flotation cells.

The cleaner-scavenger concentrate will be combined with rougher concentrate for regrinding. Cleaner-scavenger tailings will be combined with rougher tailings and pumped to the tailings thickeners. The first cleaner concentrate will be pumped to a distributor feeding four 4.5 m diameter x 14 m high recleaner column cells. Recleaner column tailings will be combined with primary regrind cyclone overflow and routed to the cleaner/scavengers.

For 85,000 t/d operations, the vertical stirred mill circuit will be duplicated to provide eight mills for regrinding the combined rougher concentrate and cleaner-scavenger concentrate. The cleaning circuit for regrind cyclone overflow will be expanded from two to three parallel rows of eight flotation cells. The circuit for the first cleaner concentrate will be expanded from four to twelve recleaner columns.

Concentrate Dewatering and Storage

Final concentrate will be thickened to 65% solids in two 20 m diameter, high-rate concentrate thickeners and stored in an agitated surge tank prior to filtration. When the plant is expanded for the 85,000 t/d phase, a third thickener and second stock tank will be required. Automatic pressure filters will reduce the concentrate moisture to less than 9%. Two 108 m2 filters will be required for 70,000 t/d operation. For the 85,000 t/d operation processing the high-grade Hugo North ore, these two filters will be converted to 144 m2, and two additional 144 m2 units will be installed. Because of the cold winters, the concentrate thickeners and the stock tanks will be enclosed in a building, with the concentrate filters on a floor above a concrete bunker providing storage for approximately 10 days of production. Shuttling, reversible conveyors below each filter will intercept the falling concentrate and distribute it along the length of the bunker.

Concentrate Load-Out

During the initial operations phase, a wheel loader will load the concentrate into trucks for transport to a railhead in China. During the Phase 1c expansion, rail service will be available at the mine, and a rail siding will be routed through the loading point. The filter plant and storage shed will be enlarged to double the storage capacity, and a second loading point will be added. Wheel loaders will fill the railway cars from the pile below the filters.

Tailings Disposal

Flotation tailings will be thickened to 55% to 65% solids in two 125 m diameter tailings thickeners. The thickener rakes, designed for winter operation, will be traction driven. Thickened tailings will be pumped through two tailings lines to a booster pumpstation near the tailings storage facility (TSF). The tailings lines will follow a graded corridor to allow the tailings lines to drain into the booster pumpbox if operations are interrupted. Two two-stage booster pump lines will distribute tailings around the TSF.

Process Water

Process water will be supplied from two ponds at the concentrator, each capable of storing 24 hours requirement. Make-up water will be added to the pond from the raw water supply system to maintain the inventory. The ponds will collect reclaim water from the thickener s tailings dam, surplus water from mine dewatering, and runoff from the site drainage containment system.

Raw water from the borefield will be pumped to a tank close to the process plant for use in fire fighting, cooling, gland seal, column sprays, and other applications where clean water is required.

Grinding Media and Reagents

Grinding balls will be delivered from China and dumped into storage bins at site. Ball feeders will meter the balls from holding bins onto the SAG mill feed belt, and onto conveyors delivering balls to the feed chutes of the ball mills. Grinding balls for the lime slaking mill and the regrind mills will be loaded into buckets and charged to the mills by the bridge cranes.

Flotation reagents will be obtained from international suppliers, generally through Chinese-based affiliates. Storage will be provided for a six-week supply of unmixed reagents and for a one-day supply of diluted, mixed reagent. Quicklime will be received in bulk from China and stored in a silo capable of holding a two-week supply. Quicklime will be slaked as required to maintain a one-day supply of slurry in holding tanks.

19.7 Concentrate Handling and Shipping

19.7.1 Concentrate Transport to Railhead

Mongolia is land-locked and lacks developed ground transportation infrastructure. Because smelters within China will be the primary customers for the concentrate, a transportation link connecting Oyu Tolgoi with the rail system in northern China will be created. Wuyuan, China, was assumed to be the railhead location for study purposes.

For the first three years of operations, concentrate will be loaded into 40 tonne trucks for transport to Wuyuan. The operation will be conducted 24 h/d, requiring more than 50 trucks each day in Year 3. Because the route passes through heavily populated areas, operating procedures will need to be negotiated with the communities to address safety and environmental concerns.

By the beginning of the fourth year, the trucking operation will be replaced with rail transport. A rail line expected to be constructed as part of the development of regional coalfields to the northwest of Oyu Tolgoi will pass within 40 km of the mine site, en route to northern China. A spur line will be constructed to the mine site, directly connecting Oyu Tolgoi to the Chinese rail system. Peak production rates arising from the Phase 2, 140,000 t/d mining schedule reach 2.5 million wmt/a, requiring an average of four trainloads per day. Capital costs for the connecting spur and the on-site track are included in project costs as part of Phase 1c development. No costs are included for the rail link between China and the coal fields or for road upgrades required within China.

19.7.2 Concentrate Transport to Smelters

Pricing for concentrate transport from Wuyuan to smelters was estimated based on concentrate production information and the likely mix of smelter customers. Potential customers within an average distance of 1,800 km from site have been identified for approximately 0.5 Mt/a of concentrate, which represents most of the production for each of the first three years. As production expands, IMMI anticipates that volumes of between 0.5 and 1 Mt/a would be sold to Chinese smelters within an average rail distance of 2,300 km from site. Quantities in excess of 1.5 Mt/a would be sold to smelters in Asia, exported through the Chinese port of Tianjin.

The average estimated cost of concentrate transport from Oyu Tolgoi to the smelters varies from US$38.17/wmt in the early years, when the first leg includes trucking, to as low as $20.15/wmt once the rail line to site is in place.

19.8 Tailings Management

The design of the tailings storage facility (TSF) is based on testwork conducted by Knight Piésold. The tailings were classified as predominantly silt-sized with low plasticity. The settling rate is moderately fast (95% of final settled density within five days), and relatively high final settled densities are achievable with up to 42% of the initial water volume released as supernatant.

Geochemical characterization of tailings samples concluded that most of the tailings are non acid forming (NAF) and only a small proportion is potentially acid forming (PAF). The PAF tailings will be encapsulated within the NAF tailings in the TSF cells.

19.8.1 TSF Site

The TSF site is lower in elevation than the tailings thickeners and adjacent to the waste rock storage area. This location minimizes pumping requirements from the thickeners and the costs for waste rock haulage. Mine waste rock will be the principal construction material for the starter dam. Because of the low topographical relief at site, a four-sided, bunded impoundment will need to be constructed. A range of near-surface NAF mine waste materials (clays, sands and gravels, competent rock) will be available for various uses.

19.8.2 Facility Description

The initial TSF will be constructed in cells, each consisting of two sub-cells for separate winter and summer deposition. At the 85,000 t/d production rate, the first cell will be filled in Year 14. Each cell will have similar underdrainage, decant, and deposition systems.

The natural clay material at the site will be conditioned to form an impermeable base as a natural liner. The embankment of the starter dam will consist of an upstream low-permeability layer and an area of structural fill. In subsequent lifts, the inner layer, facing the impoundment, will be constructed with tailings from the upper beach area. Use of the tailings for construction will be climate-dependent and will be practical during summer months only, when the material can be suitably dried, moisture conditioned, and compacted. Mine waste material for the structural fill will be obtained directly from the open pits up to Year 7 and from stockpiles or local borrow areas thereafter. The outer layer of rock will provide a durable surface to resist wind erosion.

Seepage through the tailings mass will be intercepted by a series of collector, branch, and finger drains, which will join to form a basin underdrainage system. The drainage network will be connected to three concrete sumps at the upstream toe of the main embankment; seepage will be pumped back into the impoundment.

19.8.3 Facility Operation

Sub-aerial deposition methods will be used for the following reasons:

- The supernatant pond can be as small as practicable to reduce water losses due to evaporation and seepage.
- It allows operating flexibility to mitigate dust generation on the tailings surface.
- It allows full drying of the tailings adjacent to the embankments to prevent liquefaction and facilitate lift construction.
- It reduces the extent of saturated beach area and consequently will reduce the potential for seepage.

Water from the tailings pond will be reclaimed to the process water ponds. This recovery will be maximized by using two pumping systems to minimize environmental losses and reduce the amount of raw water required from external sources.

Three independent tailings pipelines will be installed to ensure that tailings can be discharged from anywhere around the cell periphery or the central divider embankment and that operations are not limited by embankment construction. During winter, tailings will be discharged from single, large-diameter line. A thin sheet of ice and glaciated tailings will be allowed to develop over otherwise inactive beach areas in each of the two sub-cells. The sub-cell used for winter deposition will be taken out of service during spring and allowed to thaw. As much stored water and thawed ice as possible will be pumped back from the TSF. The supernatant pond will be drawn down to reduce evaporative losses.

Figure 19-13: General Arrangement of TSF

19.8.4 Facility Closure

The TSF will be developed in a way that suits ongoing rehabilitation and the closure objectives. The overall embankment slope will be relatively flat, and a waste rock cover will be placed over the tailings surface to control wind erosion.

After periods of rainfall, water will accumulate within the old tailings pond area. This could result in the creation of a natural vegetated zone similar to the original topography. The aim will be to return the final surface of the facility to conditions similar to the existing environment to the extent practical.

19.9 Mine and Process Water Supply

19.9.1 Water Supply and Management

Aquaterra Consulting Pty Ltd (Aquaterra) completed a comprehensive assessment of potential raw water sources to meet the project s total estimated water demand of 650 Mm^3 over 40 years for the 70,000 to 85,000 t/d case. The IDP does not consider the use of surface or subsurface water extracted from the Umdai River because of its intermittent flow and the potential for impact on users downstream.

Vast reserves of groundwater are stored in nearby sedimentary basins, which are considered to offer the most cost-effective option for a long-term process water supply. Field investigations identified three regional aquifers:

- Gunii Hooloi
- Galbyn Gobi
- Nariin Zag.

Of these, the Gunii Hooloi aquifer was selected as the priority for development, based on supply capacity, economics, and environmental impact. The Galbyn Gobi system has potential as a supplemental supply, while the Nariin Zag system proved to be insufficient.

The groundwater resource at Gunii Hooloi has the capacity to supply the long-term demand requirements of the mine for a production rate of 70,000 to 85,000 t/d. When a second grinding line is installed in the future 140,000 t/d production scenario, then other water sources will need to be investigated, including the Galbyn Gobi aquifer.

A site-wide water balance was prepared for the nominal plant production rate of 70,000 to 85,000 t/d over a 40-year mine life. Considering maximum recovery of water from the tailings supernatant pond for process use, yearly average and seasonal peak raw water demands were calculated to be 1,865 m^3/h (518 L/s) and 2,624 m^3/h (729 L/s), respectively. The seasonal peak demand occurs in the winter, primarily because the tailings ponds will be frozen and water will not be reclaimed to the process plant until spring thaw.

A water balance at the design maximum production rate, defined as 15% above the instantaneous design rate at 70,000 to 85,000 t/d, was also produced. Peak demand in this case is estimated to be 3,179 m^3/h (883 L/s). This rate was used as the design maximum flow for the raw water supply pipeline system for continuous but short periods of operation.

19.9.2 Borefield Water Supply System

The initial borefield development will consist of 48 production bores, 28 of which will be adequate for average demand and the other 20 to meet short-term peaks in demand. Multi-stage, fixed-speed submersible pumps will be installed in all bores.

The water will be pumped to a raw water tank at the central plant facilities through a steel pipeline arranged with two booster pumpstations en route. The pipeline will be buried at a depth of 2.2 m, below the soil freeze/thaw active layer. Each booster station will be equipped with three variable-speed, vertical turbine pumps (two operating, one standby), connected in parallel, to meet the fluctuating demand. Telemetry between the raw water tank, the booster stations, and the bore pumps will control the system. The bore pumps will be cycled on and off as required to control the level in the raw water tank and to minimize any drawdown effects at each bore.

Environmental Impacts of Borefield Operation

Depth to groundwater level over the Gunii Hooloi system is more than 35 m, whereas the limited vegetation that exists in the area has a maximum estimated root depth of 10 m. As such, the vegetation does not depend on the aquifer. In localized areas vegetation may rely on water in streambeds, but these are not expected to be affected by borefield extraction.

Figure 19-14: Basement Topography Gunii Hooloi North East

19.9.3 Camp and Construction Water Supply

During the construction period, water supply for the camp and construction activities will be developed from sources as close as practical to the Oyu Tolgoi site. Existing sources located on site will be adequate initially, but other sources will be required as the workforce construction activities and resulting demand increases. For a period during construction, it may be necessary to develop a small number of the bores in the southwest section of the Gunii Hooloi basin and to transport this water to site by tanker truck until the borefield pipeline is operational.

19.9.4 Mine Dewatering

Aquaterra studied the dewatering requirements and impacts associated with the mining developments. A numerical flow model was used to predict inflow into the open pits and the underground mine workings and was also used in conjunction with an analytical model to assess the post-mining pit water balance and water recovery levels. The combined mine dewatering rates from the open pits and Hugo North are predicted to rise to a peak of approximately 125 L/s after four years, remain above 100 L/s until year 11, and then gradually drop to approximately 60 L/s at the end of mining. Under the 140,000 t/d case, the peak is estimated to be 140 L/s.

During the period of underground mining, groundwater levels are estimated to drop to the base of open pits and to depths of 150 m below surface in the area above the underground mining. This drawdown extends out to a maximum of 5 km from the mine site.

After mining, the underground mines will flood, but evaporative losses from the open pits will cause a long-term zone of drawdown approximately 300 m deep at the Southwest pit, extending out nearly 4 km. Water levels north of the open pits will recover substantially because of the underground mine flooding, but it will take at least 300 years for steady-state conditions to develop.

Environmental Effects Related to Dewatering

Mine dewatering together with post-mining evaporative losses will result in the development of a groundwater sink below regional static water levels in the pit areas. Under quasi-steady-state conditions after mining, groundwater gradients around Oyu Tolgoi will trend toward the pits. This will potentially mitigate possible effects on groundwater quality from any contaminants released in runoff or seepage from the decommissioned facilities. With the exception of part of the TSF, most of the mine infrastructure falls within the anticipated cone of depression at the end of mining, and any water-borne contaminants will be captured by the prevailing flow patterns towards the pits. The degree of capture will depend on the status of the pit at the particular time, i.e., less capacity in the early years. Subsequent evaporation will prevent the dispersion of these waters.

The only groundwater-dependent vegetation identified within 10 km of Oyu Tolgoi is elm trees adjacent to or in streambeds. The end-of-mining drawdown contours extend to these areas, but on closure, when groundwater recharge resumes, the trees will be outside any drawdown zone. After rainfall events, the local streams receive considerable runoff, and the trees are expected to have adequate water supply throughout mine operations.

19.10 Electrical Power Requirement and Supply

The projected electrical power load profile for Oyu Tolgoi is illustrated below. At the initial production rate of 70,000 t/d, average 15-minute power demand will be approximately 130 MW. This will increase to approximately 200 MW when the production rate increases to 85,000 t/d during the fourth year of operation.

Initial investigations to assess various options for the supply of power to Oyu Tolgoi began as early as mid-2002. Three primary options were identified:

obtaining power from the Mongolian Central Electricity System (CES) located approximately 560 km to the north of Oyu Tolgoi

obtaining power from the Inner Mongolian (China) grid approximately 100 km to the south at its closest point

generating power at or near Oyu Tolgoi fuelled by local coal resources.

Studies of these options by recognized independent consultants and engineering firms Teshmont and Fluor (power plant pre-feasibility study) have reached the following conclusions:

Considering the current load resource balance, the condition of existing generation equipment, and the significant load of the region, CES will require additional generation capacity in the future.

The cost of construction for a dual-circuit 220 kV transmission line from the CES to the project site is in the range of $150 million to $200 million. There is no apparent, readily available funding available to the CES for this construction. There is a substantial risk that the line will not be operational in time to meet the needs of the Oyu Tolgoi project.

Substantial and reliable power appears to be readily available from Inner Mongolia (China) and can be obtained in a timely manner.

The construction of coal-fired power plants in the vicinity of Oyu Tolgoi is both technically and economically feasible.

The most cost-effective and reliable power supply for Oyu Tolgoi is considered to be the combination of a coal-fired power station at the Tavan Tolgoi coal property 140 km northwest of the site, in conjunction with a 220 kV transmission line connection to the substantial power grid in Inner Mongolia. Connection to the Chinese grid would allow Oyu Tolgoi to start up on schedule, provide IMMI and the Mongolian government early access to revenue, provide a long-term solution for power supply stability, and act as a source of backup power.

Given these conclusions, the IDP is based on power being provided by the equivalent of an independent power producer (IPP) through the construction of coal-fired power plants at Tavan Tolgoi. These units would initially be operated to provide power solely for Oyu Tolgoi and the coal mine at Tavan Tolgoi but, over time, as the need for additional power within the southern Gobi region develops and additional power generating stations are constructed, the plants will function more as a utility, with Oyu Tolgoi being a significant customer.

Assuming that an IPP or utility would require similar returns on its investment, IMMI developed a financial model having tax and depreciation parameters consistent with the project s economic model and a rate of return of 10%. From this model, the price of electricity is estimated to be US$0.0426/kWh.

It is important to note that the Mongolian government is not in full agreement with the conclusions of the studies performed for IMMI and continues to assert that the CES can reliably provide both short-term and long-term power requirements of Oyu Tolgoi. Consequently, approval has not been received to import power from Inner Mongolia, and discussions between IMMI and the Mongolian government continue.

Figure 19-15: Electrical Power Load Profile

In addition, the Government of Mongolia, other internationally recognized consultants, and IMMI have agreed to perform further studies that will more intimately involve members from Mongolia s National Dispatch Centre (NDC) and the Mongolian government. These studies commenced in early June and are expected to be completed in late September 2005.

On the basis of ongoing discussions, the IDP is based on the assumption that this issue will be resolved to the benefit of the southern Gobi region and the Oyu Tolgoi project. Despite the advantages of connection to the Chinese power grid, engineering studies have shown that reliable and economic power can be achieved through the construction of stand-alone, coal-fired power plants at Tavan Tolgoi or other Gobi coal properties.

Expansion to 140,000 t/d If the Hugo Dummett resource achieves reserve status, Oyu Tolgoi will be one of the largest underground mines in the world. Present strategy anticipates a significant expansion of the mining and processing operation from 85,000 t/d to more than 140,000 t/d around Year 8 of production. As a result of this expansion, electric power demand will increase from approximately 200 MW to 350 MW. This demand will be met through the further development of coal-fired power plants at either Tavan Tolgoi or another Gobi coal property in proximity to Oyu Tolgoi.

19.11 Other Infrastructure and Facilities

19.11.1 Plant Site

The selected plant site is close to the open pit and underground mines and provides a compact, cost-effective layout. The site is generally flat, with some relief to about 6 m height, and includes a bedrock plateau where the SAG and ball mills will be founded. The ancillary buildings will be founded on gravel/alluvial type deposits. All facilities are located beyond the underground mine subsidence zone outline, as estimated by McIntosh Engineering.

To prepare the building site foundations, topsoil will be removed and stockpiled, followed by cut-and-fill levelling as required. Approximately 1.5 Mm^3 of additional fill from selected borrow pits is required to form elevated pads for the thickener, process water ponds, and the coarse ore stockpile.

19.11.2 River Diversion

The existing Umdai River channel runs through the future open pits. Subsurface flow in the river channel is constant, but surface flow is sporadic, occurring only after heavy rainfall. The river must be diverted to prevent the mining hazard represented by water inflows to the pit and to ensure continued supply to downstream users. A dam and diversion channel will be constructed and the submerged flow diverted through a buried pipe arrangement. Surface floodwater will be diverted via the diversion channel to the parallel tributary. Both flows will return to the Umdai River downstream of the site.

Because the near-surface water in the river flows in a perched water table, separated from the underlying groundwater table, the river flow is not expected to be affected by the drawdown associated with mine dewatering.

19.11.3 Roads

Knight Piésold and IMMI conducted a reconnaissance of several road routes from the site to the Mongolia-China border. The route selected for the project traverses approximately 95 km southeast from the project site, generally following an existing track to Gashuun Sukhait, the border post on the Mongolian side, and Ganqimaodao, on the Chinese side

This road will be constructed with a gravel sub-bed, using borrow materials from local sources, and have an 8 m wide sealed running surface and 1 m wide shoulders. The design will suit construction requirements and maximum 40 tonne payload truck-trailers or trucks to transport ore concentrate to China. Costs for improving this road are included in the capital cost estimate for the Oyu Tolgoi project, although there may be an opportunity for the road to be constructed with international development funds.

A number of on- and off-site gravel roads will be constructed to access the raw water borefield, tailings dam, accommodation village, airstrip, and mines.

South of the Mongolia-China border, the existing road to Wuyuan, the proposed location of the railhead facility, will be upgraded; this represents a total distance of approximately 260 km. Only short sections of the existing road are suitable for the large volume of construction traffic to site and the concentrate truck transport operation in the early years. The route passes through heavily populated areas north of Wuyuan but connects to a recently improved road that bypasses Wuyuan itself and connects to the railhead. The final decision on routing and IMMI s capital contribution to road-building will depend on consultation and negotiation with local authorities in northern China. Currently, no costs are included in project estimates for upgrading or maintaining roads within China.

19.12 On-Site Support Buildings, Structures and Facilities

Warehouse

The main site warehouse will provide heated, covered storage for equipment spares and weather-sensitive materials, as well as office space for warehouse personnel. Adjacent external storage areas will include a concrete-surfaced pad and yards for bulk materials that do not require protected storage. All external yards will be surrounded by security fencing.

Truckshop Complex

The truckshop complex will consist of two self-contained, structural steel buildings, the main one for service bays, warehousing, and offices, and the second for lube storage. In the main building, space is provided for integrated service bays for heavy and light vehicles as well as other maintenance and repair shops and facilities. The warehouse space will include ground floor and mezzanine storage. Offices for mine operations, administration, mine management, engineering, safety, training, and a lunchroom will be allocated on the second and third floors.

In preliminary discussions with equipment maintenance contractors, there is an option to include construction of the truckshop in the scope of the MARC (maintenance and repair contract). This will be further evaluated prior to award of the contract; however, capital has been provided in the IDP for the construction of this facility.

Explosives Magazine and Emulsion Mixing Plant

The magazine and emulsion mixing facilities will be constructed and operated by a contractor. Facilities will consist of fuel oil storage tanks, an ammonium nitrate storage area, a detonator storage area, and an emulsion mixing plant. The project capital estimate includes the provision of services for the facility, but not for construction of the facility itself.

Accommodation Village

The permanent accommodation facilities will be arranged as a village at the foot of the low hills that rise at the north boundary of the lease. The buildings will be constructed from modules manufactured off site. Facilities will include the following:

- dormitories
- kitchen and associated food storage and preparation facilities
- local style and Western style mess
- wet mess
- laundry and associated room-cleaning facilities
- village administration and recreation facilities
- shop, including post office and public phones
- first aid facility
- occupational health testing facility.

Figure 19-16: General Site Plan

The village will be constructed in phases and will be utilized for both construction and operations. Initial facilities to house construction management and general service contractor personnel during construction will house 1,500. As production commences and production personnel replace construction personnel, the village will be expanded to house 500 additional general employees, bringing the total population of the village to 2,000. The village will be refurbished for operations occupancy after the construction phase of the project.

Security Facilities

The site will have two manned guardhouse gates and a perimeter fence to enhance safety and security of personnel and property, to prevent animals from wandering onto the site, and to protect native fauna.

Airstrip

The airstrip design is based on specifications derived from the International Civil Aviation Organisations (ICAO) and will be suitable for Lockheed C130 and Fokker F50 aircraft. A single gravel-surface strip will be constructed southwest of the process plant.

The terminal building will be 12 m wide x 25 m long and will include an entry area with a check-in counter, security check-point with bag x-ray and personnel metal detector, a departure lounge sized for 50 persons, and male and female washrooms.

No facilities will be provided for fuel storage or airplane refuelling.

Power Distribution

On-site facilities will be supplied by a 35 kV distribution system through radial feeders originating at a 220 kV main substation and routed through underground cables or overhead power lines. The following voltages will be utilized for systems and equipment:

- 35 kV for the plant site power distribution system and the primary feeders to the converter transformers for the gearless mill drives
- 3.3 kV for large motors above 200 kW rating
- 10.5 kV and 3.3 kV for the underground mining power distribution systems
- 690 V for process equipment rated less than 200 kW
- 380/220 V, three phase and single phase, for lighting and small power loads.

Heating

The site facilities will be heated by coal-fired boilers burning coal available in the vicinity of the site. Two central boiler plants, one at the process plant and the other at the accommodation village, will provide building heating by means of glycol circulation to air-handling and heating units. A third boiler plant will be constructed to provide heated ventilation air to the underground Hugo North mine; this system will be expanded as the mine develops. All remote small buildings and modules will be provided with electric heating.

Emergency Power

Emergency power will be provided by diesel-fuelled generating sets, installed in the following locations:

- process plant (four 1.5 MW diesel generators for a total of 6 MW capacity)
- tailings pumphouse (one 1.5 MW diesel generator)
- truckshop facilities and boiler house (one 750 kW diesel generator)
- accommodation village (four 750 kW diesel generators for a total of 3 MW capacity)
- airstrip (one 150 kW diesel generator).

In the event of a utility power failure, the emergency power generators will start automatically, providing power to the essential loads such as lighting, heating, and communication systems in buildings, and to emergency loads for selected process equipment in the process plant to ensure orderly shutdown and permit plant maintenance activities.

Communications

A communications network will be established based on satellite technology and wireless communication for voice, fax, Internet, and PC network traffic. The communications and IT infrastructure will consist of satellite link, PABX, Ethernet LAN, IT servers, desktop computers, UPS system, copper and fibre cabling, and site VHF radio system. VSAT (very small aperture terminal) satellite equipment on site will consist of satellite antenna, transceiver, modem, and bandwidth manager. Ethernet LAN points will be provided in all offices, stores, and workshops. A trunked repeater system will provide the infrastructure to enable VHF and mobile radio sets to communicate around the site. System security will be achieved by a centralized access control server with a network intrusion detection system and VPN (virtual private network) concentrator. Voice communications will be based on an IP network using wide area network (WAN) links, which will result in lower operating costs.

Fuel and Coal Supply

Diesel fuel will be stored in a central fuel storage depot supplied and operated by the diesel fuel supplier under contract. The facility will consist of a lined and bunded tank farm with two tanks, each of 2 ML capacity, located south of the truckshop.

Coal will be required for the boilers used to heat the process plant, accommodation area buildings, and underground mine. Coal will be delivered to site, dumped, and pushed by bulldozer into stockpiles adjacent to the heating units. Initial delivery will be by truck, but rail transport is anticipated in the future. During the initial years of open pit mining, annual diesel fuel consumption will reach approximately 50.0 ML/a. Coal consumption is estimated at 12,000 t/a initially, increasing to 20,000 t/a when Hugo North is in full production.

Water Systems

Raw water will be pumped approximately 70 km from the Gunii Hooloi borefield to the raw water tank adjacent to the process water ponds. From the tank, water will be distributed by underground pipelines to the process water ponds, the process plant, and the potable water treatment plant. As the underground mine is developed, raw water will be supplied to a tank at the shaft farm through a line routed along the overland conveyor. Excess inflow water from the open pit and the underground mine will be pumped to the process water ponds. Raw water for potable use will be treated in a suitable plant near the concentrator and be distributed to the various facilities.

The raw water tank, primary crusher raw water tank, and potable water tank at the accommodation village will each have a reserve of fire water in the lower portion of the tank that will be drawn from below the primary water nozzles. The fire-fighting reserve in each tank will meet a two-hour demand of 340 m^3/h.

Sewage Treatment and Waste Disposal

A modular sewage treatment plant will be provided midway between the accommodations village and the process plant area. The plant will be a two-train system, each train having a treatment capacity for the requirements of 1,000 people. Sludge from the plant will be dried and buried, and wastewater will be pumped to the tailings storage facility. Recyclable wastes, including waste oils, will be collected on site before being removed. Non-recyclable wastes will be disposed of in a sanitary landfill.

19.12.1 Off-Site Facilities

Railhead and Associated Facilities

The IDP is based on trucking concentrate to storage facilities at a railhead facility in Wuyuan, China, for the first years of operation. The facility, to be owned and operated by IMMI and included in the cost estimates, will have the capacity for a minimum of 10 days of storage at an annual concentrate production rate of 450,000 t/a. The design of this facility will be reviewed during the basic engineering phase of the project to evaluate options such as the use of an existing facility or acquiring space on a lease basis.

Off-Site Administration

A regional office will be established at a major city in China for the following operations functions:

- concentrate marketing and sales
- concentrate transport logistics
- procurement and logistics.

The existing office in Ulaanbaatar will be modified to include offices for personnel involved in the following activities:

- government relations
- legal support
- travel coordination
- human resources
- translation.

It is envisaged that Dalanzadgad, northwest of the project site, will be the main regional centre for recruitment of semi-skilled and unskilled personnel, as well as some skilled and professional employees. Khanbogd is the community closest to the site and will be another source of personnel. Funds have been allocated in the operating budget to support the following activities, which will be supported from site or by establishing facilities in these communities:

- provincial government relations
- recruiting
- workforce training and education.

19.12.2 Project Implementation

Successful development of the initial phase of the project (Phase 1a) will involve the implementation of a plan for the concurrent management of at least three major project components open pit, concentrator & infrastructure; underground development; and power supply (refer to Level l project schedule presented earlier in project overview). After the initial development phase, a near-continuous program of phased studies and associated development/construction efforts will be required over a period of 12 years to achieve the possible mining and processing rate of 140,000 t/d (Phase 2).

The execution strategy recognizes several key factors:

- No new technology is proposed for the process plant.
- Project management and engineering firms exist that are experienced with the proposed technology, but no local contractor has experience with a development of this size or complexity in Mongolia.
- Certain governmental and commercial negotiations are outstanding.
- Regulations, permitting, and taxation issues in Mongolia may be subject to ongoing negotiation and adjustment.
- Benefits arising from the project are to be maximized in favour of Mongolia and the Mongolian people.
- The Mongolian construction labour force is of modest size and has not participated in a mining development of this size or complexity.
- The site is located near China, which has a large, skilled workforce and an industrial manufacturing sector experienced in major modern mining developments.
- Mongolia is landlocked without direct access to tide water. China has well-developed infrastructure from the coast to within 80 km of the site.
- Advancement of the underground development will enhance project economics.
- Long-lead procurement items associated with the process plant will need to be ordered early to satisfy the construction schedule.
- EPCM contractors and suppliers for the metals mining industry are currently in high demand.

To meet the diverse and extensive management for the development, a Western contractor with significant experience in mining and in Asia will be appointed to lead a Program Management Organization (PMO) as part of an integrated team with IMMI. This team will have overall responsibility for directing and coordinating the major project components.

The PMO will manage the various principal contractors associated with the process plant and infrastructure development from a base in Beijing or another location within China. Concurrently, the PMO will manage the underground mining development work associated with the advancement of the two shafts at Hugo North, the power supply initiative, and project-related off-site developments.

A key component of the execution plan is to maximize opportunities for Mongolia while also maximizing Chinese value. Chinese value will be captured by involving experienced Chinese contractors in construction of major components of the processing plant, some on-site infrastructure, and shaft sinking. Chinese manufacturers are expected to supply many of the bulk materials and some equipment. To realize the benefits in these high-value areas, it is anticipated that Chinese Design Institutes (CDIs) will complete much of the detailed design. This approach reflects recent experience in China where Western expectations of quality and schedule performance have been met to the satisfaction of major international clients.

The principal contract packages for the combined open pit, concentrator, and infrastructure are as follows:

- PMO Services (international firm)
- Basic Engineering process and on-site infrastructure, including procurement of off-shore open pit equipment (international firm)
- Detailed Engineering process and on-site infrastructure (CDI in China)
- Basic Engineering utilities and off-site infrastructure (international / China)
- Detailed Engineering utilities and off-site infrastructure done as E, EP, or EPC (CDI or Mongolian firm)

Further plans for construction execution are summarized below:

- Procurement of key process equipment will be carried out by the PMO. With the buoyant mining industry, some delivery times of 75 or 80 weeks have been quoted. Purchase orders for this equipment will therefore require early attention.
- Construction contracts will be a combination of unit price/lump sum and direct hire. The heavy industrial work will be tendered to major Chinese firms and components of infrastructure to Mongolian contractors; the site services activities will be performed by direct-hire Mongolian labour.
- Chinese and Mongolian contractors with larger workforces will be required to provide their own camps, while all other site workers will be housed in an Owner-provided camp.
- Logistics and transportation studies have concluded that equipment and supplies procured from off shore will be received at the Chinese port of Tianjin. These goods and Chinese-manufactured materials will be sent to a consolidation yard, then be transshipped to site by road or rail.
- Off-shore shipments will be transported under bond, and all receiving, consolidation, and custom-clearance activities will be conducted by a freight-forwarding contractor.
- The preferred road route from Tianjin to site is by way of the Inner Mongolian town of Ganqimaodao at the China-Mongolia border.

Currently, this border crossing is open only intermittently. The IDP assumes that the border will be opened full time in the near future.

Importation of equipment and materials is currently subject to Mongolian duties and taxes. It is anticipated that the Special Stability Agreement being negotiated with the Mongolian government will reduce many of these obligations. Certain activities in China may also result in tax or duty exposure. Certain duties and taxes can be avoided or mitigated by structuring appropriate corporate and contracting relationships. The cost of duties and tax is excluded in the capital cost estimate.

The execution plan presented here does not address the expansion to 140,000 t/d. Although the strategies and approaches outlined for Phase 1a are expected to remain essentially the same, the Mongolian workforce is expected to be more effective and regional infrastructure more developed when in-depth planning for Phase 2 begins.

Figure 19-17: Tianjin to Oyu Tolgoi Road Routes

Schedule

Development of the open pit, concentrator, and infrastructure will be completed over a 33-month period following project approval.

The early activities include basic engineering for the process plant, construction of temporary services, and placement of long-lead equipment orders for process plant and major mine mobile equipment. Mining activities are scheduled for the final 16 months of construction and include training.

Based on recent experience in mine developments executed in remote locations, the schedule is reasonable and achievable, although full cooperation of Mongolian and Chinese authorities will be necessary to expedite the transportation of equipment and supplies and to accommodate the joint Mongolian and Chinese workforce.

19.13 Operating Plan

19.13.1 Personnel Organization

Mine management and administration functions will be centralized at the site. Off-site offices will be set up at Ulaanbataar for government relations, at Dalanzadgad for hiring and regional government affairs, and at a major centre in China for procurement, marketing, and other Chinese business matters. Initial staffing will include a combination of expatriates and Mongolians.

The number of expatriates will be relatively large at the beginning but will eventually be similar to levels at world-scale operations in developing countries run by Western companies. Expatriates will fill senior management roles. These individuals will be among the leaders in their fields of expertise and will have hands-on experience from other major mines. Other expatriate personnel with specific technical expertise will assist in training and in implementing operational procedures in the early years of the operation. Their goal will be to bring the Mongolian workforce to skill and knowledge levels that permit them to replace most of the initial expatriates.

Table 19-4: Initial Operations Work Force

Year	Number of Expatriates	Total Employees
1	78	880
4	43	1,095
8	12	1,185
12	7	1,187

Mongolian-based professional staff and approximately 50% of other non-expatriate staff are expected to live in Ulaanbataar and the rest in Dalanzadgad or other centres in the Gobi. Accommodation facilities will be provided at the mine site for employees on rotational work schedules. While on site:

Most employees will work 12-hour shifts

Senior managers will work 5 days, then be returned to Ulaanbaatar

Expatriates will work 6 weeks, then be returned to their country of hire for 2 weeks

Mongolian nationals will work 14 days followed by 7 days at home.

Mongolian Workforce

IMMI has been carrying out exploration activities in Mongolia for more than four years and has developed considerable knowledge of the available skills and applicable wage rates. Supplemental data have also been provided by other companies operating in the country.

The level of education in Mongolia is comparable to that in many Western countries, with almost universal literacy and a high participation rate in tertiary education. However, Mongolian exposure to the particular technical and trades skills that will be required for the Oyu Tolgoi operation has been limited. Although another large mine is in operation in northern Mongolia (Erdenet), technology and working methods are not consistent with those envisaged for Oyu Tolgoi.

IMMI plans to establish significant training resources and facilities. IMMI s objective is to maximize Mongolian employment levels and to have a 90% national workforce by the fifth year of operation.

19.13.2 Fuel Supply

Diesel fuel will be used for the mobile equipment associated with open pit mining and, to a lesser extent, underground mining. There are no oil refineries in Mongolia; supply is expected to be from Russia.

Facilities on site will be heated by coal-fired boilers. The coal will be sourced regionally from the large nearby coalfields in Mongolia.

Other fuels, such as gasoline and liquefied petroleum gas, will only be used where diesel or coal are impractical.

19.13.3 Power Supply

For the first five years of operation, it is anticipated that power will be obtained from the Inner Mongolian grid. Thereafter, power is expected to be supplied from a coal-fired power station built at Tavan Tolgoi or other Gobi coal field. The point of power purchase will be at the site substations at a cost of $0.0426/kWh.

19.13.4 Operating Consumables

Grinding media, bulk chemicals such as lime and flotation reagents, and most maintenance supplies will be obtained from China. Exceptions are certain proprietary collectors and specialty spare parts for process equipment. Supplies and stores will be marshalled at a yard in China and forwarded to the site.

Adequate warehousing will be maintained at Oyu Tolgoi for spare parts and supplies. The MARC contractor responsible for mine mobile equipment maintenance will maintain a stock of spares for the open pit mine equipment.

19.13.5 Maintenance Contracts

Oyu Tolgoi will undertake most maintenance with its own workforce. Exceptions are the mine mobile equipment fleet, which, as noted, will be maintained by a MARC contractor, and mill relining, which will be performed by contract crews for the first five years of operation. After this time, the relining will be done by Oyu Tolgoi personnel.

19.13.6 Analytical Services

Assays for concentrator control, mine grade control, metallurgical accounting, and shipments will be done in a laboratory on site at the process facilities. Most environmental analysis work will be performed in Ulaanbataar.

19.14 Socio-Political Assessment

Socio-political assessment for the project has included the collection of baseline data on communities with direct historic, economic, and cultural links to the project site and surrounding area, and on other communities most likely to be influenced by project activities. In addition, traditional ecological knowledge (TEK) has been gathered in conversations with nomadic herder families.

Information used for impact assessment was drawn from a wide variety of sources, including field surveys, personal interviews, community consultation, existing records for the area, and desktop studies. The economic studies relied heavily on econometric models of the national and regional economies.

19.14.1 Effects on Local Communities

The main socioeconomic effects of the Oyu Tolgoi project on local communities are expected to be:

- provision of direct employment at the mine
- improved opportunities for employment in secondary sectors
- higher fiscal revenue
- infrastructure development
- work-related training
- a better quality of life overall.

Induced impacts on local residents from environmental change may occur in the areas of local water supplies, grazing land, air quality, and noise levels. IMMI has implemented a residential exclusion zone surrounding the project site and is assisting with the relocation of herders who have customarily used this area for traditional activities.

19.14.2 Effects on National Economy

IMMI commissioned three socioeconomic and macroeconomic studies on the impact of the Oyu Tolgoi project on Mongolia. These studies were prepared in 2004 and reflect earlier project data. In mid-2005, IMMI commissioned a new report to assess the socioeconomic impact on Mongolia of the IDP expanded case (nominal 140,000 t/d) for the project.

The mine is expected to have significant, long-lasting, and net positive effects on the economy of Mongolia in terms of investment expenditures, exports, and jobs. The project is also expected to help Mongolia expand its industrial and manufacturing sectors and to bring job-intensive diversification to an economy that is currently dominated by agricultural production.

More than 10,000 person-years of construction employment and 38,000 person-years of total employment will be generated. IMMI aims to have a 90% Mongolian national workforce by the fifth year of operation.

Over the life of the mine, the average increase in the number of jobs created in Mongolia is forecast to be 10.3% per year. It is assumed that sufficient workers are available in Mongolia to meet the operational needs of the project, including indirect employment. The largest effects will not be seen in the mining industry, but rather in other support industries that are currently under-utilized.

The real Gross Domestic Product (GDP) of Mongolia is forecast to increase by approximately 34.3% from 2002 to 2043. In addition, the project will dominate national economic performance during its lifetime. Correspondingly, variations in mine production will affect overall economic conditions in the country over time. Fiscal effects are indicated by the cumulative difference in the government sector s current revenues. The increase from base case revenues is projected to US$7.9 billion over the life of the mine, potentially producing a substantial cumulative reduction in government debt. Corporate taxes show the largest increase over the project period.

Other economic effects include changes to physical infrastructure and human resource capabilities. Regional infrastructure will be improved with new road and railway transportation links and a new electricity generating station and power transmission lines.

IMMI will also be undertaking training and capacity-building activities on a national scale to assist with efforts to reach its employment target for Mongolian nationals on the project and in support of its broader social responsibilities.

From the report published in August 2005, the impacts of the expanded case are summarized below.

Table 19-5: Project Impacts (2002 2043) Expanded Case

Economic Factor	Average % Increase	Cumulative Increase
Real GDP	34.3	
Consumer expenditures	9.3	
Exports	71.6	
Imports	44.2	
Net exports (US$1995 billions)		11.2
Employment	10.3	
Labour force participation rate (avg)	5.8	
Real per capita disposable income	11.5	
Government operating balance excluding debt payments (US$2005 billions)		7.85

Figure 19-18:Impact on Government Revenues (Tg 2005 billions) Expanded Case

19.15 Safety, Health and Environment

Occupational Health and Safety Standards

IMMI policy insists on, and the company is dedicated to, implementing a comprehensive health and safety program that meets or exceeds mining industry standards for best practice. The project will be executed under local, international, and IMMI guidelines and standards for occupational health and safety. To create and maintain a safe and healthy working environment, IMMI will implement a comprehensive Health & Safety Management System (HSMS) that:

- provides a framework for continually improving overall health and safety performance
- is appropriate for IMMI operations
- integrates with other systems and core functions
- assists IMMI in managing its legal obligations
- meets the requirements of the Ivanhoe Mines Health and Safety Policy
- outlines the requirements of the site-specific Health & Safety Management Program.

The HSMS will be based on the Australian/New Zealand Standard AS/NZS 4801:2001, Occupational Safety and Health Management Systems, General Guidelines on Principles, Systems and Supporting Techniques, and will incorporate the following five principles from the standard:

- commitment and policy
- planning
- implementation
- measurement and evaluation
- review and improvement.

IMMI has reviewed the existing Mongolian mine safety legislation and identified no significant compliance or operational constraints. For future considerations, where Mongolian regulations do not meet these international standards, other regulations, specifically Canadian or Australian, will be adopted. The HSMS meets the standards prescribed by the international safety standard OSHAS 18001.

Management of Emergencies

In the event of an emergency, evacuation, or other serious emergency, the site Emergency Management Team (EMT) will initiate an appropriate response to safeguard life and minimize damage to the environment, property, and equipment.

19.16 Environmental Assessment and Management

IMMI has stated that it is committed to the implementation of ISO-14001 for the Oyu Tolgoi project.

Extensive baseline data have been gathered and plans developed to assess the potential impacts of the Oyu Tolgoi project on the bio-physical and social environment in the south-central region of Mongolia. Work to date also includes preliminary environmental risk assessment, proposed mitigation, protection, and monitoring plans, and the identification of areas where work is incomplete or outstanding. The available information covers three broad project components:

- access road and powerline corridor from site to the Mongolia-China border at Gashaan Sukhait (access road corridor)

- groundwater resource use from the Gunii Hooloi and Galbyn Gobi regional aquifers (aquifer locations and water supply corridor)

- Oyu Tolgoi project mine licence area.

The access road corridor from the Mongolia-China border to Wuyuan in China, the destination for mine concentrate and location of the rail head for the first three years of operation, has not been addressed in terms of environmental baseline conditions and impact assessment.

Regulatory Framework

The Mongolian Ministry for Nature and Environment (MNE) is responsible for environmental legislation and approvals for new projects in the country. The primary legislative instrument is the Law of Mongolia on Environmental Impact Assessment (EIA) (2001).

Mining projects must produce project documents for screening before obtaining a licence for mineral use. After negotiations between MNE and IMMI in 2002, preliminary project concepts were submitted to MNE in February 2003, including baseline environmental data produced by Mongolian consultants licenced for undertaking EIA under Article 9 of the Law on EIA. On review of this information, the MNE screening committee established formal guidelines for the Oyu Tolgoi EIA in March 2003. The MNE screening guidelines for the project were originally valid until the end of the first quarter of 2004 and have since been extended to 15 October 2005.

The EIA for the project is being completed in three stages access road corridor, aquifer locations and water-supply corridor, and mine licence area that reflect the current status of project planning and development. The EIA for the access road corridor from Oyu Tolgoi to Gashuun Sukhait was completed in April 2004 and approved by the MNE in May 2004. The second document on groundwater resource use was submitted 22 June 2005. The last, covering the mine licence, will be submitted during the second half of 2005.

An annual environmental report must be produced during project construction and operation, providing details of environmental management and monitoring activities in accordance with the plans and approved programs. An environmental bond equivalent to 50% of the annual budget to meet environmental management plan obligations must be deposited in a bond account with the Soum (local government) authority.

19.16.1 Existing Environment

Topography

The access road corridor, aquifer and water supply corridor, and mine licence areas are situated within the Galbyn Gobi, one of 33 Mongolian Gobi deserts. The Galbyn Gobi is a broad, flat valley at the lowest altitude in the country (860 to 1,075 m) surrounded by mountains up to 1,351 masl. Project-related impacts on topography are subject to current assessments of the project area layout. Detail design will focus on minimizing the footprint of project components as well as following best practices during development and reclamation of the waste rock stockpiles, tailings impoundment, mine facilities, and linear structures. Within the water resource area, groundwater extraction will be managed to minimize the potential for surface subsidence.

Climate and Air Quality

IMMI is currently monitoring climatic conditions at several locations in the region. Further long-term monitoring is required to complete air quality modelling. Baseline assessments of the air quality in the mine licence area were carried out in July 2002. Additional meteorological and air quality monitoring is required in this area and along the access road corridor.

Acid Mine Drainage and Metal Leachate

Geochemical testing has been conducted on samples of tailings and the open pit waste rock. No modelling has yet been done to predict the potential for post-closure acid-mine drainage and metal leachate generation. The existing testwork results suggest that potential geochemical issues can be managed by a combination of mine scheduling of relevant waste types and appropriate design and construction of the waste dumps and TSF. The potential for acid mine drainage and metal leachate from materials sourced from borrow pit areas should be assessed prior to excavation and use on roads.

Hydrology and Surface Water Quality

The Oyu Tolgoi project area is located within the closed Central Asian drainage basin and has no outflow to the ocean. Most riverbeds in this drainage basin are ephemeral creeks that remain dry most times of the year. The Umdai River is the most significant hydrological feature of the project area. A tributary of the river passes through the site. Flows after heavy summer rainstorms often result in very turbulent, high-velocity mud flows, locally termed Gobian wild floods. These floods have been known to destroy road crossings and to carry away vehicles caught in the riverbeds. No surface flow data are available for these isolated and episodic flood events. Discussions with local herders indicate that, on average, four to six flow events occur in summer to autumn each year.

Shallow springs are used by wildlife and livestock as drinking water sources. Migratory wildlife movements during summer months in the Gobi are likely to be dictated by the presence of surface water in natural springs.

Water quality baseline data for surface waters throughout the project area, access road corridor, and aquifer areas are being collected through current monitoring programs. This information will be established prior to project development as a basis for assessing potential project-related impacts on surface water quality during routine monitoring.

Potential impacts on surface water systems in the project area include changes to natural flow paths and depletion of springs, ephemeral wetlands, and salt-marshes from project development and operation activities, which may cause loss of wildlife habitat, increased wildlife mortality rates, and changes to wildlife distribution and migration patterns.

Potential impacts on surface water quality include increased sedimentation and risk of pollution of springs, ephemeral wetlands, and salt-marshes from increased erosion, contaminated dust fallout, contaminant spills, and accidents associated with project construction and operational activities. Fugitive dust control management plans and spill management systems are being developed to avoid and mitigate potential impacts to surface water quality. These impacts may result in loss of wildlife habitat, decrease in wildlife health, and decrease in wildlife population because of higher mortality rates.

Positive impacts associated with the upgrading of road facilities along the corridor include the formation of dedicated stream crossings, which will reduce the number of undefined and informal crossings that now exist along the section of local roads. This will significantly reduce the area where stream banks and riverbeds are disturbed by uncontrolled vehicle access. Improvement of the road and crossings will reduce the risk associated with transport of hazardous materials.

Hydrogeology and Groundwater Quality

Detailed groundwater investigations to date have been concentrated in the Gunii Hooloi, Galbyn Gobi, and Nariin Zag aquifer areas to assess the potential to meet the project s estimated water demand. Groundwater investigations conducted in the mine licence area focused on assessment of required dewatering rates for mine works and the potential to meet the project s camp and construction water demands.

Following a review of available studies completed in the region by Aquaterra, AAJV confirmed that additional work is needed to further characterize groundwater conditions in each project area and the region as well as to increase confidence levels in existing conceptual resource and impact models.

Soils

Six soil types were identified in the 2002 field surveys, all containing low nutrient content and ranging from medium to high alkalinity. Soils in elevated areas contain a high proportion of rock fragments throughout poorly developed horizons. Sandy eluvium over preserved brown loams cover the valleys and steppe areas, providing an indication of the major impact of wind and dusting on soil development. The sandy valley and steppe soils are generally non-saline. Further baseline work within the project area is continuing to identify key concentrations of quality parameters in soils so that potential changes resulting from project development can be assessed.

Vegetation

The flora in the Oyu Tolgoi project area has been classified as representative of the eastern region of the Gobi Central Zone within the Central Asian Greater Zone. Vegetation tends to be homogenous across the Eastern Gobi Desert Steppe and consists of drought-tolerant shrubs and thinly distributed low grasses. Four rare plant species occur within the mine licence area. Some shrubs are used for cooking and heating fires in ger dwellings. However, pressure from human use is lower near Oyu Tolgoi because the population density is very low. Traditional nomadic herders have used specific local plants as medicinal drugs, while other plants are used as seasonal food. Vegetation in the region also serves as wildlife habitat and food source for wildlife and livestock.

Other current stresses on vegetation cover and health in the region arise from vehicle traffic over unformed tracks that have disturbed large areas. Construction of the access road and designated project roads may significantly reduce this stress on vegetation.

Project-related impacts on vegetation cover and health include permanent removal of vegetation cover for the development of project facilities and infrastructure, i.e., open pit, plant site, rock piles, mine roads, tailings storage facility, borrow areas, access road, and power line; and temporary removal and disturbance of vegetation cover for development of underground mines and the water resource pipeline and borefield. Indirect impacts on vegetation cover and health are expected from dust fallout, surface water runoff, and shallow groundwater contamination along the access road and within the mine licence area. Desiccation caused by changes to the surface water drainage system and possibly by groundwater extraction are expected to lead to loss of vegetation cover; these impacts may remain post-closure. Mitigation and monitoring will be implemented to reduce these impacts.

Fauna

The fauna of Mongolia is represented in the north by forest-steppe species of Eurasia and in the south by desert species of Central Asia. The central belt of Mongolia is a transitional zone that includes both. The desert fauna of the Gobi region is extremely diverse, with many species typical of the Central Asian desert. The low population density and isolation of the southern Gobi region of Mongolia has resulted in the survival of many endangered species that no longer exist in neighbouring countries.

Although the entire project area serves as habitat for reptiles and to migratory mammals and birds, low sandy dunes areas and shrublands provide habitat to distinct wildlife communities.

Many of the larger mammals found within the general project area are rare and endangered species. Six species having conservation significance have been recorded in the mine licence area (MNE, 1997). Two species (the Asiatic wild ass and black-tailed gazelle) listed as threatened were recorded in the access road corridor and Galbyn Gobi aquifer area.

Potential impacts on fauna associated with development of the project include changes in abundance, geographic distribution, and productivity at the species and ecosystem level. Wildlife management plans will be developed along with local authorities and government bodies to minimize these impacts. These plans will include initiation of wildlife research programs with Mongolian research facilities to gain a better understanding of wildlife populations, migration, and species diversity.

Noise and Vibration

No baseline noise and vibration data have been collected for the project areas of impact. Noise and vibration assessment is required to ensure compliance with Mongolian and World Bank criteria during both construction and operations, and also to address anticipated concerns by stakeholders, including the general public. An assessment is proposed prior to mine development to meet Mongolian and World Bank standards.

Protected Areas

The Small Gobi Strictly Protected Area (SGSPA) is approximately 80 km south of the mine licence area, on the Mongolia-China border. The access road corridor traverses through 13 km of the protected area. With the acceptance of the EIA for the corridor in June 2004, IMMI has received approval to cross through this area.

Land Use

The land surrounding the mine licence area is predominantly used for nomadic herding of goats, camels, and sheep by small family units. Use is based on informal traditional Mongolian principles of shared grazing rights with limited land tenure for semi-permanent winter shelters and other improvements. Initiation of the herder support program has reduced the incidence of land use conflict between current mineral exploration and grazing practices. The project intends to maintain coexistence of traditional grazing practices and mineral development except where there is a risk to public safety or livestock.

Risk Assessment

The Law of Mongolia on Environmental Impact Assessment (2001) and the guidelines issued for IMMI s EIA (2001) require the inclusion of a risk assessment in project documentation. Risk assessment means identification and prediction of the possible emergencies and accidents that could occur during the production process or natural disasters, and elimination and mitigation of their consequences.

Ongoing Work

A complete list of outstanding work to be completed at various stages of development, and current status, is included in the main body of the IDP report. Key work includes baseline studies and assessment of project-related impacts along the access road corridor from Mongolia-China border to Wuyuan, China; wildlife population dynamics, habitat use, ecology and migratory habits of key species within the region; transboundary issues, cumulative effects, human health risks, and noise effects; and continued evaluation of acid mine drainage and metal leachate potential, hydrology, water quality of surface water occurrences, groundwater resources, air quality, soil chemistry; and projected impacts. Completion of this work will aid in customizing and improving existing environmental management and monitoring plans as part of an Adaptive Environmental Management System.

19.16.2 Closure and Reclamation

As part of overall project planning, IMMI has prepared a preliminary reclamation and closure plan. Certain features of the mine, such as the open pit, waste dumps, and tailings impoundment, will create permanent changes to the current landscape that cannot be completely remedied through reclamation. The closure plan will, however, ensure that these disturbed areas are stable and have no residual impact on the surrounding water, air, and land.

The closure plan for the Oyu Tolgoi project will address the socioeconomic impacts of mine closure considering that the existence and economic survival of some communities may have become dependent on the project. Issues include ongoing environmental management during and after reclamation, loss of jobs, and continued operation of social infrastructure such as water supply, electricity, and road networks in and around local communities.

Reclamation and sustainability considerations are integrated into mine and facility design. Progressive reclamation will be an ongoing activity throughout the life of the operation.

The primary reclamation objective is to develop the mine in a manner that prevents leaving an unsustainable environmental legacy and that considers community input and values. Other key objectives:

- protect public health and safety during all stages of project development
- prevent or mitigate environmental degradation caused by mining-related activities
- return the maximum amount of disturbed land to pre-mining conditions suitable for nomadic herdsmen and their grazing animals
- secure the open pit areas, subsidence zones, waste dumps, and tailings storage facilities to ensure public and environmental safety
- plan and implement reclamation techniques that eliminate the need for long-term maintenance presence on site and permit IMMI to walk away from the reclaimed mine with no environmental or social encumbrances.

IMMI will develop environmental monitoring plans, including proposed activities and schedules, to ensure that environmental parameters meet the criteria, standards, and limits laid out in the EIA and Environmental Protection Plan. In accordance with Mongolian law, IMMI will undertake monitoring at its own expense using approved methods and accredited facilities. The monitoring will permit procedures and activities to be adjusted and/or modified as necessary to ensure optimal environmental protection.

Parameters to be monitored during the closure and post-closure phases of the mine include the following:

- surface water and groundwater quality
- physical stability of tailings deposits
- physical stability of the river water diversion dike, waste rock dumps, drainage ditches, and concrete shaft/raise caps
- isolation of open pit voids and unfilled subsidence zones, including status of open water and erosion controls
- success of indigenous revegetation, including remediation as required until proven to be self-sustaining

condition of groundwater monitoring wells, piezometers, survey monuments, and other instrumentation

effectiveness of dust-control measures on waste rock, TSF, and other waste areas with specific attention to potential wind-blown contaminant sources.

19.17 Marketing

During 2004, IMMI began analyzing the copper market in anticipation of developing the Oyu Tolgoi deposit in the Southern Gobi region of Mongolia. From the data obtained, copper consumption projections have been developed that demonstrate a continued demand for refined copper through 2010. Specifically, the analysis shows that by 2008, when Oyu Tolgoi commences commercial production, it will be entering a market where there is growing demand for copper concentrate and in which it will hold an advantage with its strategic geographic location.

Other committed and anticipated copper mining projects appear capable of meeting the needs of the refined copper market through 2008. Beyond 2008, however, mine production levels will need to increase substantially over the capacity that is already firmly committed to meet the projected copper demand. These increases are required not only to meet rising consumption, but also to offset the natural decline in production at existing mines as a result of falling ore grades and depletion of resources. The following graph shows China s actual (2000 to 2004) and projected (2005 to 2010) production of copper metal by major source against the curve of anticipated demand for refined copper within China until 2010. Given the disparity, most of the increased mine production will have to come from new projects, and the timing of Oyu Tolgoi appears to be well positioned.

After 2010, the challenge of maintaining sufficient mine production to meet rising metal demand will become even greater. By 2015, a number of large mines currently in operation will have reached the ends of their productive lives. The Oyu Tolgoi mine will be a custom concentrate producer a mine that produces concentrate for sale on the open market rather than delivering concentrate to its own smelter. While initially all of the Oyu Tolgoi production will be delivered to Chinese smelters, the commercial terms Oyu Tolgoi receives will be dictated by conditions on the international concentrate market. The custom concentrate market currently represents nearly half of the Western World s concentrate production, but treatment and refining charges are determined by the entire concentrate market balance, not just the custom concentrate markets.

Based on a review of the concentrate market, IMMI has incorporated a treatment charge of $75/dmt of concentrate and a refining charge of $0.075/lb of payable copper, along with price participation of ±10% from a base price of $0.90/lb of copper, into the financial analysis for the project. These terms equate to 22.3% of the base price, which is close to the average price between 1987 and 2003 a period that spans both surplus and deficit conditions.

Looking ahead to 2007, IMMI s analysis suggests that all mine development required to meet growing copper consumption will need to be stimulated by an average copper price similar to that in the 1990s: about $1.24/lb in 2005 dollars. However, this overlooks the effects of any possible consumption downturn. Market indicators and projections support the expectation of a long-term average copper price of $1.00/lb (2005 constant dollars), which is used in the base case financial analysis for Oyu Tolgoi. This is slightly higher than the frequently reported assumption of $0.90 to $0.95/lb, but it appears to be justified by the strong fundamental outlook for copper.

With regard to gold price, Central Banks have sold off approximately 400 t/a of gold in recent years, which has had a negative effect on price. Without such intervention, the gold price would probably be higher than the range seen in the past year ($385 to $454/oz). Another recent influence is the value of the U.S. dollar compared to the Euro and other currencies. With the growing U.S. trade deficit, it seems likely the U.S. dollar will come under further pressure, which probably will lead to an increase in gold price when expressed in U.S. dollars. IMMI has selected a gold price of $400/oz in 2005 constant dollars for the IDP.

Silver price has tracked gold price upwards in the last year, but its largest market, photographic film, is being constantly eroded by the rising popularity of digital photography. IMMI has selected a silver price of $6.00/oz in 2005 constant dollars for the IDP.

During 2004 and 2005, IMMI held commercial discussions with five Chinese smelters that are favourably located to receive copper concentrate from Oyu Tolgoi. All have indicated a strong desire to purchase concentrate. One, Jiangxi Copper Co. Ltd., signed a Memorandum of Understanding with Ivanhoe Mines in June 2004. In total, these five smelters could purchase 500,000 dmt per year; commercial discussions will continue. IMMI will also continue to monitor the future development of other smelters that would make sense geographically for consumption of Oyu Tolgoi concentrate.

Figure 19-19: China s Sources vs. Consumption for Refined Copper until 2010

Sources: Antaiki, Brook Hunt, ICSG, various corporate reports

19.18 Project Economics

19.18.1 Summary of Results

The following economic evaluation uses, in part, Inferred resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves and, accordingly, there is no certainty that this economic evaluation will be realized.

A detailed financial model was developed for two operating scenarios: the Phase 1 base case and Phase 2 expanded case. The cases were analyzed at discount rates of 10% and 8%.

The net present value (NPV) of the base case at a discount rate of 10% is $1,979 million before tax and $1,513 million after tax. At a discount rate of 8%, the NPV is $2,855 million before tax and $2,221 million after tax. The internal rate of return (IRR) of this case is 19.25% after tax, and the payback period is 5.8 years. Total cash cost after gold credits over the life of the project is $0.39/lb. During the first five years, the cash cost is substantially lower, at $0.29/lb, reflecting the high gold grade in the Southwest deposit.

The NPV of the expanded case at a discount rate of 10% is $2,388 million before tax and $1,852 million after tax. At a discount rate of 8%, the NPV is $3,434 million before tax and $2,706 million after tax. The IRR of this case is 19.75% after tax, and the payback period is 6.53 years. Total cash cost, after gold credits over the life of the project is $0.40/lb.

Gold hedging of early year production would increase the presented NPVs (8% and 10% discounted rates) by more than $200 million at a gold price of $550 for the first 6 years. The high gold content in those years is sourced from the Southwest deposit and therefore the improvement in value is similar for both the base and expanded cases.

19.18.2 Basis of Analysis

Pre-tax and after-tax models were constructed using a base copper price of $1.00/lb and base gold price of $400/oz. No factors were applied for escalation or inflation of operating costs, capital costs, or metal prices. The model is based on 100% equity financing. All costs are expressed in U.S. dollars, with no provision for exchange rate variation. NPV was calculated from the fourth quarter of 2005. The evaluation covers the period from October 2005, the anticipated project decision date, through a 33-month development and construction stage, to the end of the operating life of each case.

Expenditures to date and those anticipated to 1 October 2005, including the drilling and exploration program for the Hugo North shaft, are treated as sunk costs and are excluded from this analysis. These costs total $175 million. Expenditures during the period 1 October 2005 to 30 September 2006 are not discounted. Therefore, the first discounted year is 1 October 2006 to 30 September 2006.

The fiscal regime used to estimate the project cash flow is based on information currently available and incorporates the draft terms of the Special Stability Agreement currently being negotiated with the Government of Mongolia.

Table 19-6: NPV ($ million) After Tax @ 10% Discount Rate

Cu Price			Gold Price ($/oz)		
($/lb)	350	375	400	425	450
Phase 1 Base Case					
0.80	536	592	649	706	763
0.90	966	1,024	1,081	1,138	1,196
1.00	1,399	1,456	***1,513***	1,571	1,628
1.10	1,831	1,888	1,945	2,003	2,060
1.20	2,263	2,320	2,378	2,435	2,492
Phase 2 Expanded Case					
0.80	622	689	756	823	892
0.90	1,166	1,234	1,303	1,371	1,440
1.00	1,715	1,784	***1,852***	1,920	1,988
1.10	2,260	2,328	2,396	2,464	2,532
1.20	2,803	2,871	2,939	3,008	3,076

Table 19-7: NPV ($ million) After Tax @ 8% Discount Rate

Cu Price			Gold Price ($/oz)		
($/lb)	350	375	400	425	450
Phase 1 Base Case					
0.80	1,003	1,069	1,136	1,204	1,272
0.90	1,543	1,611	1,678	1,746	1,814
1.00	2,085	2,153	**2,221**	2,288	2,356
1.10	2,627	2,695	2,763	2,830	2,898
1.20	3,169	3,237	3,305	3,372	3,440
Phase 2 Expanded Case					
0.80	1,162	1,242	1,322	1,403	1,484
0.90	1,849	1,931	2,013	2,094	2,176
1.00	2,543	2,625	**2,706**	2,787	2,869
1.10	3,230	3,312	3,393	3,474	3,556
1.20	3,917	3,998	4,080	4,161	4,242

Table 19-8: Basic Production Data Life-of-Mine Average/Total

	Unit	Base Case	Expanded Case
Ore Milled			
Rate	Mt/a	30	44.1
Total	Mt	1.207	1.553
Grade			
Copper	%	1.20	1.14
Gold	g/t	0.34	0.30
Project Life	years	40	35
Strip Ratio		1.62	1.71
Concentrate			
Production	Mt/a (dry)	1.0	1.4
Grade			
Copper	%	31.9	31.7
Gold	g/t	7.74	7.21
Metal Produced			
Cu in Concentrate	Mt	13.2	16.0
Au in Concentrate	M oz	10.3	11.7
Ag in Concentrate	M oz	68.8	82.0
Total Cash Costs for Cu*			
after gold credits	$/lb Cu	0.39	0.40
before gold credits	$/lb Cu	0.53	0.53
Treatment & Refining			
Charges for Payable Cu	$/lb Cu	0.21	0.21

* includes treatment & refining, realization & transport costs

Smelter Terms

IMMI anticipates that all concentrate produced in Phase 1 will be sold to smelters in China. Realization costs comprise treatment and refining charges from smelters plus concentrate transport. In Phase 2, concentrate sales will likely extend to smelters outside of China. The same terms were adopted for both cases in the financial analysis.

Table 19-9: Smelter Terms

Description	Unit	Value
Payable		
Copper payment	%	96.5
Minimum deduction	% Cu	1
Gold payment:		
1 to 3 g/t	%	90
3 to 5 g/t	%	92
5 to 10 g/t	%	95
10 to 15 g/t	%	96
15 to 20 g/t	%	97
20 g/t +	%	98
Minimum payment level for Au	g/t	1.00
Silver payment:		
Full silver content	%	90
Minimum payment level for Ag	g/t	30.00
Treatment Charge		
Rate of charge	$/wmt	75.00
Smelter price participation	%	10
Base price for participation	$/lb Cu	0.90
Refining Charges		
Base copper refinery charge	$/lb	0.075
Rate for recovered gold	$/oz Au	6.00
Rate for recovered silver	$/oz Ag	0.45
Penalties		
Arsenic:		
Penalty threshold	%	0.3
Penalty per 0.1%	$/dmt	2.00
Rejection level	%	0.5
Fluorine:		
Penalty threshold	ppm	300
Penalty per 100 ppm	$/dmt	2.00
Rejection level	ppm	1,000
Concentrate Transport		
Rail/Truck Transport Years 1 to 3	$/wmt	38.17
Rail Transport after Year 3:		
First 500 kt	$/wmt	20.15
500 kt to 1.5 Mt	$/wmt	21.48
Above 1.5 Mt	$/wmt	37.93

19.18.3 Special Stability Agreement (SSA)

The current form of the SSA, unchanged since January 2005, addresses a range of conditions under which IMMI XXK will construct and operate the mine. This agreement essentially represents the main Mongolian legislation currently applicable for Oyu Tolgoi:

- General Law of Taxation of Mongolia
- Foreign Investment Law of Mongolia

Minerals Law of Mongolia

Business Entity and Organization Income Tax Law of Mongolia

The financial analysis required the interpretation of certain clauses with regard to four main legislative provisions:

Period of Concessional Taxation

From the commencement of production, the investor shall be exempted from the corporate income tax for five years and will have a 50% exemption for the following 5 years.

The operating life of the Oyu Tolgoi mine begins with a ramp-up period in 2008 and reaches nameplate capacity in 2009. The model treats 2009 as the year of commencement of production.

Investment Allowance

If the investor reinvests to its entity from its applicable income, its taxable income shall be subject to a deduction equivalent to the amount of such reinvestment.

In the model, reinvestment is considered to cover all capital expenditure in a given year to the limit of the amount of taxable profit determined in the preceding year. This provision is treated as a separate item from depreciation, which continues to be calculated as per the legislation. Claiming the investment allowance does not reduce the taxable base of the asset.

Carry Forward of Tax Losses

Tax losses can be carried forward for a three-year period.

Application of this provision to mining remains unclear. In the models prepared for this analysis, the tax loss carry forward provision had no impact on the results.

Customs and VAT Exemptions

Customs duty and VAT are exempt for a specific list of construction items.

The models assume that most items on the initial capital investment schedule will be exempt under these provisions. Allowance has been made for customs duty to be payable at a rate of 5% on a number of limited construction items. Customs duty is calculated separately on operating costs and is disclosed as a G&A cost once production commences. VAT is calculated on a similar basis but at a rate of 15% and is disclosed in working capital. Successful conclusion of current discussion with the Mongolian government is required to achieve the values assessed in the IMMI model.

Other Fees and Taxes

Sales Royalty is calculated at 2.5% of net sales.

Immovable Property Tax is calculated at 0.6% of the written-down value of immovable property each year. Immovable property was assumed to comprise the capital expenditure category that depreciates over 40 years.

Calculation of Corporate Tax was based on current legislation applicable to the metallurgy industry, which provides for a tax holiday for the first five years of operations, following by a further five years at half the corporate tax rate. The first year was taken to be 2009, the first full year of production. Beyond Year 10, corporate tax will be paid at the full rate of 30% of taxable income.

19.18.4 Capital Cost Estimate

The base date for the estimate is second quarter 2005. All costs are expressed in U.S. dollars with no allowance for escalation. The initial capital estimates for components other than the underground mine were developed to a prefeasibility level with an expected accuracy range of -5% to +20%.

Table 19-10: Summary of Capital Costs over Mine Life ($M)

Item	Phase 1 Base Case	Phase 2 Expanded case
Initial Capital (prior to first mill feed)		
Open pit	75.1	
Process plant	230.1	
Tailings storage facility	31.4	
On-site infrastructure	114.8	
Off-site infrastructure	98.8	
Indirects	195.8	
Owner s cost (incl. pre-strip)	175.2	
Contingency	120.2	
Escalation	55.2	
Underground mine	232.2	
Subtotal	1,328.8	1,328.8
Ramp-up	*51.1*	*51.1*
Future Capital		
Open pit		
Process plant	38.4	228.9
Tailings storage facility		21.0
On-site infrastructure	38.3	71.0
Off-site infrastructure		59.9
Indirects	28.3	171.0
Underground mine	728.7	1,211.9
Subtotal	833.7	1,763.7
Sustaining Capital		
Open pit	35.8	74.5
Process plant	79.8	132.8
Tailings storage facility	158.4	269.9

On-site infrastructure	38.3	40.1
Off-site infrastructure		
Indirects		
Underground mine	1,519.5	1,865.8
Closure		50.0
Subtotal	1,831.8	2,432.9
Total incl. Initial Capital	4,059.5	5,576.5

Initial Capital

Initial capital includes the cost of constructing the open pit, concentrator, and infrastructure components of the project. A program was implemented during preparation of the IDP to include China value in the initial capital cost estimates. Pricing was obtained from Chinese firms based on schedules of quantities provided by AAJV and analyzed to developed unit rates.

Initial capital also includes construction of the Hugo North underground Shafts 1 and 2 and associated surface works.

Future Capital

In the base case, expenditure continues on underground development after ore feed to the mill commences. Additional capital is also spent on the processing plant and infrastructure to meet the higher throughput rates associated with underground mining.

In the expanded case, work also begins on development of the Hugo South underground mine, and more capital is required for the process plant and infrastructure.

Sustaining Capital

Sustaining capital is included in the analysis in each subsequent year following the major capital expenditure periods. The most significant item in sustaining capital is expansion of the tailings dam facility.

19.18.5 Operating Costs

Operating costs were separated into mining, processing, and G&A costs. The detailed costs were supplied by AAJV for processing and G&A, by GRD Minproc for open pit mining, and by McIntosh for underground mining.

Table 19-11: Operating Costs

Area	Phase 1	Phase 2
Unit Costs ($/t)		
Mining $/t ore mined		
Open Pit Mining	2.11	2.39
Strip Ratio	*1.62*	*1.71*
UG Mining Hugo North	2.17	2.16
On-Site Costs		
Mining average all sources	2.16	2.28
Process	2.61	2.53
G&A	1.09	0.78
Customs Duties	0.05	0.01
Immovable Property Tax	0.03	0.02
Total Unit On-Site Costs	5.94	5.62
Total Operating Costs ($M)		
Total Site Operating Costs	7,182	8,725
Mongolian Government Royalty	662	791
Concentrate Transport Costs	1,006	1,375
Treat./Ref. Charges/Penalties	5,963	7,200
Total Operating Costs	14,813	18,091

Figure 19-20: Phase 1 Base Case Cumulative Cash Flow ($/lb Cu, $/oz Au)

Figure 19-21: Phase 2 Expanded Case Cumulative Cash Flow ($/lb Cu, $/oz Au)

19.19 Opportunities

Further Resources

IMMI has identified further opportunities for mining developments on the adjacent claim to the north owned by Entrée Gold Ltd., as reported in a June 2005 disclosure statement by Ivanhoe Mines.

Initial drilling results confirm the presence of additional high-grade mineralization. IMMI has recently concluded an Earn-In-Agreement with Entreé. This represents a good opportunity to expand the resource, possibly by developing a separate high-grade underground operation.

Smelting

The IDP uses a base treatment charge of $75 /wmt of concentrate. After price participation, this escalates to $82.50. Transportation costs for concentrate range from $21 to $38 /wmt, depending on destination and transportation method.

To increase value and/or reduce risk, evaluation of the possible benefits of a dedicated smelter at or near the site is warranted. If a dedicated smelter is demonstrated to be advantageous, then optimization of metal recoveries and concentrate grades to suit the revised treatment and transportation conditions should be considered.

With a smelter providing a nearby source of sulphuric acid, it could be advantageous to process the low-grade resource identified in the Southwest pit in a heap leach operation. The amenability of this material for heap leaching should be evaluated.

High Density Tailings

The combined use of high-compression thickeners to increase the deposition density of tailings and of decant towers to reduce the size of the tailings pond area has the potential to reduce make-up water requirements and operating costs.

Concentrator Capacity

The results of throughput determinations by means of lab test simulations and SAG mill pilot-plant testing were discounted 10% for operational contingency and potential sample set bias. The IDP process plant design may have additional capacity without the need for further capital expenditure.

Additionally, the grinding circuit of the expanded case plant has a nominal capacity of 170,000 t/d for Hugo ores. This may permit a further plant expansion to be made at a modest cost.

Gold Hedging

Although not included as a basis of the financial analysis, the project $NPV_{8 \& 10}$ would increase, for both the base and expanded cases, by more than $200 million if gold production for the first six years was hedged at $550/oz. As IMMI explores funding alternatives for the project, investigation from specific conditions necessary to realize a benefit from gold hedging should be assessed.

Open Pit Mineable Resources

The expanded case includes four open pit stages out of a potential nine. Mine planning has identified 879 Mt within pit shells, but the expanded case includes only 245 Mt of Southwest resource. Central and Hugo South both remain as a potential open pit feed sources for different production schedule options.

19.20 Sensitivity Analysis

An analysis was performed to assess the sensitivity of after-tax NPV and IRR to changes in a number of key parameters. Each parameter was assessed on its own while holding base conditions for all other parameters, not in combination. Combined beneficial or adverse changes in parameters could have more (or less) marked effects on the returns from the project than individual variations. The sensitivity of each case to variations in key parameters is summarized in Table 19-12.

Table 19-12: Sensitivity Analysis*

Parameter	Base Value	Change	IRR Change (%)	NPV_8 Change ($M)	NPV_{10} Change ($M)
Base Case					
Gold Price	$400/oz	± $25/oz	0.4	68	57
Copper Price	$1.00/lb	± $0.05/lb	1.2	271	216
Initial Capital	1.274 M	± 10%	1.3	116	113
Site Operating & Transport	$6.78/t	± 10%	0.9	183	149
Smelter Charges	$75/wmt, $0.075/lb	± $10/wmt, $0.01/lb	0.4	93	74
Copper Recovery	90.8% (avg)	± 1% point	0.2	50	40
Power Cost	$0.0426/kWh	± 10%	0.2	46	36

Parameter	Base Value	Change	IRR Change (%)	NPV_8 Change ($M)	NPV_{10} Change ($M)
Expanded Case					
Gold Price	$400/oz	± $25/oz	0.4	81	68
Copper Price	$1.00/lb	± $0.05/lb	1.2	346	274
Initial Capital	1.274 M	± 10%	2.1	116	113
Site Operating & Transport	$6.50/t	± 10%	1.0	241	195
Smelter Charges	$75 /wmt, $0.075/lb	± $%, $0.01/lb	0.4	120	94
Copper Recovery	89.7% (avg)	± 1% point	0.2	62	49
Power Cost	$0.0426/kWh	± 10%	0.2	58	46

* This assessment includes the use of Inferred resources that are considered too speculative geologically to have economic considerations applied to them that would enable them to be categorized as a Mineral Reserve. Inferred resources will require further exploration before they can be upgraded to the higher Measured and Indicated categories.

Although the assumptions underlying the preliminary assessment are considered reasonable, there is no certainty that the predicted results will be realized.

The project is particularly sensitive to changes in the price of copper and operating costs. It is also quite sensitive to changes in initial capital cost and copper recovery. The project is far less sensitive to changes in gold price or power cost. The results reflect the fact that copper provides more than 85% of the gross metal value of the project.

SECTION 20 CONCLUSIONS AND RECOMMENDATIONS

20.1 Geology QP: Steve Blower

Four deposits are known in the Southern Oyu system:

The Southwest deposit consists primarily of pyrite-chalcopyrite mineralization related to biotite-magnetite alteration, overprinted by chlorite-sericite alteration. Mineralization is characterized by high gold contents with Au:Cu ratios (ppm:%) of about 1:1 in the main part of the deposit, rising to 3:1 in the core of the system and at depth. Gold in the Southwest Oyu deposit is closely associated with chalcopyrite and occurs intergrown with chalcopyrite, as inclusions and fracture infills within pyrite, or on grain boundaries of pyrite. The deposit is essentially hosted in augite basalts.

South deposit mineralization is hosted in quartz monzodiorite in the southwest and basalt throughout the central portion of the deposits. Chalcopyrite is the principal copper sulphide, but in higher-grade areas bornite locally exceeds chalcopyrite. Alteration in basaltic rocks consists of chlorite, biotite, hematite / magnetite, and weak sericite. Quartz monzodiorite contains advance argillic alteration. Small zones with elevated gold values occur locally.

Mineralization in the Central deposit is characterized by an upward-flaring high-sulphidation zone that overprints and overlies porphyry-style chalcopyrite-gold mineralization. A secondary enriched supergene chalcocite blanket tens of metres in thickness overlies the high-sulphidation covellite-pyrite zone. The high-sulphidation portion of the Central Oyu deposit contains a mineral assemblage of pyrite, covellite, chalcocite/digenite, enargite, tennantite, cubanite, chalcopyrite, and molybdenite. Dominant host rocks are dacite tuff and quartz monzodiorite. Higher-grade mineralization is associated with disseminated and coarse-grained fracture-filling sulphides in zones of intensely contorted quartz stockwork veins and anastamosing zones of hydrothermal breccias. Chalcopyrite-gold mineralization is dominant on the south and western margins of Central within either basalt or quartz monzodiorite adjacent to intrusive contacts with basalt. The high-sulphidation part of the Central deposit lacks significant gold. Alteration in the Central deposit shows a close spatial relationship to mineralization and original host lithology. Biotite-chlorite and intermediate argillic alteration coincide with chalcopyrite-gold mineralization within basalt. Advanced argillic and sericite alteration coincide with the high-sulphidation mineralization within quartz monzodiorite and ignimbrite.

The Wedge deposit contains a zone of high sulphidation mineralization hosted principally in dacite tuff, grading downward and southward into chalcopyrite mineralization in basalt and quartz monzodiorite host rocks. High-sulphidation mineralization consists of pyrite, chalcopyrite, bornite, enargite, covellite, and primary chalcocite in advanced argillically altered host rocks. The high-sulphidation mineralization grades downward into chalcopyrite, with lesser bornite within basalt host rocks, and pyrite + chalcopyrite mineralization in quartz monzodiorite. Gold is absent, except locally in drill holes adjacent to the South Fault.

The geologic characteristics of the Hugo Dummett deposit are summarized as follows:

The highest-grade copper mineralization in the Hugo Dummett deposit is related to a zone of intense stockwork to sheeted quartz veins. The high-grade zone is centred on thin, east-dipping quartz monzodiorite intrusions or within the upper part 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 in its high gold (ppm) to Cu (%) ratios (0.5:1). Bornite is dominant in the highest-grade parts of the deposit (3% to 5% Cu) and is zoned outward to chalcopyrite (2%). At grades of <1% Cu, pyrite-chalcopyrite ± enargite, tennantite, bornite, chalcocite, and rarely covellite occur, hosted mainly by advanced argillically altered dacite tuff.

Elevated gold grades in the Hugo North deposit occur within the up-dip (western) portion of the intensely veined high-grade core, and within a steeply dipping lower zone cutting through the western part of the quartz monzodiorite. Quartz monzodiorite in the lower zone exhibits a characteristic pink to buff colour, with a moderate intensity of quartz veining (25% by volume). This zone is characterized by finely disseminated bornite and chalcopyrite, although in hand specimen the chalcopyrite is usually not visible. The sulphides are disseminated throughout the rock in the matrix as well as in quartz veins. The fine-grained sulphide gives the rocks a black sooty appearance. The red colouration is attributed to fine hematite dusting, mainly associated with albite.

The Hugo Dummet deposit is characterized by copper-gold porphyry and related styles of alteration. This includes biotite-K-feldspar (K-silicate), magnetite, chlorite-muscovite-illite, albite, chlorite-illite-hematite-kaolinite (intermediate argillic), quartz-alunite-pyrophyllite-kaolinite-diaspore-zunyite-topaz-dickite (advanced argillic), and sericite/muscovite zones.

Resource Estimation

The database used to estimate the mineral resources for the Oyu Tolgoi project consists of samples and geological information from core drill holes, some of which are daughter holes drilled from a parent. The holes were drilled by Ivanhoe between 2002 and April 2005. Data transfer to the resource database was validated from original assay certificates through a 5% check of the database.

Ivanhoe employs a comprehensive QA/QC program. Each sample batch of 20 samples contains four or five quality control samples. The quality control samples consist of one duplicate split core sample and one uncrushed field blank, which are inserted prior to sample preparation; a reject or pulp preparation duplicate, which is inserted during sample preparation; and one or two reference material samples (one <2% Cu and one >2% Cu if higher-grade mineralization is present based on visually estimates), which are inserted after sample preparation. AMEC reviewed Ivanhoe s QA/QC procedures at site and found them to be strictly adhered to. Duplicate performance of core, coarse reject, and pulp duplicates was evaluated by AMEC and found to be well within the respective accepted ranges. The current Ivanhoe QA/QC program exceeds industry standards and demonstrates that the assay process for the Southern deposits samples is in control.

The Oyu Tolgoi resource models were developed using industry-accepted methods. AMEC validated the model estimates and found them to reasonably estimate grade and tonnage for the Southern deposits.

The mineral resources of the Oyu Tolgoi project were classified using logic consistent with the CIM definitions referred to in National Instrument 43-101. The mineralization of the project satisfies sufficient criteria to be classified into Measured, Indicated, and Inferred mineral resource categories.

20.2 Open Pit Mining QP: Bernie Peters, Allan Haines

The open pit design work was performed by GRD Minproc Limited, focusing on the Southern Oyu deposits.

The open pit provides feed to the plant as the underground mine ramps up to full production. The open pit mine plan is based on a mineable resource of 126 Mt of Measured and 752 Mt of Indicated material (total of 878 Mt in pit shells that may be suitable for open pit mining). The production schedule includes a total of 123 Mt of open pit feed in the base case and a total of 245 Mt of open pit feed in the expanded case.

Timing of the availability of the resource models and metallurgical parameters has meant that the pit designs are based on optimizations of models, NSR calculations, and throughput schedules that are not those of the final IDP. Optimization work has shown that the pit shells are similar to those developed for the IDP. Updating of the pit designs based on the most current resource models and updated metallurgical parameters should be part of further work.

The open pit plan in the IDP is based on diesel-powered shovels. If the operating life of the open pit were to be extended, then the use of electric-powered equipment may provide an opportunity to improve the overall project efficiency. If the open pit is to be limited to the stages in the IDP, then contract mining may be of benefit; this should be examined further in the next stage of study.

IMMI is currently undertaking a tender process for MARC (maintenance and repair contract) on the open pit equipment. This should be completed.

Key geotechnical design parameters were provided by SRK Consulting based on extensive geotechnical studies.

Because Oyu Tolgoi is in an arid area with very low rainfall, no significant acid rock drainage (ARD) issues are expected. The base of the waste rock dumps will be sealed by working the subsurface clay materials. Potentially acid forming (PAF) waste material will be encapsulated within non-acid-forming (NAF) material, and the final dump surfaces will be capped with rock armouring. This methodology will be suitable for progressive construction and rehabilitation of the dumps.

20.3 Underground Mine Development QP: Scott McIntosh, Jarek Jakubec

McIntosh s assessment for the IDP is based on the results of exploration and development drilling to March 2005, from which IMMI and AMEC derived the currently defined resource tonnage and grades. SRK Consulting (Canada) reviewed geotechnical data and conducted the necessary geotechnical analyses of data collected and collated from all drill core. SRK s findings are supportive of the block-cave mining method and integral to McIntosh s assessment.

Presuming that the current defined resource tonnages and grades are substantiated during underground development and operatio